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

Subject: Oconee Nuclear Station
Docket Nos. 50-287
Licensee Event Report 287/2001-02, Revision 0
Problem Investigation Process No.: O-01-0786

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report 287/2001-02, Revision 0, concerning operation in a condition prohibited by Technical Specifications. One required Reactor Building Cooling Unit was discovered to have been inoperable longer than the allowed action time.

This report is being submitted in accordance with 10 CFR 50.73 (a)(2)(i)(b). This event is considered to be of no significance with respect to the health and safety of the public.

There are no NRC commitment items contained in this LER.

Very truly yours,

W. R. McCollum, Jr.

Attachment

IE22

cc: Mr. Luis A. Reyes
Administrator, Region II
U.S. Nuclear Regulatory Commission
61 Forsyth Street, S. W., Suite 23T85
Atlanta, GA 30303

Mr. D. E. LaBarge
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Mr. M. C. Shannon
NRC Senior Resident Inspector
Oconee Nuclear Station

INPO (via E-mail)

NRC FORM 366 (1-2001) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 6-30-2001

LICENSEE EVENT REPORT (LER)

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

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TITLE (4)
Containment Cooler Inoperable Due to Design, Exceeds Tech Spec Time

EVENT DATE (5)			LER NUMBER (6)			REPORT DATE (7)			OTHER FACILITIES INVOLVED (8)	
MO	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO	MO	DAY	YEAR	FACILITY NAME	DOCKET NUMBER 050-
03	07	2001	2001	- 01 -	00	05	07	2001	FACILITY NAME	DOCKET NUMBER 050-

		THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) (11)			
OPERATING MODE (9)	5	20.2201(b)	20.2203(a)(3)(ii)	50.73(a)(2)(ii)(B)	50.73(a)(2)(ix)(A)
POWER LEVEL (10)	00	20.2201(d)	20.2203(a)(4)	50.73(a)(2)(iii)	50.73(a)(2)(x)
		20.2203(a)(1)	50.36(c)(1)(i)(A)	50.73(a)(2)(iv)(A)	73.71(a)(4)
		20.2203(a)(2)(i)	50.36(c)(1)(ii)(A)	50.73(a)(2)(v)(A)	73.71(a)(5)
		20.2203(a)(2)(ii)	50.36(c)(2)	50.73(a)(2)(v)(B)	OTHER Specify in Abstract below or in NRC Form 366A
		20.2203(a)(2)(iii)	50.46(a)(3)(ii)	50.73(a)(2)(v)(C)	
		20.2203(a)(2)(iv)	50.73(a)(2)(i)(A)	50.73(a)(2)(v)(D)	
		20.2203(a)(2)(v) X	50.73(a)(2)(i)(B)	50.73(a)(2)(vii)	
		20.2203(a)(2)(vi)	50.73(a)(2)(i)(C)	50.73(a)(2)(viii)(A)	
		20.2203(a)(3)(i)	50.73(a)(2)(ii)(A)	50.73(a)(2)(viii)(B)	

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
L.E. Nicholson, Regulatory Compliance Manager	(864) 885-3292

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

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
B	BK	MO	Reliance	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 15 single-spaced typewritten lines) (16)

On 3/7/2001, while Oconee Unit 3 was in Mode 6, the Unit 3 "B" Reactor Building Cooling Unit (3B RBCU) stator temperature exceeded the operability limit during a special test. The 3B RBCU was declared inoperable. An investigation team concluded that a manufacturing deficiency of the 3B RBCU motor, installed on 12/19/1999, might have prevented proper operation under certain accident conditions. This event is being reported as operation in a condition prohibited by Technical Specifications.

The root cause of this event is vendor design/manufacturing deficiency. Corrective actions include replacement of the affected motor and a specification change for future replacement motors. This event is considered to have no significance with respect to the health and safety of the public.

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NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* **(17)**

EVALUATION:

BACKGROUND

This event is reportable per 10CFR 50.73(a)(2)(i)(b) as operation in a condition which was prohibited by Technical Specifications (TS) due to one required Reactor Building Cooling Unit (RBCU) [EIIS:BK] being inoperable longer than allowed by TS.

The RBCU System is one of two independent Engineered Safeguards (ES) Systems provided to remove heat from the Reactor Building (RB) atmosphere following an accident. The other system is the Reactor Building Spray (RBS) [EIIS:BEI] System.

The capacity of each of these systems is designed to remove heat from the RB to reduce pressure following a Loss Of Coolant Accident. During normal plant operation, RBCUs "A" and "C" operate in the high-speed mode to help cool the RB in conjunction with the Reactor Building Auxiliary Coolers. RBCU "B" is not typically operated during normal operation. During an emergency, the RBCU System mode of operation changes automatically. The ES System is activated when the RB pressure reaches 3 psig. Upon actuation, the fan motors associated with RBCUs "A" and "C" change from high to low speed and the fan motor associated with RBCU "B" is started at low speed. All three RBCUs then operate continuously to circulate the RB steam-air mixture past the cooling coils to transfer heat from the RB atmosphere to the Low Pressure Service Water System (LPSW) [EIIS:BI] which is supplied from Lake Keowee (the ultimate heat sink).

Several years ago, Oconee initiated a program for scheduled refurbishment and or replacement of RBCU motors due to aging concerns. Prior to the events described below, several RBCU motors had been replaced with refurbished/rebuilt motors. Two RBCUs (1C and 1B) had new motors installed in 6/1999 and 4/2000 respectively. A replacement schedule called for additional replacements with new motors over the next several years.

In November 2000, unexpectedly high stator temperatures were observed on the Unit 1 "B" RBCU. The 1B RBCU was determined to be operable but was replaced due to loss of margin. A Failure Investigation Team (FIP) was formed to investigate the problem. The stator temperatures on the other Unit 1 RBCUs were found to be

acceptable. As a result of inspections and continuing investigation of this Unit 1 event, the Mechanical Systems Engineering section initiated plans to test the RBCUs on the other two Oconee Units. Engineering developed a correlation between motor supply voltage and current at low speed as a preliminary "screen" to determine if motor stator temperature data was needed to further assess RBCU motor condition.

Although the RBCU motors are equipped with installed thermocouples to monitor stator temperatures, these thermocouples are normally not connected to any remote monitoring equipment. In order to measure and observe the stator temperatures, test instruments must be connected within the reactor building. Each RBCU has a single vibration sensor mounted on the fan housing that provides an alarm in the control room when vibration exceeds its setpoint. Detailed vibration analysis requires mounting and monitoring of a number of sensors on the fan motor inside the housing. Therefore, troubleshooting requires a special test procedure to control installation and monitoring of the test equipment and to control the operating configuration (number and speed of operating fans, etc.).

TS 3.6.5 requires, in part, that two RBS trains and three RBCUs be Operable in Modes 1 and 2. Should one of these five cooling trains be inoperable, it must be restored to Operability within 7 days per TS 3.6.5 Required Action B.1. If Required Action B.1 is not met, Condition D must be satisfied by placing the Unit in Mode 3 within the next 12 hours.

At time of discovery of this event, Unit 3 was shutdown in Mode 6 with no safety systems or components out of service that would have contributed to this event.

EVENT DESCRIPTION

Unit 3 was shutdown on 2/16/01 for a scheduled maintenance outage.

On 2/26/01, voltage and current data were taken on the Unit 3 RBCU motors. The results on the 3A and 3C RBCU motors were acceptable. Data for the 3B RBCU indicated the need to verify actual stator temperatures.

On 3/7/01, while Unit 3 was in Mode 6, a special test was initiated on the 3B RBCU to monitor motor stator temperatures during operation with all three of the RBCUs at the low (emergency) speed. After running in low speed for approximately 4 hours, the stator temperature data for the 3B RBCU exceeded the stator temperature acceptance limit.

Engineering made the recommendation that the 3B RBCU be considered inoperable and that the motor be replaced. Engineering further concluded that the motor should be considered inoperable since installation in December 1999, after extensive evaluation determined that the problem was a design configuration and tolerance issue. Therefore, Oconee Unit 3 operated with one inoperable RBCU between 12/19/99, when the 3B RBCU was declared operable following completion of replacement of the previous motor, and 2/16/01 when Unit 3 was shutdown for maintenance. This duration exceeds the seven day out-of-service time allowed by TS 3.6.5.

CAUSAL FACTORS

Duke Engineering has concluded that the high stator temperature on the 3B RBCU Motor was due to saturation of the magnetic circuit at low speed due to their unique two-speed winding design. Two design issues caused the stator temperature to exceed operability limits:

a) a generic issue affecting all RBCU motors, which is lack of sufficient cross-sectional area of the magnetic circuit components (i.e. insufficient core iron) and
b) a specific issue affecting the 1B and 3B RBCUs, which is a larger than normal air gap between the stator and rotor.

Motor magnetic materials (core components) have a characteristic such that the Ampere-turns required to generate a given flux density (flux divided by the area) is linear up to a given flux. The condition at this flux density is known as saturation of the magnetic circuit. Once this point is exceeded, the Ampere-turns needed to increase flux becomes non-linear and motor heat generation (proportional to the square of the current) increases significantly. In order to keep the size of a motor within reason, it may be economical or practical to design the magnetic circuit to operate a reasonable amount above the linear saturation line.

The root cause of this event is design deficiency by the vendor. As a result of the FIP team investigation, Duke determined that the original RBCU Motors were marginally designed with respect to saturation of the magnetic circuit in the stator. The motor manufacturer, the fan qualifier and supplier, and Duke Power Engineering personnel were unaware that the design was marginal prior to these events.

One result of the marginal design is that nominal voltage values produce an exaggerated stator temperature response. The RBCU motors (nameplate voltage of 575 VAC) were specified for use at a nominal 600 VAC with an expected post-accident range of 540-614 VAC (i.e +/- 6% of nameplate rating). The RBCU motors operating at low speed were found to reach saturation conditions at around 95%-100% of rated voltage due to their specific two-speed winding design. Therefore, RBCU motor temperature response becomes non-linear at rated voltage, and thus can exhibit higher than desired stator temperatures, especially at the high end of the allowed terminal voltage range.

Another result of the marginal design is that the machine is extremely sensitive to larger than design air gap lengths. Because this sensitivity was not recognized, unsatisfactory tolerances were allowed which worsened the stator temperatures at higher voltages and resulted in marginal or unacceptable performance. Also, there was not appropriate guidance to monitor stator temperatures after maintenance or during normal operation. This conclusion is further supported by the fact that a new motor was manufactured after 1998 with a larger than nominal air gap (a deviation from nominal in the order of 0.005 inch) as shown by manufacturer's inspection and test data. The manufacturer's Engineering Department deemed it to be within tolerance. It was installed as the 1B RBCU motor in April 2000. Special testing in November 2000, as mentioned in the Background section, identified that its operation was marginal so it was replaced in December 2000.

The 3B RBCU motor also had larger than normal air gap between the stator and rotor, with a deviation from nominal in the order of 0.010 inch. The fact that the 3B RBCU had the largest gap caused the 3B RBCU motor to reach stator temperatures in excess of the operability limit.

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Duke Engineering has concluded that this design issue applies only to RBCU motors operating at low speed and is due to certain aspects of this specific two-speed winding design.

CORRECTIVE ACTIONS

Immediate:

1. The 3B RBCU motor was replaced. Motor stator temperature monitoring was included during Post-Maintenance Testing and demonstrated acceptable stator temperatures.

Subsequent:

1. Screening of the Unit 2 RBCUs found acceptable stator temperatures based on the voltage/current correlation. As a result, all nine (9) installed RBCU motors at Oconee have now been tested or screened for acceptable stator temperatures.

2. Duke and the vendors have addressed the design issues raised in this report. The specification for new RBCU motors has been revised to assure that new replacement RBCU motors have greater margin to operate with acceptable stator temperatures.

Planned:

1. A report containing the results of the Duke Failure Investigation Process for the high stator temperatures of the 1B and 3B RBCU is being sent to the appropriate vendors.

2. A proposed revision to the directive that specifies Post-Maintenance Testing requirements (WPM 501) will be reviewed for acceptance. This revision addresses enhancements to testing requirements for motors following replacement.

3. The maintenance procedure specifically applicable to RBCU motor replacements will be revised to routinely require measurement of motor stator temperatures for future RBCU motor replacements.

There are no NRC Commitment items contained in this LER.

SAFETY ANALYSIS

During a design basis event (i.e. LOCA or steam line break inside containment), the 3B RBCU would have started and would have contributed to the mitigation of the event. Provided that station voltages remained at median values or with-in acceptable under-voltage limits, the 3B RBCU would have been capable of performing its safety function.

However, if voltages were higher than normal, the stator temperatures might exceed the temperature for which the motor has been qualified in a steam and pressure environment, even though it would not have exceeded the demonstrated thermal capabilities of the insulation system. Therefore, it could be anticipated that the 3B RBCU would initially contribute to the mitigation of the event, but might fail later in the event. As a result, Engineering has concluded that there is reasonable doubt that the 3B RBCU would have performed successfully for the full mission time after a design basis event.

The Oconee UFSAR takes credit for two of the three RBCUs operating after an event (thus allowing for a single failure of the third RBCU). Testing performed on the 3A and 3C RBCUs indicated acceptable stator performance. Therefore, the 3A and 3C RBCUs are considered to have been operable for the period that the 3B RBCU has been inoperable.

In addition, an evaluation was performed of the capability of each of these RBCUs to transfer heat in the post-accident environment. This evaluation considered the capability of the available containment heat removal systems and components to meet the containment heat removal requirements using actual initial conditions (such as containment and ultimate heat sink temperatures, cooling coil fouling coefficients, etc.) for the period that the 3B RBCU is now considered inoperable. This evaluation concluded that either remaining RBCU alone was capable of handling the required heat load. Therefore, the RBCU system was still capable of performing the required safety function, even with an additional assumed failure. As a result of this conclusion, this event is not a safety system functional failure.

The primary role of the RBCUs is long term prevention of containment overpressurization. The RBCU function is only weakly correlated to the large early release frequency (LERF). The LERF for Oconee is dominated by containment bypass sequences, in particular the interfacing system loss of coolant accidents, which are not affected by RBCU operation. The only influence of the RBCUs on the core damage frequency (CDF) is as an alternative means of cooling the containment sump water indirectly by cooling the containment atmosphere, thereby reducing the reliance on the LPI coolers. The unavailability of a single RBCU does not measurably increase the estimated CDF for Oconee. Therefore, the impact on CDF and containment performance, including LERF, was evaluated to be insignificant.

Therefore, there was no actual impact on the health and safety of the public due to this event.

ADDITIONAL INFORMATION

A review of events over the previous three years found several instances of RBCU motor problems. A December 1999 failure of the 3B RBCU was reportable under 10 CFR 50.73 (reference LER 287/1999-02). The cause of that event was significantly different from this event and the corrective actions would not be expected to prevent this event. Also, there is some similarity to the November 2000 1B RBCU event, which is described in the Background section above. However, this event was initiated by installation of a motor with an unknown design deficiency prior to the November 2000 event, and was discovered as a result of the on-going corrective actions from the November 2000 event. Therefore, this is not considered a recurring event.

This event is considered reportable under the Equipment Performance and Information Exchange (EPIX) program. The RBCUs were initially purchased from, and certified by, Joy Manufacturing Company (presently Howden Buffalo, New Philadelphia Division). The RBCU motors are 150/75 HP, 1200/600 RPM, 575 VAC, Model 600276-3, NEMA Frame Number D5005 and were made by Rockwell International, Reliance Electric Division. The 3B RBCU motor that is the subject of this report had been rebuilt on-site prior to installation.

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There were no releases of radioactive materials, radiation exposures or personnel injuries associated with this event.

Energy Industry Identification System (EIIS) codes are identified in the text within brackets [ ].