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SUBJECT: LER 89-006-00: on 890804, improper relay setting due to design deficiency could trip 2B reactor bldg spray pump.
 W/8 ltr.

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September 5, 1989

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
LER 270/89-06

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report (LER) 270/89-06 concerning improper relay setting, due to design deficiency, which could trip 2B Reactor Building Spray Pump during a LOCA/LOOP event.

Since this report is due to a Design Basis Documentation effort, there will be a supplementary Licensee Event Report at the conclusion of this Design Basis effort.

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LICENSEE EVENT REPORT (LER)

FACILITY NAME (1) Oconee Nuclear Station, Unit 2										DOCKET NUMBER (2) 0 5 0 0 0 2 7 0										PAGE (3) 1 OF 1	
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Trip Proper Relay Setting, Due to Design Deficiency, Could Trip 2B Reactor Building Spray Pump During LOCA/LOOP Event

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	8	0	4	8	9	8	9	0	0	6	0	0	0	9	0	5	8	9	Oconee Unit 1	0	5	0	0	0	2	6	9
																			Oconee Unit 3	0	5	0	0	0	2	8	7
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)		1 0 0		20.402(b)				20.405(a)				90.73(a)(2)(iv)				73.71(b)											
				20.405(a)(1)(i)				90.38(a)(1)				90.73(a)(2)(iv)				73.71(c)											
				20.405(a)(1)(ii)				90.38(a)(2)				X 90.73(a)(2)(vi)				OTHER (Specify in Abstract below and in Text, NRC Form 308A)											
				20.405(a)(1)(iii)				90.73(a)(2)(i)				90.73(a)(2)(vi)(A)															
				20.405(a)(1)(iv)				90.73(a)(2)(ii)				90.73(a)(2)(vi)(B)															
				20.405(a)(1)(v)				90.73(a)(2)(iii)				90.73(a)(2)(v)															

LICENSEE CONTACT FOR THIS LER (12)										TELEPHONE NUMBER									
NAME Henry R. Lowery, Chairman Oconee Safety Review Group										AREA CODE 8 0 3									
										8 8 5 - 3 0 3 4									

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)														
CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRC		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRC				
SUPPLEMENTAL REPORT EXPECTED (14)										EXPECTED SUBMISSION DATE (15)		MONTH	DAY	YEAR
X YES (If yes, complete EXPECTED SUBMISSION DATE)										NO				

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

On August 4, 1989, at 1045 hours, Duke Power Design Engineering discovered that the overcurrent protective relay setting for the 2B Reactor Building Spray Pump Motor were insufficient and may trip the motor during starting under voltage conditions associated with a LOCA/LOOP event. This potential trip condition had existed since June 1980 when the original motor was replaced with a spare motor. The problem was identified while performing a Design Basis Documentation Study of the 4.16 KV Electrical System. All three Oconee Units were at 100% Full Power when discovery was made. A Design Deficiency during purchase of the spare motor in 1979 was the root cause of this event. Immediate and subsequent corrective actions were to determine the appropriate relay setting and make the necessary setting adjustment. A seven day Limited Condition of Operation for Unit 2 was declared on August 4, 1989, and cleared on August 5, 1989.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMS NO. 3150-0104
EXPIRES 8/31/85

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (3)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	0 5 0 0 0 2 7 0	8 9	- 0 0 6	- 0 0	0 2	OF	1 1

TEXT (If more space is required, use additional NRC Form 306A's) (17)

BACKGROUND

The Reactor Building Spray (RBS) System [EIIS:BE] is one of two independent Engineered Safeguard (ES) systems [EIIS:JE] designed to remove heat from the Containment Building [EIIS:NH] following an accident. The RBS System, which serves no function during normal operation, removes post-accident energy by spraying borated water into the Reactor Building atmosphere thus quenching the steam. The additional system is the Reactor Building Cooling (RBC) System [EIIS:BK] which removes heat from the reactor building atmosphere to the Service Water System [EIIS:BI] with recirculating fans and cooling coils. These systems control building pressure in the event of a Loss Of Coolant Accident (LOCA). Both systems (RBS and RBC) independently possess full (100%) post-accident cooling capability.

The RBS system consists of two pumps, two building spray headers, isolation valves, and the necessary piping, instrumentation and controls. The pumps [EIIS: P] and remotely operated valves [EIIS: V] can be operated from the control room or upon automatic actuation of the ES system (channels 7 and 8). A high Reactor Building pressure signal of 10 psig actuates ES channels 7 and 8, which in turn, automatically starts RBS pumps 'A' and 'B'. The pumps are initially aligned to the Borated Water Storage Tank (BWST) [EIIS:BG]. Long term recirculation spray can also be established from the Reactor Building Emergency Sump [EIIS:BD] to keep containment pressure low thereby reducing containment leakage following an accident.

The 2B RBS pump is driven by a 250 HP, 3600 RPM, 4160 VAC, 3 phase, 60 Hz Westinghouse motor [EIIS:MO]. Instantaneous, time delay and ground overcurrent protection [EIIS:RLY] is provided on the pump circuit breaker to protect the motor and associated feeder cable. In the event of an overcurrent condition, the time delay trip relay device will trip the circuit breaker regardless of an ES actuation signal. The RBS Motor is powered from the 2TD-11 switchgear.

Technical Specifications 3.3.6,c,(2), (b) allows one RBS train to be out of service for seven (7) days (when the reactor is critical) provided all three RBC trains are operable. These conditions require the applicable unit to be placed under a seven day limited condition of operation.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMB NO 3150-0104

EXPIRES 8/31/85

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	05000270	89	006	00	03	OF	11

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

EVENT DESCRIPTION

On April 10, 1978, Duke Power Design Engineering issued a requisition for purchase of a spare Reactor Building Spray (RBS) Pump Motor for Oconee Nuclear Station. This order was placed through Duke's purchasing agency, Mill-Power Supply Company, and awarded to Westinghouse Electric Company. The requisition called for a 250 horsepower, 3600 rpm motor to be designed and built in accordance with Duke Motor Specification OS-314-6 revised May 15, 1968 and amendment 1 dated October 20, 1969. Electrical characteristics of the motor were to be identical to those furnished on a previous referenced Westinghouse supply order. Several other specific non-event related requirements were also stated on the purchase order. The purchase order was dated August 3, 1978 and required submittal of drawings and data to Design Engineering for owner approval prior to commencing manufacture of the motor.

Westinghouse Electric Corporation responded by letter on September 8, 1978 to Mill-Power Supply Company that their factory was currently designing the motor. Mention was made concerning drawing and data submittal upon design completion.

On October 13, 1978, Westinghouse informed Duke, via Mill-Power Supply Co., that certain criteria in the Duke Motor Specifications could not be met and that Duke's preferences in these areas were needed before proceeding with design work. First, Westinghouse could not meet the three (3) second acceleration time requirement and achieve the minimum full load speed requirement of 3560 rpm. According to the Westinghouse design engineer for this order, the highest speed of the motor would be 3555 rpm and the specification speed of 3560 rpm would never be reached. Second, Westinghouse informed Duke that a higher full load speed could be achieved if the three (3) second acceleration time was waved. A request was made for Duke's advice on this matter.

On January 5, 1979, Duke Power Motor Specification OS-314-16 was amended by Design Engineering. The revision removed the time requirement for the motor to be capable of accelerating the RBS Pump to full load and speed operation in three (3) seconds.

Design Engineering prepared an addendum to the original purchase requisition on February 1, 1979 revising the purchase order and referencing the newly amended motor specification as changed on January 5, 1979. Mill Power Supply forwarded the change order to Westinghouse on February 16, 1979 authorizing them to design the spare motor in compliance with the revised specifications. The motor specification number was also corrected in the revised purchase order from OS-314-6 to OS-314-16.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMS NO. 3190-0104

EXPIRES 8/31/85

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (6)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	0 5 0 0 0 2 7 0	8 9	- 0 0 6	- 0 0	0 4	OF	1 1

TEXT (If more space is required, use additional NRC Form 308A's) (17)

The spare RBS Pump Motor was then built and arrived at Oconee Nuclear Station on February 22, 1980. A Quality Assurance receipt inspection was performed on the same date.

The newly purchased RBS Pump Motor was removed from the warehouse on May 30, 1980 and after some initial no-load vibration testing, was installed without any documented relay evaluations or adjustments as a replacement for the original 2B RBS Pump Motor on May 31, 1980. The replacement work was conducted under Work Request #54627 and by direction of Maintenance Procedure MP/0/A/1800/22 (Controlling Procedure For Troubleshooting And Corrective Maintenance). The procedure did not provide instructions or give requirements to evaluate settings on the overcurrent protective relaying device. The following associated procedures were also used in the testing and replacement phases:

MP/0/A/1300/1 Reactor Building Spray Pump Removal and Replacement

MP/0/A/1650/01. . . . Special Vibration Testing For Safety Related Rotating Equipment

On June 24, 1987, a design deficiency was identified in which the High Pressure Injection (HPI) Pump Motor [EIIS:BQ] on each unit could trip on overcurrent during a Loss of Coolant Accident (LOCA)/Loss of Offsite Power (LOOP) scenario. This deficiency was also the result of insufficient overcurrent relay settings. This incident was investigated and reported to the NRC under Licensee Event Report (LER) 269/87-005. The origin of this problem was the failure to assess effects on the HPI Motor relay settings in conjunction with the 1979 Emergency Feedwater [EIIS:BA] modification which changed the 4160 VAC power system dynamics. The overcurrent relay settings for the HPI pump motors were not evaluated or adjusted, during installation of the modification, to account for the effects of extended starting times on the motors under the auxiliary power system voltage and loading conditions associated with a LOCA/LOOP event or a three unit LOOP event.

The protective relaying coordination for other motors (including the RBS motors) was found acceptable during investigation of LER 269/87-005. This acceptability was based on an engineering calculation which primarily examined the capability of the HPI pumps to start under a LOCA/LOOP event. The RBS Motors were included in the calculation scope, however at this time (June 1987), Design Engineering did not realize that the 2B RBS Motor had been replaced in May 1980 with a spare motor having different (worse)

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED ONE NO 3150-0104
EXPIRES 8/31/85

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (3)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	0 5 0 0 0 2 7 0	8 9	- 0 0 6	- 0 0	0 5	OF	1 1

TEXT (If more space is required, use additional NRC Form 306A's) (17)

starting characteristics. This lack of understanding allowed the starting characteristics of the original RBS motors to be evaluated in the calculation. As a result, the deficient relay setting for the in-service 2B RBS Motor (spare) was not discovered.

On August 4, 1989, while conducting a Design Basis Documentation (DBD) Study of the 4.16 KV Electrical System [EHS:EB], Design Engineering identified that the 2B RBS Pump Motor had been replaced with a spare motor having different starting characteristics than the original motor. Further investigation revealed that the overcurrent protective relay setting in the 2TD-11 switchgear was not evaluated or reset upon motor replacement in 1980. A review of engineering calculation OSC-2563 indicated that under a LOCA/LOOP scenario, the 2B RBS Pump Motor could trip with the as-set relay setting of 4.6 seconds @ 200% of rated current. All three Reactor Building Cooling Units (A, B and C) and both RBS trains (A and B) were operable at the time of this discovery and Unit 2 was at 100% Full Power.

The 2B RBS pump was declared inoperable on August 4, 1989, at approximately 1045 hours, and Unit 2 was placed under a seven (7) day Limited Condition of Operation as required by technical specifications. The immediate and subsequent corrective actions were to initiate Problem Investigation Report #2-089-0122, determine the appropriate overcurrent relay setting for the 2B RBS Motor, and make the necessary relay adjustment. These actions were completed by August 5, 1989, at approximately 1155 hours, and the 2B RBS train was returned to service. The Unit 2 LCO was also cleared.

CONCLUSION

The potential for the 2B Reactor Building Spray (RBS) Pump Motor to trip during starting under voltage conditions associated with a Loss of Coolant Accident (LOCA)/Loss of Offsite Power (LOOP) event has existed since June 1980 when the original motor was replaced. This conclusion is based on information found during this investigation and from a Design Basis Documentation Study of the 4.16 KV Electrical System performed by Design Engineering.

In 1978 and 1979, during the spare RBS Motor purchasing process, the consequences of removing a three (3) second start and run requirement from the motor specifications should have been evaluated by Design Engineering. Records to indicate that this action was taken could not be located. Further, a suitable method to tag the motor with instructions to evaluate relay coordination and to make necessary adjustments prior to installation should have been established. These actions could have prevented the station from considering the motor an exact replacement for the original.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED ONE NO. 3150-0104

EXPIRES 8/31/85

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (3)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	0 5 0 0 0 2 7 0	8 9	- 0 0 6	- 0 0	0 6	OF	1 1

TEXT IF more space is required, use additional NRC Form 308A (117)

This investigation also pointed out that the original purchase order submitted to Westinghouse in August 1978 referenced an incorrect motor specification. This mistake is believed to be a typing error and was corrected in the addendum/change order provided in February 1979. This error appeared to have no additional impact.

Procedure enclosure records available indicate that the 2B RBS Pump Motor was replaced on May 31, 1980 by direction of MP/0/A/1800/22, (Controlling Procedure For Troubleshooting and Corrective Maintenance). The correct procedure to perform this work today would be MP/0/A/2000/3 (Oconee Nuclear Station & Keowee Hydro Station Motor Inspection and Maintenance), however, no instructions on relay coordination are provided in this procedure. Appropriate procedure instructions requiring an engineering evaluation of the overcurrent relay settings on future safety-related motor replacements (equipped with relay devices) would provide additional assurance of no recurring events.

In 1987 a calculation was performed by design engineering to examine the capability of the HPI pumps to start under a LOCA/LOOP event. This calculation also examined other Engineering Safeguard motors including the RBS Motors. While both the spare and original RBS Motor starting curves were factored into the computer modeling for the calculation, only data from the original motor curves was used in the final 1987 assessment of the RBS Motors. This mistake was due to Design Engineering not realizing that the original 2B RBS Motor had been replaced with the spare motor in 1980. The extended starting time of the spare RBS Motor versus the starting time of the original motors was found to be significant on August 4, 1989 in respect to proper motor/pump operation in a LOCA/LOOP scenario.

The root cause of this incident is classified as a Design Deficiency, Design Oversight, in that the unanticipated interactions of the protective relay with the new replacement motor were not discovered and appropriately announced prior to installation of the new motor in 1980. Also, an opportunity to detect this inadequacy was missed in 1987 when a similar relay setting deficiency was discovered on the High Pressure Injection Motors. The failure to assess the proper RBS Motor in the evaluation of other motors and specifically the 2B RBS motor during the corrective action phases of the 1987 event prevented earlier recognition of the relaying problem.

Current Design Engineering policies and programs such as "TOPFORM" which were implemented in 1987 should minimize future problems of this nature. "TOPFORM" strategies require engineering personnel to investigate in depth the effects of modifications, including replacement of station equipment, with respect to system design and operation. A new program, Design Basis

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED ONE NO. 3190-0104
EXPIRES 8/31/88

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (3)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	0 5 0 0 0 2 7 0	8 9	- 0 0 6	- 0 0	0 7	OF	1 1

TEXT (If more space is required, use additional NRC Form 308A's) (17)

Documentation (DBD), has also been established within Duke Power Company to review certain plant systems and document the design basis for each of these systems in an easily retrievable manner. It was, in fact, the DBD program with its in-depth requirements to analyze all aspects of the 4 KV system that led to this discovery on August 4, 1989. Through early identification of problems, the DBD program will continue to enhance the overall capability of selected systems. Likewise, design engineers will have easy access to data that will help them be more responsive and thorough in future evaluations requiring their technical support.

No event has occurred that required actuation of the Reactor Building Spray System. This incident does not involve an actual component failure or malfunction and is therefore not reportable to NPRDS. There were no radioactive releases, radiation exposures, or personnel injuries resulting from this event. This event is also considered non-recurring.

CORRECTIVE ACTIONS

Immediate

1. Oconee Nuclear Station was notified of the insufficient relay setting by Design Engineering, the 2B RBS pump was declared inoperable, and Unit 2 was placed in an LCO.
2. Problem Investigation Report # 2-089-0122 was initiated with a proposed resolution to raise the relay setting to allow the 2B RBS Pump Motor to start at LOCA/LOOP voltage conditions.

Subsequent

1. A new overcurrent protective relay setting was determined.
2. Design Engineering calculation OSC-2563 was revised to demonstrate capability of the 2B RBS Pump Motor to start under LOCA/LOOP conditions with the new relay setting. (See Technical Data and Current Time Curves on page 11 of this report).
3. The overcurrent protective relay was adjusted to the new setting of 6.0 seconds @ 300% plus or minus 5% in accordance with Exempt Change OE-2714. This action was taken on August 5, 1989 and cleared the LCO on Unit 2.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED ONS NO. 3190-0104
EXPIRES 8/31/85

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (3)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	0 5 0 0 0 2 7 0	8 9	- 0 0 6	- 0 0	0 8	OF	1 1

TEXT (If more space is required, use additional NRC Form 308A-1/117)

Planned

1. Design Engineering will conduct an examination of all existing safety related motors, both in-service and stored, to ensure no negative interactions exist with overcurrent relay settings.
2. Design Engineering will pursue methods to adequately tag spare safety-related motors on future purchases to ensure relay coordination evaluations are performed prior to use of motor.
3. Appropriate ONS Maintenance procedures will be reviewed and revised as necessary to ensure appropriate relay coordination is assessed on safety-related motor replacements.

SAFETY ANALYSIS

The potential for the 2B Reactor Building Spray Pump Motor to trip with an overcurrent relay setting of 4.6 seconds @ 200% was only present during a Loss Of Coolant Accident (LOCA)/Loss Of Offsite Power (LOOP) scenario. The motor manufacturer guarantees the motor to start at a minimum of 80% rated voltage. During the initial phases of a LOCA/LOOP, the voltage at the RBS Pump Motor terminal dips to 81%, while during a LOCA, the startup voltage dips to approximately 87%. The difference in these startup voltages is due to the fact that a LOCA-only unit is immediately powered from the switchyard while a LOCA/LOOP unit would be powered from a Keowee Hydro unit [EIIS:EK] through transformer CT-4 [EIIS:XFMR] and the standby buses. The previous overcurrent relay setpoint of 4.6 seconds @ 200% was not sufficient to allow the motor to fully start during the reduced starting voltage of the LOCA/LOOP, but was sufficient to allow the motor to fully start during the LOCA startup voltage.

The raising of the relay setpoint to 6.0 seconds @ 300% allows the motor to successfully start at starting voltages of less than 80%. In addition, the new setpoint does not exceed the thermal damage limit for the motor which ensures that the motor will not be damaged due to the additional starting time.

The Reactor Building Spray (RBS) System and the Reactor Building Cooling (RBC) System are the two ES systems designed to remove energy from the Reactor Building after an accident. An additional system available for energy removal is the Low Pressure Injection (LPI) System [EIIS:BP] via its LPI coolers. If needed during the post-accident response, the LPI System will take suction from the Reactor Building sump and route the water through the LPI coolers which cools the water before injection into the core and simultaneously removes energy from the building.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMS NO. 3150-0104

EXPIRES 8/31/88

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (3)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	0500027089	-	006	-	00	09 of 11	

TEXT IF MORE SPACE IS REQUIRED, USE ADDITIONAL NRC Form 288A (17)

Reactor Building Cooling Unit (RBCU)/LPI cooler operability evaluations are performed to assess the ability of these heat exchangers to perform their intended safety function. Two criteria have been established to evaluate RBCU/LPI cooler operability:

1. Long Term Core Cooling: This criterion assures core cooling by demonstrating that at least one train of LPI will be capable of injecting 3000 gpm into the reactor vessel downcomer. Assuming the worst single failure, one LPI cooler must be capable of maintaining conditions in the Reactor Building sump such that no NPSH problems to the LPI pumps occur.
2. Equipment Qualification: The Reactor Building cooling capacity must be sufficient to prevent post-LOCA conditions from exceeding the qualifications of equipment required to mitigate a LOCA, again assuming a worst case single failure in both the LPI and RBCU systems. Compliance with this criterion assures equipment qualification to both post-LOCA temperature and pressure responses.

The conditions associated with Criterion 1 are met as long as Criterion 2 is satisfied; therefore, all LPI cooler and RBCU operability evaluations are now performed based on the requirements in Criterion 2.

Concerning Reactor Building pressure response, FSAR Section 15.14.5 states that for a worst case LOCA and with no Reactor Building cooling capability, the peak pressure is 54.6 psig. This maximum peak pressure is below the 59.0 psig design pressure of the Reactor Building.

The RBC and LPI systems are evaluated against the criteria without regard to the RBS system which means that when the RBCUs and LPI coolers are considered operable for worst case conditions, the Reactor Building's cooling requirements can be met without use of the RBS system. At the time of the discovery of the insufficient overcurrent protective relay setting, the RBCUs and LPI coolers were considered operable and have been since April 1987.

A review of past LERs shows that in April 1987, the Unit 2 RBCUs and LPI coolers were evaluated as having their post-LOCA performance degraded due to fouling to the point that a power reduction to 65% power was necessary (reference LER 269/87-04). It needs to be remembered that this status of RBCU and LPI cooler operability was based on only having the two worst RBCUs and the worst LPI cooler available for post-accident mitigation (i.e., no credit was taken for RBS operability).

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMS NO. 3190-0104
EXPIRES 8/31/85

FACILITY NAME (1)	DOCKET NUMBER (2)	LER NUMBER (3)			PAGE (3)		
		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER			
Oconee Nuclear Station Unit 2	05000270	89	006	00	10	OF	11

TEXT (If more space is required, use additional NRC Form 308A's) (17)

Another consideration in looking at past operability is that methods of collecting and analyzing RBCU test data have greatly improved since 1987, with the result being more accurate evaluations and evidence that past evaluations may have been overly conservative. Now knowing that past RBCU test data collection and analysis were likely conservative and assuming that all three RBCUs were available along with the remaining operable RBS train and passive structural heat sinks, it is possible that post-accident Reactor Building cooling requirements would have been met at all times in the past. This qualitative analysis cannot be easily confirmed because to do so would require the re-collection of data at more appropriate locations under the conditions experienced in 1987, before the RBCUs were subsequently cleaned.

In conclusion, the corrective action taken to raise the overcurrent protective relay setting restores the 2B RBS Pump Motor to its expected capability without the threat of damage to the motor. Even though past operability of the RBCUs and LPI coolers was considered degraded in April 1987, it is possible that the post-accident Reactor Building cooling needs would have been fulfilled. At those times when the RBCUs and LPI coolers were considered capable of independently responding to a LOCA, then a failure of the 2B RBS Pump would not have prevented the cooling of the Reactor Building.

Oconee has never experienced an accident which required the use of the RBS System or the RBCUs nor have there been any associated radiological releases; therefore, the health and safety of the public have not been affected by this investigated condition.

LICENSEE EVENT REPORT (LER) TEXT CONTINUATION

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED OMS NO 3190-8104
EXPIRES 8/31/85

FACILITY NAME (1)

DOCKET NUMBER (2)

LER NUMBER (3)

PAGE (3)

Oconee Nuclear Station Unit 2

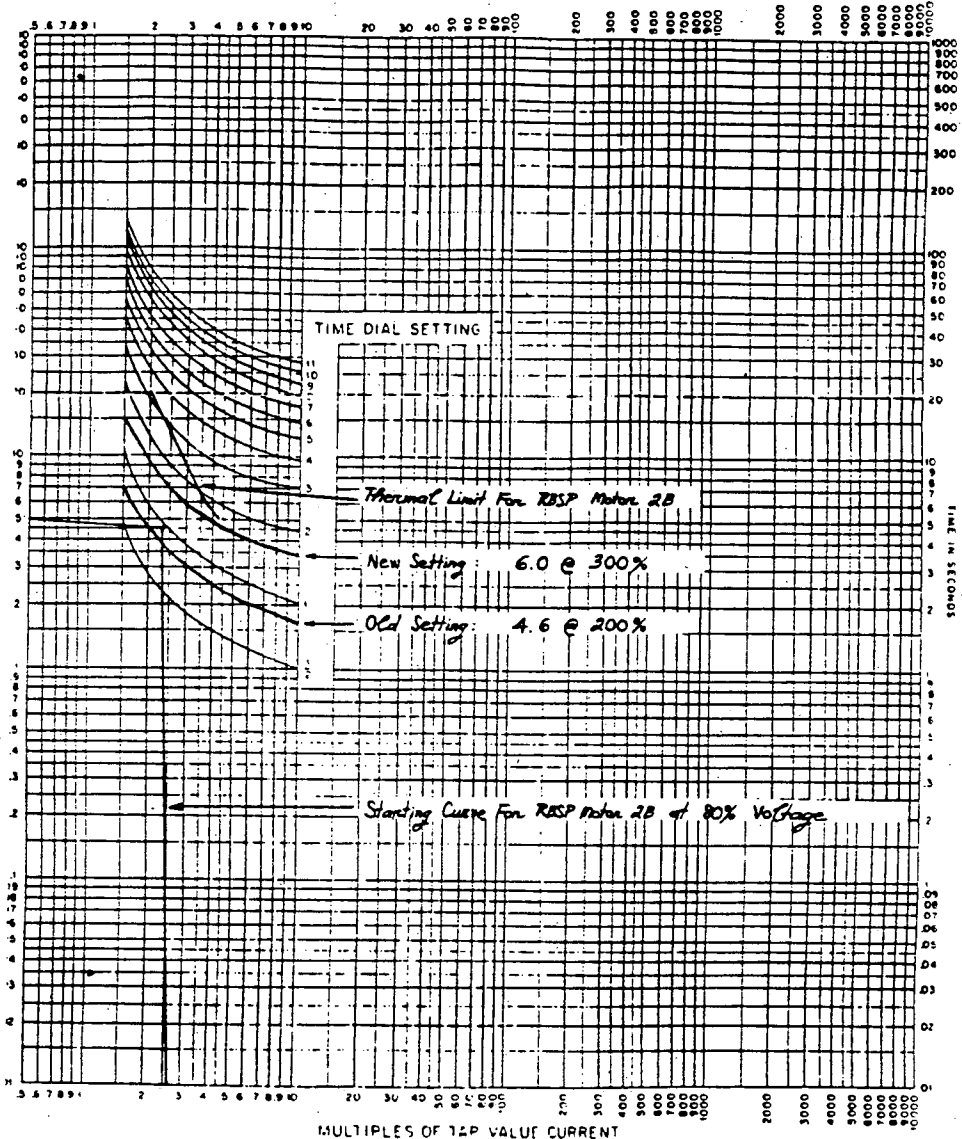
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TEXT IF more space is required, use additional NRC Form 368A (1/17)

TYPE CO-5 LONG TIME OVERCURRENT RELAY
TYPICAL 50/60 CYCLE CURRENT TIME CURVES

WESTINGHOUSE ELECTRIC CORPORATION NEWARK, N.J. U.S.A.

CURVE # 471045



OCCONEE NUCLEAR STATION UNIT 2

PLANT CONDITION	VOLTAGE (P.U., MOTOR BASE)	
	START	END
ONE-UNIT LOCA/LOOP	0.8119	1.0090

As shown above the voltage at the RSP pump motor terminal dips to 81% under a LOCA/LOOP scenario. This should be adequate for the motor to start since it is guaranteed by the motor manufacturer to start at 80% voltage.

ADDITIONAL TECHNICAL DATA

- o RSP pump motor: 250 HP, 3600 RPM, 4KV
- o Overcurrent Relay: Westinghouse, Type CO-5