NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
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EXPIRES: 8/31/88

LICENSEE EVENT REPORT (LER)

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TITLE (4) An Inadequate Procedure During Construction Resulted In Improperly Sized Motor Thermal Overload Protection

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)
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OPERATING MODE (9)	5	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11)			
POWER LEVEL (10)	0 0 0	20.402(b)	20.405(c)	50.73(a)(2)(iv)	73.71(b)
		20.405(a)(1)(i)	50.38(c)(1)	50.73(a)(2)(v)	73.71(c)
		20.405(a)(1)(ii)	50.38(c)(2)	50.73(a)(2)(vii)	OTHER (Specify in Abstract below and in Text, NRC Form 366A)
		20.405(a)(1)(iii)	XX 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
J. L. Long, Plant Operations Review Staff	6 1 5 8 7 0 - 7 2 5 4

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)	XX NO				

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

This LER has been revised in its entirety to detail several problems that are associated with thermal overload (TOL) protection devices. The most recent events involved the TOLs being incorrectly sized. There were several root causes for these problems identified, including nonconservative assumptions in design calculations and lack of coordination between design and maintenance. To provide the desired margin for safe operation, the applicable calculations were revised and the associated TOLs were replaced accordingly. In order to prevent recurrence of these events, a procedure method was prepared to ensure all limiting conditions in design documents are identified on the design output document. Also, before the replacement of TOLs requiring different sizes, a design change will be issued and design drawings will be revised. This will prevent maintenance from changing TOL sizes without obtaining a design change.

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This LER is revised in its entirety to include additional information relevant to this event.

DESCRIPTION OF EVENT

On November 24, 1986, with units 1 and 2 in mode 5 (cold shutdown), Calculation SQN-APS-003, "480V AC APS Class 1E Load Coordination Study," was completed. This calculation revealed that the thermal overload (TOL) devices that protect various motor-operated valves (MOVs) and other safety-related low voltage motors were improperly sized. As a result, on December 1, 1986, TVA initiated Significant Condition Report (SCR) SQNEEB8616) to describe the potential concerns with the TOL devices. The report concluded that not all TOLs that were installed would allow the MOVs to function as required by Regulatory Guide (RG) 1.106, "Thermal Overload Protection for Electric Motors on Motor-Operated Valves," and that not all safety-related motors were assured of performing their safety function for all conditions within the design basis of the plant. The TOLs originally installed during construction were selected in accordance with guidelines furnished by Division of Nuclear Engineering (DNE) (formally Division of Engineering Design) that did not require compensation for ambient temperature variations. The result was that the TOLs operated properly for the ambient temperature at which they were selected and tested but in some cases the potential existed for the TOLs to trip undesirably at the upper temperature limit of the plant design basis.

Before this event on March 29, 1984, the plant technical specifications were revised to delete a requirement to test MOV TOL protection bypass devices because the requirement was not applicable to Sequoyah Nuclear Plant (SQN). At that time TVA considered SQN to be in compliance with RG 1.106 such that the trip setpoints for the TOL protection devices were established with all uncertainties resolved in favor of completing the safety-related action.

On February 28, 1987, with both units in mode 5, Condition Adverse to Quality Report (CAQR) SQT870102 was initiated documenting a deficiency in Calculation N2-NCR 8119, "Safety Evaluation of NCR SQNEEB8119 R1." The calculative method which determined the transient and steady-state motor terminal voltages did not consider the impedance of the TOLs, and therefore, the worst-case calculated motor terminal voltage could be less than the minimum voltage level for which the motors are qualified to start. To determine specifically which loads could have had terminal voltage less than the minimum qualified (typically 80 percent of nameplate voltage rating), Calculation OE2-EEB CAL 001, "AC APS Voltage and Loading Analysis," was performed. The calculation revealed that four safety-related MOVs would have terminal voltages less than the minimum qualified for a period of time such that the maximum allowable stroke time as delineated in the plant technical specifications and the Final Safety Analysis Report could be

exceeded. The loads that could have terminal voltages less than qualified are: (1) 2-FCV-26-243 which is a containment isolation valve that isolates high pressure fire suppression water to the reactor coolant pump spray nozzles during a phase A containment isolation, (2) 2-FCV-62-61 which is a containment isolation valve that isolates leakoff from reactor coolant pump seal charging through the reactor coolant to the seal water heat exchanger during a phase A containment isolation, (3) 2-FCV-26-245 which is an isolation valve for the high pressure fire protection system to the annulus sprinkler system, and (4) 2-FCV-63-40 which is the safety injection system boron injection tank isolation valve that opens for emergency core cooling from the charging pumps through the boron injection tank during a safety injection.

Subsequent to performing Calculations SQN-APS-003 and OE2-EEB-CAL001, a walkdown was conducted to obtain the sizes of the installed TOLs. The walkdown data was compared with the calculated TOL sizes and Engineering Change Notice (ECN)-L6883 was issued to correct the deficiencies. Upon completing the field modifications specified in ECN-L6883, TVA considered that the installed TOLs would allow units 1 and 2 to be safely operated. However, several pieces of equipment, that were not required to operate to ensure safe plant operation and/or ensure adequate shutdown capabilities, remained with incorrectly sized TOLs. Thus, the previously stated concerns associated with TOLs at SQN had not been fully resolved.

On December 18, 1987, with both units in mode 5, Work Request (WR) B289977 was initiated when the safety injection pump 2A-A room cooler fan tripped on overload. During the performance of WR B289977, Electrical Maintenance personnel verified the integrity of the motor winding and cable insulation. As a part of the maintenance performed, the motor starter (excluding the TOLs) was replaced. After maintenance was completed the room cooler was operated for approximately 30 minutes as a postmaintenance test to ensure that the cooler was acceptable to return to service. Subsequent to successfully completing the postmaintenance test, the room cooler was returned to service by Operations on February 18, 1988. Approximately one and one-half hours after the room cooler was placed in service the fan motor tripped a second time. WR B284559 which was initiated to investigate the cause of the trip, revealed that the motor had again tripped on overload. At this point Electrical Maintenance personnel coordinated the replacement of a larger TOL in accordance with Maintenance Instruction (MI)-10.52, "Replacement of Thermal Overload Heaters," with Division of Nuclear Engineering - Electrical Engineering Branch. The new TOLs were installed and the cooler was returned to service on February 19, 1988.

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On January 18, 1988 with both units in mode 5, CAQR SQP880033 was initiated when six out of eight TOLs did not trip within the time required by Surveillance Instruction (SI)-251.1 "Channel Calibration of Class 1E Motor Operated Valve Overload Relay Heaters - Units 1 and 0" and SI-251.2 "Channel Calibration of Class 1E Motor Operated Valve Overload Relay Heaters - Units 2 and 0." Investigation into the CAQR revealed that the method for testing the TOLs differed from the criteria established in selecting the TOLs. This resulted in the application of test currents less than that which the TOLs were rated to trip for a specified time range, and consequently, caused the TOLs to exceed the maximum allowable trip time. Further, the TOLs that were tested had been previously identified in SCR SQN EEB86167 as being incorrectly sized but not required for safe operation or safe shutdown of either unit. Therefore, the TOLs were being tested by motor nameplate date as though they were correctly sized. Since it was already established that the TOLs were incorrectly sized, it would not be expected that they would trip within the timeframe for the correct TOLs.

On February 19, 1988, with unit 1 in mode 5 and unit 2 in mode 4, motor-operated valve 2-FCV-1-15 tripped during the performance of Surveillance Instruction (SI)-118.1, "Turbine-Driven Auxiliary Feedwater Pump and Valve Automatic Actuation." During normal operation of the turbine-driven auxiliary feedwater pump (TDAFWP), steam is supplied through 2-FCV-1-15 from steam generator 1 to the TDAFWP turbine. In the event of a low pump discharge pressure, 2-FCV-1-15 will automatically close after a time delay and 2-FCV-1-16, which controls the steam supply for the TDAFWP from steam generator 4, will open. Upon investigation of the event, it was determined that two problems existed. The first problem was that the TOLs were sized incorrectly for the nameplate current rating of the motor. The second problem was that a spring was discovered missing from the main contact assembly for the MOV starter. Further investigation revealed that the motors for the actuators for 2-FCV-1-15, 2-FCV-1-16, 2-FCV-1-17, and 2-FCV-1-18 had been replaced for environmental qualification concerns as a part of ECN L6823 that was issued on December 11, 1986. The replacement motors were larger (1.6 HP) than the one that was previously installed (1.0 HP) and, therefore, demanded more current. As a result of the two conditions, the current experienced by the TOLs for 2-FCV-1-15 was not only for a larger motor than the TOLs were designed for, but was also for a motor that had a current imbalance approaching a "single-phasing" condition. To correct the deficiencies described, the missing spring in the starter was replaced and Design Change Notice (DCN) 00169A was issued to replace the TOLs with properly sized TOLs.

Because of the implied generic problem from these two events that occurred within a relatively short period of time, the Division of Nuclear Engineering initiated an investigation to determine the cause(s) of these events. As part of the investigation, calculation SQN-APS-003 was reviewed, and it was concluded that the assumption that was used to justify the existing TOL sizes (by restricting motor loading) had not been communicated within Electrical Engineering Branch (EEB) or to other DNE organizations. The assumption in the calculation took credit for a procurement specification requirement that cooler fan motors be oversized by 15 percent. As a result, the calculation assumed the full load current for the cooler fan motors to be 85 percent of nameplate value. Subsequent to issuing the calculation, problems were encountered with engineered safety features equipment room coolers as described in LERs SQRO-50-327/87037 and 87072, and a program to optimize room cooler performance was undertaken. During this program, an increase in air flow across the coolers was obtained by replacing sheaves. Replacing the sheaves resulted in exceeding the 85 percent of nameplate rating assumed in the calculation; however, the only restriction that was imposed on motor loading during this program was that the nameplate full load current could not be exceeded. As a result, the margin between the normal operating current and the thermal overload trip setpoint was reduced. On February 20, 1988, with unit 1 in mode 5 and unit 2 in mode 4, CAQR SQP 880170 was initiated as a result of the calculation deficiency.

After the immediate causes of the events were determined, prompt action was taken to identify the equipment that was protected by TOLs that did not provide a margin for operation sufficient to ensure that the safety function of that equipment would not be interrupted. This action was accomplished by revising calculation SQN-APS-003 to delete the assumption that room cooler fans were purchased oversized and based the new TOL sizes on motor nameplate data and test data obtained during the program for optimizing cooler fan performance. Additionally, a review was conducted on a sample of ECNs that involved valve actuator replacements to determine if other valve actuator motors had been replaced without consideration of the TOLs sizes. After the calculation was revised and the reviews were completed, it was concluded that the TOLs for the other MOVs were sized correctly; however, six additional fans were determined to have TOLs that were smaller than desired to provide sufficient margin to preclude inadvertent interruption of service of safety-related equipment. The six fans are (1) centrifugal charging pump 2B-B room cooler fan, (2) elevation 669.0 penetration room cooler fan 2B-B, (3) containment spray pump 2B-B room cooler fan, (4) spent fuel pit pump B-B space cooler fan, (5) 480V board room 1B air handling unit 1B-B, and (6) diesel generator 1B-B electrical board room exhaust fan. Subsequent to discovery, DCNs X00170A and X00171A were issued and the improperly sized TOLs were replaced. After the TOL replacement was complete, DNE-EEB considered the TOLs to be sized such that spurious operation would not occur.

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On February 22, 1988, with unit 1 in mode 5 and unit 2 in mode 4, CAQR SQP 880169 was initiated describing a condition where Electrical Maintenance personnel were allowed to size TOLs in accordance with MI-10.52 without DNE-EEB concurrence. As a result, TOLs that had been replaced under ECN L6883 could have subsequently been replaced with different sized TOLs. Between March 1 and March 4, 1988, DCNs X00170B, X00170C, X00171B, and X00171C were issued to replace TOLs with the calculated sizes. Before March 1, 1988, the TOLs that were installed were considered to be adequate to preclude spurious operation; however, many of the TOLs were not sized in accordance with Quality Information Request/Release (QIR) EEB 87031, "Motor Overload Heater Selection." The subject DCNs replaced the TOLs such that the desired margin between normal operation and overload trip setpoint existed. To resolve CAQR 880169, an informal walkdown was performed to determine specifically which TOLs had been replaced by Electrical Maintenance. The walkdown was completed on March 15, 1988, and the results concluded that seven deficiencies existed. These are (1) 2-FCV-070-0183A - component cooling sample heater outlet valve could not read size markings on TOL, (2) 2-MTRB-313-0475A - 480-volt board room 2A pressurization fan 2A-A as found size was smaller than calculated, (3) 1-FCV-74-21 - RHR pump 1B-B inlet flow control valve TOL should be removed and a shorting strip installed, (4) 2-MTRB-313-522 - 125-volt vital battery room III exhaust fan TOL installed is larger than calculated, (5) 2-MTRB-313-497B - 125-volt vital battery room IV exhaust fan as found size larger than calculated, (6) 1-MTRB-030-0459 - Diesel Generator 1A-A 480-volt auxiliary board room as found size smaller than calculated size, (7) 1-FCV-67-0081 - Auxiliary Building ERCW supply header A isolation valve could not read the installed TOL; however, calculation calls for the smallest available size, and therefore, the installed TOL is equal to or greater than the required size.

Because the DCNs had not been completed before the walkdown was conducted, many of the TOLs identified as being incorrectly sized during the walkdown had already been addressed by the DCNs but had not yet replaced. As a result, only the TOLs for 2-FCV-70-183 and 2-MTRB-313-475 (component cooling system sample heat exchanger discharge isolation valve and 480V board room pressurization fan 2A-A, respectively) required replacement. WR B220133 and WR B220135 were issued to replace the subject TOLs. Subsequent to replacing TOLs, all installed TOLs for equipment required to support unit 2 operation were in agreement with calculation SQN-APS-003. Therefore, the desired margin between normal operation and the TOL trip setpoint existed.

CAUSE OF EVENT

As stated previously, the cause of improperly sized TOLs during construction was that the guidelines furnished by DNE to select TOLs was inadequate. The procedure did not provide guidance for compensating for temperature variations when selecting and testing TOLs and resulted in TOLs that did not provide the desired margin between normal operation and TOL trip setpoint. Since SQN assumed the method for sizing TOLs to be acceptable in 1984, TVA considered SQN to be in compliance with RG 1.106.

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The cause of not including the impedance of TOLs in calculation N2-NCR8118 was a deficient calculation method. The calculation method utilized to perform calculation N2-NCR8119 incorrectly assumed the impedance of the TOLs to be negligible, when in fact, the voltage drop across the TOL was greater than that voltage drop attributed to the cable in some instances.

The cause for improperly sized TOLs subsequent to room cooler modification was that a nonconservative assumption in calculation SQN-APS-003 (that justified the existing TOLs) was not adequately communicated within the DNE-EEB organization or to other DNE organizations by DNE-EEB. This resulted in the margin between the normal operating current of the room cooler fans and the trip setpoint of the TOLs being greatly reduced.

The cause of not considering the size of the TOLs when 2-FCV-1-15, 2-FCV-1-16, 2-FCV-1-17, and 2-FCV-1-18 were replaced, was inattention to detail by the designer. Sequoyah Engineering Procedure (SQEP)-09 "Change Review Checklist for Electrical Calculations was available and was utilized during the preparation of ECN L6823. SQEP-09 provides a thorough checklist for the determination if electrical calculations are required to support and ECN, DCN or Field Change Request (FCR). In this instance, the motors and other electrical components were being changed out by the ECN, however, the designer either did not recognize that the motor size was being changed or recognized that the size was being increased but did not consider the increase in size to adversely affect the size of the TOLs. In either case the designer review of the ECN with regard to the need for supporting electrical calculations was inadequate.

The cause of TOLs being replaced by Electrical Maintenance personnel with TOLs of sizes different than the calculated TOL size was that MI-10.52 provided different guidance in selecting and testing TOLs than that used in determining TOL sizes in DNE calculations. Also, before January 19, 1988, TOL sizes were not included on drawings and hence there was no control of TOL change outs by SQN. The cause of MI-10.52 having different guidelines for selecting and testing TOLs from that established by DNE-EEB was the lack of a design output document which specified the TOL sizes required for replacements.

ANALYSIS OF EVENT

This event is reported pursuant to 10 CFR 50.73, paragraph a.2.ii, as a condition found while the reactor was shutdown that could have resulted in the nuclear power plant being outside the design basis.

The TOLs that were selected and installed during construction did not have the desired margin between normal operation and the trip setpoint of TOLs primarily because the procedure did not compensate for temperature variations. The upper limit of the design basis temperature for the electrical board where the TOLs are located is 104 degrees F. However, the overloads were selected and tested at ambient temperature conditions. Since TOL operation (trip time) is temperature dependent and the trip time of the TOLs decreases as temperature increases, the TOLs would trip sooner at higher temperatures and the margin between normal operation of equipment and the trip setpoints of the TOL would be reduced. Therefore, the potential for spurious operation of the TOLs and consequential interruption of equipment service increases with temperature.

Another consequence of the TOLs being sized smaller than desired is an increase in voltage drop across the TOL. The larger voltage drop across the TOL would reduce the motor terminal voltage. As previously mentioned, four MOVs had voltage less than the qualified value. All four MOVs determined to have voltage less than qualified by CAQR SPT 870102 have redundant valves such that the safety function could be performed. Additionally, the spray nozzles which would be isolated by 2-FCV-26-243 and 2-FCV-26-245 open only during a fire, and therefore, if these valves did not isolate during accident conditions, neither inside containment nor the annulus would be sprayed down. Therefore, safe shutdown capability and the ability to clean up releases would not be impaired.

The starter with a missing spring would not have prevented safe shutdown because two motor-driven auxiliary feedwater pumps would have been available for supplying feedwater to two steam generators each. Also, even though 2-FCV-1-16 would not automatically open unless 2-FCV-1-15 closed, it could have been manually opened by operator action. The accident analysis described in Chapter 15 of the SQN Final Safety Analysis Report (FSAR) have shown acceptable consequences for all design basis accidents provided at least two steam generators are available for reactor coolant system heat removal. Since two motor-driven pumps were available with each supplying feedwater to two steam generators, only two steam generators are needed for safe shutdown.

The TOLs that were replaced by MI-10.52 because they did not meet the acceptance criteria prescribed in SI-251.1 and SI-251.2 would also have reduced the margin between normal operation and the TOL trip setpoint. As with the TOLs sized during construction, the potential for spurious operation of the TOLs and consequential interruption of equipment from service would be increased. Subsequent to the room cooler improvement program, the margin for operation of the fans was reduced because the motor loading and current demand were increased.

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CORRECTIVE ACTION

The immediate corrective action associated with the improperly sized TOLs was to determine the correct TOL sizes and replace the TOLs. As previously stated, improperly sized TOLs were replaced by ECN L6883, DCNs X00169A, X00170A, X00170B, X00170C, X00171A, X00171B, X00171C, WR B220133, and B220135. Also, a review of MOV test data was performed to ensure that other MOV starters were functioning properly.

To correct calculation SQN-APS-003, the nonconservative assumption for room cooler fan oversizing was deleted and the calculation was revised accordingly. To prevent recurrence of not communicating operational restrictions and limitations, DNE-EEB has issued Procedure Method 88-03. This document will ensure the control of limiting conditions used in preparing calculations. All limiting conditions will be identified on DNE output documents.

To ensure other DNE-EEB calculations receive an adequate review for calculations to support an ECN, DCN, or FCR, DNE-EEB has issued Sequoyah Engineering Procedure-09, "Change Review Checklist for Electrical Calculations." This procedure identifies all the electrical parameters that when affected by a modification require revised calculations to support issuance of ECNs, DCNs and FCRs.

To prevent TOLs from being replaced with different sizes by EM, TOL sizes are now specified on TVA drawings. This will prevent EM from changing TOL sizes without obtaining a design change.

ADDITIONAL INFORMATION

The starter is a full voltage, 3-pole reversing type starter, manufactured by Arrowhart.

COMMITMENTS

None.

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TENNESSEE VALLEY AUTHORITY
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May 24, 1988

U. S. Nuclear Regulatory Commission
Document Control Desk
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Centlemen:

TENNESSEE VALLEY AUTHORITY - SEQUOYAH NUCLEAR PLANT UNIT 1 - DOCKET NO. 50-327 - FACILITY OPERATING LICENSE DPR-77 - REPORTABLE OCCURRENCE REPORT SQRO-50-327/88049 REVISION 1

The enclosed revised licensee event report provides details concerning an inadequate procedure during construction resulting in improperly sized motor thermal overload protection. This event was originally reported in accordance with 10 CFR 50.73, paragraph a.2.i, on September 5, 1987.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

S. J. Smith
Plant Manager

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