NRC FORM 366 (4-95) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMD NO. 3150-0104
EXPIRES: 04/30/98
ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

LICENSEE EVENT REPORT (LER)

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Oconee Nuclear Station, Unit 2	05000 270	1 of 10

TITLE (4)
Emergency Start Of Keowee Hydro Units Due To Unknown Cause

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 NAME	DOCKET NUMBER(S)
												05000
04	09	98	98	-	02	-	00	05	28	98		05000

OPERATING MODE (9)	N	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR (Check one or more of the following) (11)					
POWER LEVEL (10)	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)	X	OTHER (Specify in	
		20.405(a)(1)(iii)	50.73(a)(2)(i)	50.73(a)(2)(viii)(A)		Abstract below and	
		20.405(a)(1)(iv)	50.73(a)(2)(ii)	50.73(a)(2)(viii)(B)		in Text, NRC Form	
		20.405(a)(1)(v)	50.73(a)(2)(iii)	50.73(a)(2)(x)		366A)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER	
	AREA CODE	
J.E. Burchfield, Regulatory Compliance Manager	(864)	885-3292

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)

On April 9, 1998, Oconee Units 1 and 3 were operating at 100% Full Power. Unit 2 was defueled for a refueling outage. Keowee Hydro (KH) Units 1 and 2 were generating to the Duke Power grid. At 1550 hours, a KH Emergency Start Channel 2A relay energized and caused both KH Units to separate from the grid and revert to no-load in a standby mode. KH did not supply power because there was no loss of power at Oconee. A Failure Investigation Team (FIP) concluded that the emergency start relay did not energize as the result of valid actuation conditions or equipment failure. The FIP also determined that the emergency start did not involve the Engineered Safeguards System. Therefore, this event is NOT an Emergency Safety Feature actuation and this is a Voluntary LER. Instrument & Electrical technicians were tracing wires in the Keowee Emergency Start Channel 2A cabinet in the Oconee Unit 2 cable room. However, a Human Performance Evaluation Team found no evidence of inappropriate action. Therefore, the root cause is Unknown. Corrective actions include replacing the relay and communicating the importance of the sensitivity of all electrical cabinets.

EVALUATION:

Background

Keowee Hydro (KH) Station has two hydro-electric turbine generating units which serve as the emergency power source [EIIS:EK] for Oconee Nuclear Station. The two KH units are also used routinely to generate to the grid. KH can be started manually by local KH operators, and remote manually from the Oconee Unit 2 control room by Oconee control operators. There are also several conditions which initiate an emergency automatic start.

Automatic start signals using Oconee Unit 1 circuitry are:
- Loss of Switchyard [EIIS:FK]
- Unit 1 Engineered Safeguards (Channels 1 and 2) [EIIS:JE]
- Unit 1 Main Feeder Bus Monitor Panels (Undervoltage) [EIIS:EA]
- Unit 1 and 2 Control Room Emergency Start Manual Pushbuttons (Channels A and B) [EIIS:HS]
- Emergency Start Cabinet local key switch (Channels A and B) [EIIS:HS].

Automatic start signals using Oconee Unit 2 circuitry are:
- Unit 2 Engineered Safeguards (Channels 1 and 2)
- Unit 2 Main Feeder Bus Monitor Panels (Undervoltage)
- Emergency Start Cabinet local key switch (Channels A and B).

Automatic start signals using Oconee Unit 3 circuitry are:
- Unit 3 Engineered Safeguards (Channels 1 and 2)
- Unit 3 Main Feeder Bus Monitor Panels (Undervoltage)
- Unit 3 Control Room Emergency Start Manual Pushbutton
- Emergency Start Cabinet local key switch (Channels A and B).

Once a KH unit is operating at rated rpm and voltage, the Emergency Power Switching Logic (EPSL) Systems at Oconee will automatically operate switchgear to align the KH units to supply power to any or all Oconee units affected by a loss of AC power.

Technical Specifications normally require both KH units, associated power paths, and Unit specific EPSL systems to be operable when Oconee Units are above 200F. Below 200F, during cold shutdown, Site Directive 1.3.5

establishes system requirements for shutdown risk management. While defueled, Site Directive 1.3.5 only requires one emergency power path (and associated logic channels) from Keowee to the defueled Oconee unit.

Event Description

On April 9, 1998, Oconee Unit 1 and Unit 3 were operating at 100% Full Power. Unit 2 was defueled for a refueling outage. The Operator Aid Computer on Oconee Unit 2 was being replaced under a Nuclear Station Modification and was out of service. Therefore, many computer indications which might have assisted in diagnosing this event were unavailable.

At 1550 hours, Keowee Hydro (KH) Units 1 and 2 were generating to the Duke Power grid when an emergency start signal was received. Both KH units responded appropriately to the emergency start signal by separating from the grid and reverting to a standby mode, running at no load.

Control room alarms [EIIS:ANN] indicated that Emergency Start Channel 2A was actuated, which, by design, provides emergency start signals to both KH units.

The Unit 2 Engineered Safeguards Channel 1 is one of the systems that can actuate Emergency Start Channel 2A. If Engineered Safeguards Channel 1 had been actuated, other Engineered Safeguards components and appropriate alarms and control room indications should also have actuated, and the Engineered Safeguards Channel should have remained actuated until reset by operator action.

The Main Feeder Bus Monitor Panel system is another of the systems that can actuate Emergency Start Channel 2A. If the Main Feeder Bus Monitor Panel system had actuated, Unit 2 should have undergone a momentary loss of all AC power with a load-shed of non-safety related components. Emergency Start Channel 2B should also have been actuated. Also, appropriate alarms and control room indications should have been generated, and the system should have remained actuated until reset by operator action.

However, neither of these systems, which send initiating signals to Channel 2A, appeared to be actuated or exhibited any of the symptoms listed above.

Because neither the Engineered Safeguards nor the Main Feeder Bus Monitor Panel systems appeared to have actuated, the Oconee Operators were unsure why the automatic emergency start had occurred. The Oconee Operators left the KH units running at no load, where they were considered fully operable, until troubleshooting progressed sufficiently to assure that the emergency start circuitry was operable.

Another potential actuation method was a key operated switch mounted on the Emergency Start Channel 2A cabinet, located in the Oconee Unit 2 Cable Room, one floor under the control room. One key is maintained in a key locker under control of the shift Senior Reactor Operators. It was not checked out prior to this event. A second key is located on the cabinet door in a glass case with a break-away lock. The cabinet door was inspected later and the key, glass, and lock were found intact.

It was determined that Instrument & Electrical (I&E) technicians were working in the cabinet containing the Channel 2A emergency start relay. When an Operator arrived at the cabinet, three I&E technicians were working in the cabinet and were unaware that the channel had actuated. These technicians had been assigned to trace the control wires in the Emergency Start Channel 2A cabinet as part of a project to resolve apparent discrepancies in the as-built drawings and wiring diagrams. The initial assumption by the Operators was that the technicians had inadvertently actuated the 2A emergency start relay.

Electrical Systems Engineers questioned the technicians, who stated that one of them had been physically tracing individual wires while the other two verified and marked drawings. Based on the technicians' description of their activities, none of their actions should have caused the actuation. They reported hearing a noise, which one described as a "thump" and another described as sounding like the cabinet had been struck or bumped. Initially the Engineers assumed this was the sound of the relay actuating. The Engineers resumed investigation of an electrical actuation signal. A Failure Investigation Process (FIP) team was initiated to define and perform additional troubleshooting.

Because one of the possible actuation signals comes from the Unit 2 Engineered Safeguards System, the decision was made to conservatively declare the event a potential Engineered Safety Feature actuation pending

the results of the investigation. A four hour non-emergency ENS notification was made to the NRC at 1831 hours.

Through additional trouble shooting, the FIP team confirmed that no active actuation signal was present, and that the Channel 2A emergency start relay was being energized by a seal-in contact. By design, when a valid actuation signal is received, this seal-in contact keeps the relay energized, even if the initiating system is reset, until an Emergency Start reset button is pressed in the Unit 2 control room.

Therefore, the FIP team focused on potential failure modes which may have momentarily given a signal to the Channel 2A emergency start relay. Such a signal would have to exist long enough to actuate the relay and pick up the seal-in contact. However, after continued investigation, especially of the condition of the Engineer Safeguards System, no evidence could be found to indicate the existence of any momentary actuation signal.

The relay was reset, and the KH Units shutdown. Links were opened in the 2A relay output signal circuit so that further relay operations during trouble shooting would not start Keowee. (Keowee Emergency Start remained operable from the 2B relay on Oconee Unit 2, and all of the Oconee Unit 1 and 3 Emergency Start relays).

The FIP team attempted to re-enact the event. During this re-enactment, none of the actions described by the technicians would reproduce the event. The wiring was inspected for nicks, cuts, frayed or burned spots which may have indicated a potential location for an inadvertent short circuit. Two minor nicks were observed, but they were sufficiently separated to prevent them from resulting in a short circuit.

The relay is mounted directly to the back of the metal cabinet. Based on the technicians' statement about a "thump" sound, one of the FIP engineers struck the back of the cabinet behind the relay with his hand. After several tries with increasing force, the relay actuated. The FIP engineers inspected the back of the cabinet for signs of impact. They looked for a scrape in the cabinet paint or other mark on the cabinet, and for potentially fallen objects. None were found.

Civil Engineering personnel familiar with seismic analysis of electrical cabinets and equipment were contacted and the FIP team discussed this finding with them. The FIP team specifically questioned whether or not the relay should be tested in place to compare seismic analysis assumptions to the impact loads necessary to actuate the relay. The Civil Engineering personnel noted that vibration and impact load profiles for mechanical impact of this type are considerably different from seismic load profile assumptions.

The FIP team assembled the I&E technicians and asked them to re-enact their steps. During this re-enactment, the engineer again struck the back of the cabinet, re-actuating the relay. The technicians immediately identified the sound as being the same as they had heard previously.

The Keowee Emergency Start Cabinet is located in one of several parallel rows of cabinets. The rows are blocked at one end by cable trays, such that each row is "dead-ended". The door of the 2A cabinet opens such that it blocks off view of the passage way at the open end of the row. Thus, while working in the cabinet, the technicians would not have been able to easily observe anyone passing by or standing behind the cabinet.

The cable room is a secure area, so the security computer log was checked to determine who else was in the cable room at the time. Four other individuals were in the area: two I&E technicians and two support staff members were investigating a modification installation problem several rows of cabinets from the Emergency Start cabinet. Within a short time of the emergency start signal, these four people passed the row which contains the Emergency Start Cabinet and exited the cable room. Without turning into a dead end lane between rows, they would not have come within close proximity of the Emergency Start cabinet.

These individuals and the crew of I&E technicians working in the cabinet were interviewed by maintenance management and/or a human factors investigation team. All of them stated that they had NOT entered the lane behind the Emergency Start cabinet, that they had NOT struck the cabinets, either purposely or inadvertently, and that they were NOT aware of anyone striking the cabinet, either on purpose or accidentally.

Both work teams acknowledged that other personnel had been observed in the cable room during the work shift (as indicated on the security log), but no one was aware of any other personnel in the immediate area at the time of the event.

These individuals and the crew of I&E technicians working in the cabinet stated that pre-job briefings included the fact that some cabinets in the cable room were known to contain relays sensitive to vibration.

The 2A relay was removed and taken to the shop. When bench tested, the contact clearances and relay operation were within normal specifications, therefore the FIP team concluded that the relay had not failed. Additionally, the relay was mounted on a test panel with a replacement relay. The relay crew was able to actuate both relays if the panel was hit hard enough. However, they were able to consistently hit the panel with a degree of force such that only the old relay actuated. This indicated that the old relay was more sensitive than the new relay.

The new relay was installed in the Emergency Start cabinet and functionally tested. The 2A Emergency Start cabinet was returned to service.

The four hour non-emergency ENS notification was retracted on May 7, 1998 at 1630 hours.

Conclusions:

The root cause of this event was determined to be Unknown.

The Failure Investigation Process (FIP) team found no valid initiation signal or equipment malfunctions to explain the emergency start of Keowee Hydro (KH) Units 1 and 2. It specifically concluded that the actuation did not involve the Engineered Safeguards System actuation signal. Therefore, Oconee does not consider this emergency start of Keowee Hydro (KH) Units 1 and 2 to be a reportable Emergency Safety Feature actuation, but is submitting this report as a Voluntary LER.

The human factors team concluded that there was no KNOWN contact (inadvertent or intentional) sufficient to actuate the relay on the part of the personnel known to be in the area.

A factor contributing to this event is Work Planning, in that the work was performed with the cabinet in service. The cabinet could easily have been taken out of service, which would have prevented the unintended emergency start of KH. When evaluating the consequences of potential problems, the consequences of an inadvertent emergency start were deemed less significant than the consequences of a failure to achieve an emergency start if the redundant channel failed during a real power loss. The work was scheduled during defueled conditions to minimize the safety significance of any potential events (either inadvertent actuations or unplanned inoperabilies).

Another contributing factor was the condition of the old relay such that it was more sensitive to actuation by impact-induced vibration than the replacement relay. Although the Keowee Emergency Start 2A relay was replaced, the replacement was considered precautionary. The old relay met the acceptance criteria of the relay Periodic Maintenance procedure, and is not considered to have failed.

There were no equipment failures, radioactive releases, or personnel injuries associated with this event.

LER 287/96-01 describes an event which is similar in that it was caused when relay contacts closed unexpectedly due to vibration. On March 16, 1996, during a Performance Test of portions of the Emergency Power System which monitor the Oconee switchyard, contacts on a certain Unit 3 relay closed unexpectedly due to vibration caused by operation of other relays as part of the test. These contacts caused an invalid momentary load shed signal which resulted in the loss of several secondary system pumps, and an anticipatory reactor trip due to the loss of Main Feedwater Pumps. A KH emergency start was an expected result of the test in progress. Due to the reactor trip and the existing test alignment, Unit 3 lost AC power for approximately 20 seconds before the Emergency Power Switching Logic aligned Unit 3 power to KH. The root cause of the event was determined to be Installation Deficiency due to improper assembly of a relay. Corrective actions included replacing and properly installing the relay and revising

procedures. The contact configuration from this 1996 event did not apply to the relay involved in the current (1998) event.

Voluntary LER 269/97-06 describes an event which is similar in that an unplanned KH emergency start occurred. On June 20, 1997, a KH emergency start was an appropriate response to a real, but un-intended, loss of power due to inappropriate action (mis-alignment of switchyard dis-connects) during testing.

The corrective actions from these two referenced events would not be expected to prevent this event. No other inadvertent Emergency Starts have occurred in the past two years. Therefore, this event is not recurring.

CORRECTIVE ACTION:

Immediate:

1. Both Keowee Hydro Units were allowed to run unloaded until Emergency Start operability was confirmed.

Subsequent:

1. A Failure Investigation Team was formed.

2. The Emergency Start Channel 2A relay was replaced as a precautionary measure.

Planned:

1. A communication sheet will be sent to crew supervisors to address, where appropriate during pre-job briefings, that ALL electrical cabinets should be considered sensitive to vibration/impact and that this should be applied to surrounding cabinets, not just the cabinets in which work is being performed.

This planned corrective action is NOT considered to be an NRC Commitment Item. There are NO NRC Commitment items contained in this Voluntary LER.

SAFETY ANALYSIS:

This event was an invalid emergency start signal to Keowee Hydro (KH) Units 1 and 2, which were generating to the Duke grid at the time of the event. Both KH units responded as designed and isolated from the grid and remained in no-load standby. They did not attempt to close in and supply power to any of the Oconee units because there was no loss of power to any of the Oconee units. Had there been an actual loss of power, the KH units were ready to supply power, and would have responded as required by the Emergency Power Switching Logic system, which actively seeks out available power from the available sources.

Because they were in the emergency start mode, both KH units were fully operable throughout the event. Therefore this event had no safety significance. The health and safety of the public was not affected by this event.

ENCLOSURE 1

SIGNATURE SHEET

PIP K-098-1854

Prepared By: _____ Date: 5-13-98

Revised By: _____ Date: 5-18-98

Reviewed By: _____ Date: 5-13-98

_____ Date: _____

_____ Date: _____

_____ Date: _____

_____ Date: _____

_____ Date: _____

Approved By: _____ Date: 5-14-98
Manager, RGC

Reviewed By: _____ Date: _____
Station Manager

ENCLOSURES:

1. Regulatory Compliance Signature Sheet
2. References
3. Corrective Action Schedule
4. Personnel Contacted
5. Cause Code Summary