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)
Clinton Power Station	0 5 0 0 0 4 6 1	1 OF 0 9

TITLE (4) Relay Misapplication Causes Contact Oxide Buildup and Loss of Control Signal Resulting in Reactor Scram During Feedwater Pump Shift

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 6	2 4	8 8	8 8	0 1 7	0 1	0 9	1 2	8 8	None	0 5 0 0 0
										0 5 0 0 0

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

OPERATING MODE (9): 1
POWER LEVEL (10): 0 6 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)	X OTHER (Specify in Abstract below and in Text, NRC Form 366A) 10CFR21.21
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	
R. D. Freeman, Manager-Nuclear Station Engineering Department X3538	2 1 7	9 3 5 - 8 8 8 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
B	J B	R L Y	A 3 4 8	N	B	B R	R L Y	A 3 4 8	N
B	I J	R L Y	A 3 4 8	N	B	B H	R L Y	A 3 4 8	N

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE)	X NO	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR

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

ABSTRACT

On June 24, 1988, an Agastat GP relay failed while a Control Room Operator (CRO) was shifting the feedwater system from two turbine-driven reactor feedwater pumps (TDRFP) on the Master Controller to the "A" TDRFP in manual and the "B" TDRFP on the Startup Level Controller (SULC). As a result, a "Control Signal Failure" alarm annunciated and the SULC would not stay in automatic. The "B" TDRFP flow decreased. The CRO attempted to gain control of reactor water level but was unsuccessful. As a result, when reactor water level decreased to the Level 3 scram setpoint, an automatic reactor scram occurred. The root cause of this event is attributed to a design error by General Electric. The Agastat relay was inappropriate for the low current application in the feedwater control system logic circuitry. Because of this misapplication, a buildup of oxide occurred on the relay contacts resulting in the interruption of the circuit and a loss of the control signal. Corrective actions include determining other susceptible relay applications, cleaning and testing or replacing and testing all susceptible relay contacts, and periodically testing the contact resistance. This report includes information required under the provisions of 10CFR21 relating to similar relay defects in the leak detection system.

NRC Form 366B
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES 8-31-88

LICENSEE EVENT REPORT (LER) FAILURE CONTINUATION

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
Clinton Power Station	0 5 0 0 0 4 6 1	8 8	— 0 1 7	— 0 1	0 2 OF 0 9

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	C E	R L Y	A 3 4 8	N							
B	D F	R L Y	A 3 4 8	N							

NRC FORM 366B
(9-83)

DESCRIPTION OF EVENT

On June 24, 1988, at approximately 2310 hours, with the plant in Mode 1 (POWER OPERATION), at approximately 60% reactor [RCT] power, an automatic reactor scram occurred when the reactor water level decreased to the Level 3 scram setpoint because of a failure in the feedwater control system [JB]. The scram occurred while a control room operator (CRO) was removing the "A" turbine [TRB] driven reactor feedwater [SJ] pump [P] (TDRFP) from service for corrective maintenance.

To secure the "A" TDRFP for maintenance, the CRO was shifting the feedwater system from a configuration of two TDRFPs on the Master Controller [FIK] to a configuration of one TDRFP in manual and one TDRFP on the Startup Level Controller. The CRO first placed both TDRFPs in manual. The "B" TDRFP was shifted to the manual mode of the Startup Level Controller and then to the automatic mode of the Startup Level Controller. The CRO noted that the reactor water level started increasing. A "Control Signal Failure" alarm annunciated. The CRO noticed that the Startup Level Controller had shifted back to manual; he attempted to place it back in automatic but it would not stay. The "B" TDRFP flow decreased. The CRO attempted to gain control of the reactor water level using both the Startup Level Controller and the individual Pump Loop Flow Controllers in the manual pushbutton mode but he was unsuccessful. As a result, the reactor water level decreased to Level 3 (approximately +9 inches) and a reactor scram occurred. Both reactor recirculation (RR) system [AD] pumps automatically tripped from fast speed (as designed) due to low feedwater flow cavitation interlocks.

After the scram, the reactor water level dropped 43 more inches and then turned upward (before reaching Level 2, approximately -45 inches) to reach Level 8 (+60 inches). The "A" RR pump shifted to slow speed while the "B" RR pump, as a consequence of its start logic, did not pick up in slow speed. The "B" RR pump was later manually started in slow speed. A review of the RR system design determined that the "B" RR pump responded properly to the plant conditions at the time of this event.

Reactor water level stabilized at approximately 2313 hours. Stable plant conditions were achieved by approximately 2350 hours. Following the scram, the plant entered Mode 3 (HOT SHUTDOWN).

An investigation was initiated to determine the immediate cause of the reactor scram. On the morning of June 25, Control and Instrumentation (C&I) technicians determined that the feedwater control system failure was caused by relay [RLY] contact failure in the Startup Level Controller circuitry (1C34-K28 relay). This failure prevented the "B" TDRFP from receiving a control signal during the feedwater control system realignment. The investigation also determined that the CRO had conducted the TDRFP shift in accordance with the system procedure.

At 0030 hours on June 26, a spare relay was tested to determine its operability prior to installation in the 1C34-K28 relay location. The relay was determined to have relatively high resistance between the contacts. At 0230 hours on June 26, after testing approximately fifty spare relays with a Fluke Model 8062 multimeter and finding that the relays had relatively high contact resistance (30 ohms to 3 megohms) caused by contact oxidation, the relay contact problem was determined to be a generic concern. Subsequent testing of some of the same relays and of some additional relays with a Biddle Model 247350 digital low resistance ohmmeter gave much lower resistance readings (12-16 milli-ohms). These readings were on the order of the resistance parameters of the purchase part drawing. The variance between the resistance values obtained by using the Fluke and the Biddle instruments is consistent with the difference in applied current of the two devices. (The Fluke uses a lower than one milliampere current while the Biddle applies a greater than one ampere current when measuring resistance through the relay contacts.) C&I technicians mechanically cleaned the contacts on one of the spare relays to obtain zero contact resistance and then installed the relay in the 1C34-K28 relay location. At 0330 hours on June 26, post maintenance testing of the 1C34-K28 relay installation was successfully completed. This testing consisted of shifting the Startup Level Controller from automatic to manual several times.

The reactor reached criticality in Mode 2 (STARTUP) at 0420 hours on June 26. No failures of the feedwater control system were observed during the reactor startup or subsequent power ascension.

No other automatic or manually initiated safety system responses were necessary to place the plant in a safe and stable condition. No other equipment or components were inoperable at the start of this event such that their inoperable condition contributed to this event.

CAUSE OF EVENT

The failure of relay 1C34-K28 was caused by oxide buildup on its contact surfaces. Oxidation of relay contacts is a common occurrence. Normally this oxidation is removed by the electrical arcing of the contacts and the wiping action of the relay contact arm. For relay 1C34-K28, the voltage and current levels are too low to cause arcing, and the relay is normally used only every two or three months, therefore, the wiping action does not occur often enough to be effective in removing oxide buildup. The combination of these factors allowed oxide to build up to the point where the relay contact failed to conduct the applied circuit current/voltage when the contact closed.

The root cause of this event is attributed to a design error by General Electric Company (GE). GE specified Agastat, Type GP relays for low current applications in the feedwater control system logic circuitry. Agastat, Type GP relays are nominally rated for one to ten amperes and are not appropriate for controlling the one to twenty-five milliampere currents present in the solid state circuitry of the feedwater control system.

Based on discussions with Amerace Corporation (the relay manufacturer), GE (the Nuclear Steam Supply Systems Supplier), and Sargent and Lundy (the Architect/Engineer), on a review of relay specifications, and on results of local testing, the Agastat, Type GP relays are considered suitable and reliable for the following applications:

1) Predominantly resistive loads with load current greater than 1 ampere at 120 volts alternating current (VAC) or 125 volts direct current (VDC).

2) Inductive loads with load current greater than 50 milliamperes at 120 VAC or 125 VDC.

Agastat, Type GP relays used in applications with lower voltage-current combinations must be considered susceptible to failure caused by the buildup of oxide on the contact surfaces. However, the degree of vulnerability depends on the actual circuit conditions and whether the contacts are normally closed or open (i.e., once a contact is conducting current, interruption from oxide buildup is unlikely; whereas, normally open contacts which function by completing a circuit are more vulnerable to this failure mechanism).

CORRECTIVE ACTION

Since a permanent resolution of the contact oxidation problem was not immediately established and relay 1C34-K28 had the potential to oxidize again (resulting in a high resistance condition), a caution tag was placed on the Startup Level Controller. This caution tag would prevent non-emergency use of the controller and would ensure that, prior to the next scheduled plant shutdown, the relay was checked for proper resistance. The caution tag was removed when mechanical cleaning of the relay contacts was determined to be an adequate permanent resolution to the oxidation problem of relay 1C34-K28.

Spare Agastat, Type GP relays were placed in a "hold" status which required them to be evaluated by engineering prior to being released for use. These relays will be released for use or returned to stock following mechanical or electrical cleaning and testing of the contacts. The acceptance criteria established for the testing is a contact resistance of 150 milli-ohms or less as measured with a Hewlitt Packard HP-3468A multimeter, or equivalent.

As a result of the generic implications of the Agastat, Type GP relay failure in the non-safety-related Startup Level Controller, both safety-related and non-safety-related applications of this relay required review to ensure operability. All applications of Agastat, Type GP relays at Clinton Power Station have been reviewed to determine the loads on the relay contacts and to identify those relays used in low current and voltage applications where an increase in contact resistance could interrupt or prevent current flow and result in a failure to perform safety-related functions affecting plant operability, or non-safety-related functions affecting either plant availability or important functions. The applications review of nuclear steam supply systems was performed by GE. The applications review of balance of plant systems was performed by Sargent & Lundy. These reviews identified that forty-nine installed relays were susceptible to the contact oxidation problem. Thirty of these relays are commercial grade items used in non-safety-related applications. The remaining nineteen relays are used in safety-related applications. Sixteen of these safety-related relays are used in the Leak Detection System [IJ], two are used in the Standby Liquid Control System [BR] and one is used in the Standby Gas Treatment System [BH].

The safety functions of eight of the nineteen safety-related relays were determined to be potentially impacted by the contact oxidation problem. These eight relays (four per division) are located in the Leak Detection System and are associated with isolation of the Reactor Core Isolation Cooling System [BN] (RCIC). As a result of this potential impact, at 1350 hours on July 3, RCIC system containment isolation valves [ISV] 1E51-F031, 1E51-F064, 1E51-F063 and 1E51-F076 were declared inoperable as a precautionary measure, pending a determination of the operability of the relays in their leak detection system application. The RCIC system was declared inoperable when these four isolation valves were closed.

The contacts of the leak detection system relays were tested for resistance, and four relays in Division I were found to have resistance on the order of one ohm. A subsequent functional test of these relays (a simulated trip signal was passed through the relay contacts) was performed with satisfactory results, and the relays were determined to be operable. These relays operate at a higher voltage (125 VDC) and current (approximately 24 milliamperes) than the relay 1C34-K28 in the feedwater control system (24 VDC at less than 1 milliampere). Although the circuit current for the relays is less than the manufacturer's recommendation, the higher voltage and current levels significantly decrease the probability of failure. To ensure continued reliability of the eight leak detection system relays, the contacts of these relays will be functionally tested monthly. Since the safety functions of the other eleven safety-related relays are not impacted, these relays do not require the monthly functional testing of their contacts.

The permanent resolution for all nineteen safety-related relays will consist of electrically cleaning and testing each relay or installing new, tested relays to replace the existing nineteen. These cleaning/replacing activities will be performed by Illinois Power (IP). The acceptance criteria established for the relay testing is a contact resistance of 150 milli-ohms or less as measured with a HP-3468A multimeter, or equivalent. Once these relays have been cleaned/replaced, the acceptance criteria will be reverified every eighteen months.

This permanent resolution is expected to be completed by the end of the plant's first refueling outage. This outage is currently scheduled to begin in January, 1989.

The permanent resolution for the thirty non-safety-related relays is as follows:

1. Twenty Feedwater Control System relays (includes 1C34-K28) and two Filter Demineralizer System [CE] relays

   ° Prior to the end of the plant's first refueling outage, IP will electrically or mechanically clean and test the installed relays or replace them with new, tested relays. The acceptance criteria for the relay testing is contact resistance of 150 milli-ohms or less as measured, with a HP-3468A multimeter, or equivalent. Relay 1C34-K28 was previously replaced with a spare relay that was mechanically cleaned and tested, therefore, this relay is acceptable.

   ° Once these relays have been cleaned/replaced, the acceptance criteria will be reverified every eighteen months.

2. Two Fuel Handling System [DF] relays

   ° Prior to beginning fuel handling during the plant's first refueling outage, IP will electrically or mechanically clean and test the installed relays or replace them with new, tested relays. The acceptance criteria for the relay testing is the same as described in item 1 above.

   ° Once these relays have been cleaned/replaced, the acceptance criteria will be reverified prior to each subsequent refueling outage.

3. Six Miscellaneous Ventilation System relays

   These relays are part of the Warehouse Ventilation System. Maintenance of these relays is performed by a contractor. The contractor will be informed of the operational concern associated with these relays.

In addition to the permanent resolutions for the forty-nine relays, prior to the plants second refueling outage, the IP Nuclear Station Engineering Department will determine the availability of alternate relays that are designed for low current applications and will evaluate the feasibility of replacing the existing relays with the alternate design.

ANALYSIS OF EVENT

This event is reportable under the provisions of 10CFR50.73(a)(2)(iv) because of a condition that resulted in an automatic actuation of the reactor protection system [JC].

Assessment of the safety consequences and implications of this event indicates that this event was not safety significant. This event is bounded by the Loss of Feedwater Flow Transient discussed in Chapter 15 of the Final Safety Analysis Report. This transient has been determined to be acceptable.

The assessment of safety consequences for the potential failure of the eight leak detection system relays is described in the 10CFR21 REPORT section of this report.

ADDITIONAL INFORMATION

The Agastat, Type GP relays are manufactured by Amerace Corporation and supplied by General Electric Company. Relay 1C34-K28 is a commercial grade item installed in a non-safety-related application.

No previous reactor scrams at Clinton Power Station have occurred as a result of a similar cause.

For further information regarding this event, contact R. D. Freeman, Manager - Nuclear Station Engineering Department at (217) 935-8881, extension 3538.

10CFR21 REPORT No. 21-88-01: High Contact Resistance in GP Model Agastat Relays

On June 26, 1988, while testing replacement relays for the feedwater startup level controller, IP identified a generic concern of high contact resistance in Agastat, Type GP relays. The high resistance was caused by oxidation. The concern was determined to be potentially reportable under the provisions of 10CFR21. Based on an evaluation of this matter, IP is providing the following information in accordance with the requirements of 10CFR, Part 21.21(b)(3).

(i) D. P. Hall, Vice President of Illinois Power Company, Clinton Power Station, Post Office Box 678, Clinton, Illinois, 61727, is informing the Commission by means of this report.

(ii) The basic components involved in this reportable defect are Agastat, Type GP relays.

(iii) General Electric Company performed the original design specification, procurement, and installation of these relays.

(iv) The nature of the defect involves the potential failure of eight Agastat, Type GP relays used in the leak detection system. These relays are used in low current applications, approximately twenty-four milliamperes. General Electric has determined that Agastat, Type GP relays with current loads less than fifty milliamperes are subject to failure because of oxide buildup on their contacts.

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6) YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	PAGE (3)
Clinton Power Station	0 5 0 0 0 4 6 1	8 8	— 0 1 7 —	0 1	0 9 OF 0 9

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

For these leak detection system relays to perform their safety function, their contacts must close and transmit a twenty-four milliampere isolation signal to the RCIC system. This signal causes RCIC containment isolation valves to close. Therefore, the failure of these relays can impact the integrity of the reactor coolant pressure boundary. A non-isolation of the RCIC system could result in overpressurization and failure of the secondary containment. On this basis, the matter has been determined to be reportable under the provisions of 10CFR21.

(v) IP identified the potential defect on June 26, 1988, while testing replacement relays for the startup level controller in the feedwater system. The controller had failed and caused a reactor scram on June 24, 1988.

(vi) Illinois Power Company has determined that of the forty-nine relays determined to be susceptible to failure because of oxide buildup, the only relays that could create a substantial safety hazard as a result of their failure are eight in the leak detection system (four per Division). Six of these eight relays are associated with area temperature detection of the RCIC line in the main steam tunnel, the RCIC equipment room, and the Residual Heat Removal heat exchanger bays. The two remaining relays monitor control power in leak detection system circuits. These relays and their associated safety functions are as follows:

Relay	Function
E31-K2A E31-K2B	Close RCIC system containment isolation valves
E31-K4A E31-K4B	Close RCIC system containment isolation valves
E31-K25A E31-K25B	Close RCIC system containment isolation valves
E31-K5A E31-K5B	Monitor RCIC system control power

(vii) Corrective actions for this matter are discussed in the CORRECTIVE ACTION section of this report.

(viii) Illinois Power recommends that other licensees review the application of Agastat, Type GP relays in low current applications.

*U.S. GPO 1986-0-624-538/455

U-601275
L16-L45-88(09-12)-LP
1A.120
2C.220

ILLINOIS POWER COMPANY IP CLINTON POWER STATION, P.O. BOX 678, CLINTON, ILLINOIS 61727

September 12, 1988

10CFR50.73
10CFR21.21

Docket No. 50-461

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

Subject: Clinton Power Station - Unit 1
Licensee Event Report No. 88-017-01
and 10CFR21 Defect No. 21-88-01

Dear Sir:

Please find enclosed Licensee Event Report No. 88-017-01: Relay Misapplication Causes Contact Oxide Buildup and Loss of Control Signal Resulting in Reactor Scram During Feedwater Pump Shift. This report has been revised to identify the root cause of the event, to identify all planned corrective actions, and to include 10CFR21 Defect Report No. 21-88-01: High Contact Resistance in GP Model Agastat Relays. This report is being submitted in accordance with the requirements of 10CFR50.73 and 10CFR21.21(b)(3).

Sincerely yours,

D. P. Hall

D. P. Hall
Vice President

DPH/kar

Enclosure

cc: NRC Resident Office
NRC Region III, Regional Administrator
INPO Records Center
Illinois Department of Nuclear Safety
NRC Clinton Licensing Project Manager
General Electric Company

ZZZZ
1/1
SEE ATTACHED
DISTRIBUTION LIST

50-461

B. SIEGEL	01	01
PD3-2 PD	01	01
PD3-2 LA	01	01
ACRS MICHELSON	01	01
ACRS MOELLER	02	02
AEOD/DOA	01	01
AEOD/DSP/NAS	01	01
AEOD/DSP/ROAB	02	02
AEOD/DSP/TPAB	01	01
ARM/DCTS/DAB	01	01
DEDRO	01	01
NRR/DEST/ADS 7E	01	00
NRR/DEST/CEB 8H	01	01
NRR/DEST/ESB 8D	01	01
NRR/DEST/ICSB 7	01	01
NRR/DEST/MEB 9H	01	01
NRR/DEST/MTB 9H	01	01
NRR/DEST/PSB 8D	01	01
NRR/DEST/RSB 8E	01	01
NRR/DEST/SGB 8D	01	01
NRR/DLPQ/HFB 10	01	01
NRR/DLPQ/QAB 10	01	01
NRR/DOEA/EAB 11	01	01
NRR/DREP/RAB 10	01	01
NRR/DREP/RPB 10	02	02
NRR/DRIS/SIB 9A	01	01
NUDOCS-ABSTRACT	01	01
REG FILE 02	01	01
RES TELFORD, J	01	01
RES/DSIR DEPY	01	01
RES/DSIR/EIB	01	01
RES/DSR DEPY	01	01
RGN. 3 .FILE 01	01	01
EG&G WILLIAMS, S	04	04
FORD BLDG HOY, A	01	01
H ST LOBBY WARD	01	01
LPDR	01	01
NRC PDR	01	01
NSIC HARRIS, J	01	01
NSIC MAYS, G	01	01

ARM TECH ADV	01	01
NRR CRUTCHFIELD	01	01
NRR VARGA, S	01	01
NRR/DEST/ADE 8H	01	01
NRR/DOEA/GCB 11	01	01
NRR/DRIS/VIB 9D	01	01
RGN1	01	01
RGN2	01	01
RGN3	01	01
RGN4	01	01
RGN5	01	01
INPO RECORD CTR	01	01

NOTE: THIS IS A COMBINED DISTRIBUTION FOR A[redacted] LER and A PART 21 RPT.

60 LTR. 60 ENCL.