Omaha Public Power District
444 South 16th Street Mall
Omaha, Nebraska 68102-2247
402/636-2000

September 22, 1995
LIC-95-0175

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Mail Station P1-137
Washington, DC 20555

Reference: Docket No. 50-285

Gentlemen:

Subject: Licensee Event Report 95-006 Revision 00 for the Fort Calhoun Station

Please find attached Licensee Event Report (LER) 95-006 Revision 00 dated September 22, 1995. This report is being submitted pursuant to 10 CFR 50.73(a)(2)(i), 10 CFR 50.73(a)(2)(ii),and 10 CFR 50.73(a)(2)(vii). If you should have any questions, please contact me.

Sincerely,

for

T. L. Patterson
Division Manager
Nuclear Operations

TLP/epm

Attachment

c: Winston and Strawn
L. J. Callan, NRC Regional Administrator, Region IV
S. D. Bloom, NRC Project Manager
W. C. Walker, NRC Senior Resident Inspector
INPO Records Center

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NRC FORM 366 (5-92)

U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104
EXPIRES 5/31/95

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)

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

FACILITY NAME (1)	DOCKET NUMBER (2)	PAGE (3)
Fort Calhoun Station Unit No. 1	05000285	1 OF 9

TITLE (4)
Inoperability of Number 1 Diesel Generator Discovered Following a Reactor Trip

EVENT DATE (5)			LER NUMBER (6)			REPORT NUMBER (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
08	24	95	95	-- 006 --	00	09	22	95		05000
									FACILITY NAME	DOCKET NUMBER 05000

OPERATING MODE (9)	1
POWER LEVEL (10)	100

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

	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)	X	50.73(a)(2)(vii)		OTHER
	20.405(a)(1)(iii)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)(A)		(Specify in Abstract below and in Text, NRC Form 366A)
	20.405(a)(1)(iv)	X	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 (Include Area Code)
William J. Blessie, Shift Technical Advisor	(402) 533-6896

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
X	YES (If yes, complete EXPECTED SUBMISSION DATE)	NO		11	30	95

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On August 24, 1994, at 1114, the Fort Calhoun Station experienced a reactor trip. The reactor trip provided a start signal to the diesel generators (DG-1 and DG-2) as designed. While DG-2 started to idle speed (500 rpm) as designed, DG-1 started to full speed (900 rpm). A subsequent operability evaluation for DG-1 determined that the diesel had been inoperable for an 8 day period prior to the reactor trip. The inoperability of the diesel generator was due to insufficient time for the 480 VAC load center load shed relays to operate in the event of degraded off-site power with the DG-1 governor already set at 900 rpm. The reactor trip is detailed in LER 95-005.

The causes of this event are 1) the operator appears to have operated the generator voltage regulator control switch instead of the governor control switch during the previous surveillance test, 2) there were inadequate administrative controls on this critical parameter, and 3)there is no indication of governor position.

Corrective actions include providing additional administrative controls to ensure that the governor is operated correctly, installation of a modification to provide a positive means of governor indication to the operators, and updating design and training documentation. Additional engineering analysis will be conducted and results reported in a revision to this LER.

BACKGROUND

The Fort Calhoun Station (FCS) Emergency Diesel Generators (DG-1 and DG-2) are designed to furnish a reliable source of 4160 VAC power for safe plant shutdown and for operation of Engineered Safeguards equipment. The diesel generators will energize the Engineered Safeguards buses on either a total Loss Of Off-site Power (LOOP) or a degraded voltage condition concurrent with an accident requiring Safety Injection. The degraded voltage protection logic is referred to as the Off-site Power Low Signal (OPLS). The diesel generators are normally aligned in a standby mode. They are ready to automatically start, come up to rated speed and voltage, and energize the Engineered Safeguards buses when required.

The diesel generators will automatically start and accelerate to idle speed (500 rpm) on any of the following signals 1) reactor trip, 2) containment pressure high signal, 3) pressurizer pressure low signal, 4) manual initiation of safeguards or 5) selecting a diesel start test switch to idle speed. There are three signals that will accelerate the diesel generators to full speed (900 rpm) following an automatic start signal; 1) initiation of either the "A" or "B" channels of OPLS, 2) low voltage on the 4160 VAC safeguards buses, 3) a diesel start test switch selected to full speed. Additionally, if the governor speed control is left in a position other than the lower stop, the diesel will accelerate to a speed other than the idle speed if the diesel receives any idle speed start signal.

Load shed circuitry is in place to maintain diesel generator loading within the engine load limits. In the unlikely event of a Loss of Coolant Accident (LOCA) and a LOOP, the following five load shed circuits must operate to trip sufficient loads to allow automatic loading of the Emergency Diesel Generators and maintain initial loading within the engine loading limits:

1. OPLS 4160 VAC Load Shed trips all 4160 VAC loads except the 4160 VAC/480 VAC transformers using auxiliary relays which are actuated by the OPLS lockout relays. The OPLS 4160 VAC load shed can be considered an instantaneous load shed (the only time delay being the time required for the relay/breaker to operate).

2. OPLS 480 VAC Load Shed trips selected 480 VAC loads using auxiliary relays, actuated by the OPLS lockout relays, located in the 480 VAC Safety Injection Actuation Signal (SIAS) Load Shed panels. OPLS 480 VAC load shed can be considered an instantaneous load shed (the only time delay being the time required for the relay/breaker to operate).

3. 480 VAC SIAS Load Shed operated by the SIAS lockout relays load sheds selected 480 VAC loads using auxiliary relays located in the 480 VAC SIAS Load Shed panels. The SIAS 480 VAC load shed can be considered an instantaneous load shed (the only time delay being the time required for the relay/breaker to operate).

4. Loss of voltage to selected MCC contactors results in seal-in circuits being deenergized. The loads are prevented from restarting when the Diesel Generator reenergizes the MCC. Contactor dropout can be considered an instantaneous load shed (the only time delay being the time required for the contactor to operate).

5. 480 VAC Load Center Load Shed operates using a time verses voltage undervoltage relay and a fixed time delay relay to initiate load shed via auxiliary relays. Data contained in engineering analysis, EA-FC-93-027, "Loss of Voltage IAV Relay Setpoints" (the initials "IAV" meaning undervoltage) shows a time delay to trip of a breaker of 3.15 seconds (worst case including uncertainties).

DETAILED EVENT DESCRIPTION

Fort Calhoun Station was operating at 100% power on August 24, 1995, when the reactor tripped. The reactor trip is detailed in LER 95-005. On a reactor trip, DG-1 and DG-2 both receive an auto-start signal to start the engines and accelerate them to idle speed. Both diesel generators started as designed, however, DG-1 accelerated to full speed. After recovery actions were completed, the control room operators performed a normal shutdown of DG-1.

A review of the post trip sequence of events records from the plant computer found no indication of initiation of either the "A" or "B" channels of OPLS during this event. In addition, there was no evidence of a 4160 VAC undervoltage condition during the event.

Since an acceleration signal is not sealed in for a bus undervoltage condition, the low voltage condition would have had to exist for the seven seconds (approximate time) that it takes for the diesel to accelerate from idle speed to full speed. Thus, if an inadvertent or transient signal was only briefly present the diesel generator would not have had time to accelerate to full speed. Therefore, it may be concluded that, the loss of voltage relays was not responsible for accelerating DG-1 to 900 rpm.

A full speed test is actuated by a manually operated key lock test switch (43-2A/D1 or 43-2B/D1) on the diesel control panel (AI-30A). Operator action is required to initiate this start, and would only be performed if the diesel generator failed to auto start.

Since the cause of the full speed start could not be readily identified, MWO 952826 was initiated to troubleshoot the diesel generator governor control circuitry. As part of the troubleshooting effort, the engine was given an idle speed start signal and verified to accelerate to idle speed. The engine was then manually accelerated to 900 rpm and loaded. All engine parameters were normal. The engine was then unloaded and shut down normally. The governor controls worked as designed and no problems were noted. The diesel was then started per OP-ST-RPS-0008, "Reactor Manual Trip Test," which initiates a reactor trip auto start signal. The engine started and accelerated to idle speed as designed.

Following each shutdown of the diesel engines, there is a procedural step that requires the governor control switch be held in the "LOWER" position for at least 15 seconds. This step ensures that the governor is set up for an idle speed start the next time it is run. If this step were omitted, the engine would automatically accelerate to full speed on any start signal. Discussions with operations and engineering personnel indicate that the step to run down the governor was included in plant procedures to reduce the rate of wear on the engine due to starting it to fast speed. More detailed consideration of the interaction of plant equipment has raised the concern of the ability of the diesel to perform its intended safety function after a full speed start under certain conditions.

Prior to the August 24, 1995 incident, DG-1 had last been run on August 16, 1995, for its normal monthly surveillance test. A review of the completed test procedure showed that the step to run the governor to its idle speed position had been signed off. It is suspected that the step may have been inadvertently performed on the diesel generator voltage regulator switch, which is identical to the governor control switch. The switches are next to each other. Both switches are used during the monthly surveillance test. At the end of the test, only the governor switch is required to be operated in the "LOWER" position.

If the voltage regulator control switch were operated in the "LOWER" position instead of the governor control switch, the following events would occur the next time the diesel generator was started.

1. The diesel would accelerate to the same speed (frequency) that it had the last time that it had been running.

2. The generator output voltage would be at a lower voltage than the last time it had been operating.

The physical evidence that suggests that the voltage regulator switch was mispositioned when DG-1 was last run is as follows:

1. The diesel was shut down from a frequency of between 59.5 and 59.7 Hz. Following the plant trip, DG-1 started and accelerated to nearly the same frequency, 59.3 to 59.7 Hz, suggesting the governor switch had not been adjusted after the last diesel run. Following an actual emergency start, the diesel generator would be accelerated to its emergency speed setting of about 61.7 Hz.

2. The diesel generator was shut down from a voltage setting of between 4180 and 4200 VAC. Following the plant trip, DG-1 came up to a voltage of between 3952 to 3995 VAC, providing additional evidence that the voltage control switch may have been adjusted in the "LOWER" direction, instead of the governor control switch.

An interview was held with the operator in charge of performing the diesel generator surveillance test. The operator is familiar with the procedural requirement to hold the governor control switch in the "LOWER" position for at least 15 seconds. The

operator was confident that he had operated the proper switch, but, stipulated that the physical evidence pointed to the contrary.

Following the event an analysis was performed to determine if DG-1 was inoperable over the period of time when the governor was last run to its full speed position until the reactor trip occurred (08/16/95 through 08/24/95). The results of the analysis were presented to the Plant Review Committee (PRC) on August 28, 1995. The analysis concluded that if a diesel generator was at full speed prior to the initiation of load shed by the OPLS circuitry under degraded voltage conditions, the 480 VAC load centers would be re-energized by the diesel generator before operation of the 480 VAC load center load shed time delay relay. This would cause the 480 VAC safeguards and non-safety related loads to be picked up as dead loads. This analysis, when applied to existing design basis accident analysis, concluded that there was a reasonable probability that the diesel generator would not be able to successfully operate the loads required for a design basis event in this abnormal condition. The loading of normally sequenced Engineered Safeguards and non-safety related loads and dead loads is considered to be a condition outside the plant design basis. The PRC concurred with the conclusion of the analysis at 1552.

A one-hour non-emergency notification was made to the NRC on August 28, 1995, at 1644 pursuant to 10 CFR 50.72(b)(1)(ii)(B). This report is being submitted pursuant to 10 CFR 50.73(a)(2)(i), 10 CFR 50.73(a)(2)(ii),and 10 CFR 50.73(a)(2)(vii).

SAFETY SIGNIFICANCE

Two events, a degraded system voltage coincident with a LOCA, and a LOCA followed by degraded system voltage (where event mitigation is initiated by the OPLS degraded voltage scheme) place different demands on the diesel engine/generator. The second event, a LOCA followed by degraded system voltage initiated by OPLS, could have resulted in an unanalyzed interaction if the diesel generator had already reached 900 rpm prior to the degraded system voltage.

In the design basis response to a LOCA followed by a degraded voltage scenario, the Design Basis Accident (DBA) provides a start signal to the diesel generators, which then accelerate to idle speed "in anticipation" of a loss of off-site power. The Engineered Safeguards loads begin sequencing onto the safe shutdown 4160 VAC and 480 VAC buses that are powered by off-site power. If off-site power degrades, OPLS is initiated after a nominal 4.8 second time delay. The 4.8 second delay is associated with the time required for the 4160 VAC bus voltage to recover above the OPLS setpoint after accelerating each ESF load group. When OPLS actuates, off-site power is isolated from the plant and the diesel generators receive a full speed start signal. The 480 VAC load center load shed begins to time out when OPLS is initiated and is complete in approximately 3.15 seconds. The diesel generators require 10 seconds to re-energize the 4160 VAC safe shutdown buses. This time includes engine acceleration, field flashing, voltage buildup on the generator, a fixed time delay and breaker closure time. The 480 VAC load center load shed has already been completed by the time the diesel generators re-energize the buses.

If a diesel generator is already operating at 900 rpm when OPLS is actuated, the only delays in re-energizing the safe shutdown 4160 VAC and 480 VAC buses result from the time it takes to accomplish a 4160 VAC load shed (which is virtually instantaneous) and a fixed breaker close time delay of approximately one second. The degraded voltage condition that existed before OPLS actuation may not allow the 480 VAC load shed IAV relays to begin operation. Thus, the 480 VAC load center load shed, which requires 3.15 seconds to operate, would never occur because the buses would be re-energized in approximately one second. Any 480 VAC load center loads that are not load shed by the 480 VAC SIAS load shed would be loaded as dead loads on the diesel generators.

The loading of normally sequenced 480 VAC Engineered Safeguards loads as dead loads, and the loading of normally load shed non-safety related loads are both considered unanalyzed conditions. All the possible loading sequences have never been modeled. Loading out-of-sequence under actual worst case Design Basis Accident (DBA) conditions could overload the diesel engine/generator exciter thus preventing acceleration of the loads. Loading of loads that are normally load shed could cause the same load acceleration problem or could result in the engine exceeding its load rating. Because of this unanalyzed condition, it could not be verified that DG-1 was capable of performing its design basis function, and thus would be considered inoperable.

Because the inoperability of DG-1 was not known until August 24, 1995, some safeguards equipment was rendered inoperable on the redundant safeguards train for maintenance and testing during this eight day period. The Updated Safety Analysis Report (USAR) accidents (Chapter 14) have been reviewed to determine the potential safety impact on the plant. This review has concluded that two accident scenarios would potentially be affected based on the application of a "best-estimate" scenario. The additional single failure of the other diesel generator during this short duration was not considered for this "best estimate" analysis.

First, the containment pressure peak analyzed for the Main Steam Line Break accident may have been adversely affected as there was a period of time, approximately 12 minutes, when no Component Cooling Water (CCW) pumps would have been operable during the accident coincident with a loss of off-site power.

While the containment coolers, which are cooled by CCW, are required to mitigate the containment pressure peak during this accident, it is not known if there would have been a significant increase in the containment pressure (above its design basis limit). The limiting accident as currently analyzed does not include a LOOP or a degraded voltage condition. The analyzed limiting accident allows the feedwater pumps to continue operating for a longer period putting more mass and energy into the containment.

The second accident affected is the design basis, large break, LOCA. During the eight day inoperability of DG-1, one raw water pump from the other train was inoperable for about two (2) hours. The design basis LOCA requires the operation of at least two raw water pumps to remove the energy released by the accident post recirculation actuation signal with the river water temperature above 60°F. It is

not known what the peak containment pressure and temperature values would have been in this scenario. Based on engineering judgment it is anticipated that the USAR analyses limit on containment pressure would have been exceeded.

In addition to the affected USAR accidents, a probabilistic risk assessment (PRA) was done to evaluate this condition relative to the beyond design basis, severe accident, consequences of this event. Mispositioning of the governor switch for eight (8) days, coincident with other equipment that was unavailable, was evaluated. It was concluded that the plant configuration had a non-risk significant impact upon both the mean core damage probability and the large early release probability. Although there is no evidence to suggest that a common mode failure has ever occurred, OPPD realizes that a common mode failure of both diesel generators due to mispositioning of both diesel governors, would have had a significant adverse effect on safety.

CONCLUSIONS

The causes of this event were identified as 1) the wrong switch was manipulated by the operator, 2) the inability to detect diesel generator governor position by the operator, 3) inadequate administrative controls, 4) a failure to implement governor position indication, identified by the PRC in April of 1995, in a timely fashion, and 5) there was a lack of design documentation stating that idle speed operation was critical to proper diesel generator operation.

The PRC was first made aware of the potential for a diesel generator to re-energize 480 VAC loads prior to 480 VAC load center load shed in April of 1995. In that incident, which occurred on March 27, 1995, DG-2 was given an idle speed auto-start signal during Engineered Safeguards surveillance testing. Instead of accelerating to idle speed, DG-2 accelerated to 800 rpm. When an OPLS signal was manually initiated with DG-2 at near rated speed and voltage, the diesel generator output breaker closed so quickly, that there was insufficient time for the 480 VAC load center load shed to occur. Design Engineering presented the same conclusion that the loading of normally sequenced Engineered Safeguards and non-safety related loads and dead loads is considered to be an unanalyzed condition for plant operation. The PRC concluded that since this event resulted from a refueling functional test, and would not be expected to occur at power, that the event did not meet any of the reporting criteria of 10 CFR 50.72 or 10 CFR 50.73. System Engineering was tasked with placing this control in procedures involving diesel generator starts or governor manipulation and present resolution to the PRC when completed.

The PRC questioned the adequacy of the administrative control in June of 1995 when System Engineering informed the PRC that the requirement to hold the governor in the "LOWER" position for at least 15 seconds had been incorporated into the appropriate procedures. The PRC was informed of the possibility that the governor could inadvertently be left in the full speed position by missing a procedure step. It was also noted that a number of other Technical Specifications related controls are implemented procedurally.

The desire for a governor position supervisory circuit was first identified in April of 1995. Design Engineering was tasked to evaluate the feasibility of the circuit. The evaluation results were provided to PRC on September 7, 1995. It indicated the feasibility of providing indication and recommended issuing a modification request to install the supervisory circuit.

The original plant design required that the diesel generators start and be ready for automatic loading in 10 seconds, in the event of a DBA coincident with a LOOP. From an original architect engineer document, the diesel generator starts at time 0.0, receives a full speed signal at 2.5 seconds (undervoltage relay actuation plus 0.5 seconds for bus voltage decay) into the event and is ready-to-load at 9.5 seconds into the event. The possible effects of malfunctions of other equipment, like diesel generator full speed operation without sufficient 480 VAC load shed time, during the automatic operations sequence were not provided.

Records of discussions between the architect engineer and the diesel generator vendor, suggest that the possibility of governor misposition was considered in the original design. At that time it appears that it was deemed acceptable to allow an operator to run the governor back. The same document noted that the governor should be run back to idle after engine shutdown. A detailed discussion of how critical these actions were to proper operation was not provided.

A preliminary review of the generic implications of this event on other equipment important to safety was conducted by a multidisciplinary committee, the PRA oversight committee. No other equipment was identified that could fail in a fashion similar to the diesel generator failure during their discussions.

CORRECTIVE ACTIONS

The following corrective actions will be implemented as a result of this event:

1. Modification request 95-15 was submitted to provide positive governor position indication to the operators. The modification will be installed by December 31, 1995.

2. Operators are now required to use independent verification that the diesel governor has been run back when a diesel generator is shut down. This guidance will be incorporated into all applicable procedures by September 29, 1995.

3. A review of all the diesel generator operating and testing procedures will be conducted to ensure that the operability of the diesel generators is adequately addressed. This review as well as all necessary procedure updates will be completed by September 29, 1995.

4. Engineering Assistance Request EAR 95-117 is evaluating the feasibility of replacing the control switches that are being used on the diesel generator

voltage regulator and governor control switches with distinctly different styles. This evaluation will be completed by December 31, 1995.

5. The design basis documents will be updated by December 31, 1995, to provide a detailed discussion of the idle speed start affects on diesel generator operation.

6. Training documents will be updated by December 1, 1995, to provide a detailed discussion of DG idle speed start requirements. Training on this material will be provided to all licensed and nonlicensed operators by December 1, 1995.

7. All licensed and non-licensed operators will receive training on the importance of self-checking and peer-verification. This training will be completed by February 29, 1996.

8. A "best estimate" analysis of the diesel loading capability will be completed by October 31, 1995. The effect of this analysis on the safe operation of the plant will be evaluated and a revision to this LER submitted by November 30, 1995. In addition the PRA oversight committee will conduct another review of the generic implications of this event with respect to other equipment important to safety. The PRA oversight committee will provide appropriate recommendations for any additional systematic reviews by November 15, 1995. A schedule for any additional reviews will be developed and included in the LER revision.

Similar events

Two other cases of diesel generators accelerating to full speed were discovered during a review of past Incident Reports (IR). The first event (IR 900431) occurred September 29, 1990, during a normal plant shutdown. When the turbine was tripped the diesels started as expected except that DG-1 accelerated to full speed. The incident appeared to have occurred because an operator did not effectively use a procedural checklist. The IR indicates that those who reviewed the IR at that time had no operability concerns, based on the belief that governor position did not affect diesel operability.

The second event, that occurred in March of 1995, has already been discussed in the conclusions section.