

ENCLOSURE 2

U.S. NUCLEAR REGULATORY COMMISSION
REGION IV

Inspection Report: 50-285/95-17

License: DPR-40

Licensee: Omaha Public Power District
Fort Calhoun Station FC-2-4 Adm.
P.O. Box 399, Hwy. 75 - North of Fort Calhoun
Fort Calhoun, Nebraska

Facility Name: Fort Calhoun Station

Inspection At: Blair, Nebraska

Inspection Conducted: September 5-12 and October 10-19, 1995

Inspector: R. Mullikin, Reactor Inspector, Engineering Branch

Approved:


J.L. Pellet, Chief (Acting), Project Branch A

10-31-95
Date

Inspection Summary

Areas Inspected: Special, announced inspection of the circumstances surrounding the August 24, 1995, discovery that Emergency Diesel Generator 1 failed to start at idle speed following a reactor trip.

Results:

Plant Operations

- A licensed operator's failure to follow procedures resulted in Emergency Diesel Generator 1 starting in an abnormal condition (Section 2.2).
- Management failed to inform operators of the importance of the emergency diesel generators starting at idle speed. Management knew of this importance on April 5, 1995, but did not communicate it to operators until after the plant trip on August 24 (Section 3.2).
- Corrective actions proposed as a result of the March 27, 1995, event when Emergency Diesel Generator 2 started at full speed were adequate, but not timely, to prevent recurrence (Section 3.2).

- The licensee failed to officially notify the NRC after the March 27, 1995, event when Emergency Diesel Generator 2 started in an abnormal condition. The Plant Review Committee met on April 5 and determined the event to not be reportable. The licensee's reasoning for this determination was incorrect (Section 3.2).
- A routine procedure step prior to starting the emergency diesel generators for testing prevented the licensee from knowing what position the governor was in at the beginning of testing. Thus, the licensee would not have known how many times an emergency diesel generator would have started at the abnormal full speed position (Section 5.4).

Engineering

- System engineering's questioning attitude after the March 27, 1995, event resulted in the determination that the emergency diesel generators were in an unanalyzed condition if started at full speed (Section 3.2).
- Design engineering was initially responsive to Engineering Assistance Request 94-040, but failed to secure a timely resolution (Section 3.2).

Summary of Inspection Findings:

- Violation 285/9517-01 was opened (Sections 2.2).
- Violation 295/9517-02 was opened (Section 3.2.1).
- A noncited violation was identified (Section 3.2.1).

Attachments:

- Attachment 1 - Persons Contacted and Exit Meeting
- Attachment 2 - Emergency Diesel Start Sequence

DETAILS

1 INTRODUCTION

NRC monitors plant performance to provide for timely inspection of adverse performance trends. This reactive special inspection was performed because of an event following a reactor trip on August 24, 1995, when Emergency Diesel Generator 1 started and accelerated to full speed instead of the designed idle speed.

2 AUGUST 24, 1995, EVENT

2.1 Description of Event

On August 24, 1995, the Fort Calhoun Station experienced a reactor trip while operating at 100 percent power. The reactor trip resulted from a licensed operator error during the performance of a surveillance test of the diverse scram system. The inspection of the circumstances surrounding the operator error will be documented in NRC Inspection Report 50-285/95-14.

An anomaly occurred during this event in that Emergency Diesel Generator 1 accelerated to a speed of 900 rpm (full speed) instead of its designed 500 rpm idle speed. A reactor trip is one of the signals that cause both emergency diesel generators to start and increase to the 500 rpm idle speed. However, a reactor trip signal alone would not cause an emergency diesel generator to accelerate to full speed (900 rpm) and initiate removing, or load shedding, the 4160V and 480V loads. After the emergency diesel generators get an automatic start signal, the following are the only three signals that would cause them to accelerate to full speed:

- Offsite power low signal indicating a loss of, or degraded, offsite power; or
- Low voltage signal on 4160V Bus 1A3 (Emergency Diesel Generator 1) or 4160V Bus 1A4 (Emergency Diesel Generator 2); or
- The key lock start test switch selected to full speed.

The licensee's computer event sequence records did not indicate that any of the above signals had occurred. In addition, the operating crew did not observe any of the indications related to these signals. Also, the start test switch had a key lock which would have required operator action.

2.2 Troubleshooting of Event

The licensee initiated Maintenance Work Order 952826 to troubleshoot the governor control circuit for Emergency Diesel Generator 1. During troubleshooting, Emergency Diesel Generator 1 successfully started and ran at

idle speed (500 rpm) after given a manually initiated start signal. The licensee then manually increased speed to 500 rpm and loaded the engine. No anomalies were noted during this test. The licensee then started Emergency Diesel Generator 1 in accordance with Operating Procedure OP-ST-RPS-0008, "Reactor Manual Trip Test," which initiated a reactor trip signal. Again Emergency Diesel Generator 1 started and ran at the 500 rpm idle speed as designed.

The past performance history of Emergency Diesel Generator 1 was reviewed and it was noted that the last time it was run was during its normal monthly surveillance test on August 16, 1995. Operating Procedure OP-ST-DG-0001, "Diesel Generator 1 Check," Attachment 1B, "Channel "B" Test (Full Speed)," was the test performed on August 16. After running Emergency Diesel Generator 1 at full speed (900 rpm), the engine was stopped and Step 47 required that the operator place and hold Control Switch CS-65/D1, "Diesel Generator D1 Governor," in the "LOWER" position for at least 15 seconds. This step is essential to assure that the governor is returned to the idle start position. Without performing this step correctly, Emergency Diesel Generator 1 would accelerate to 900 rpm after its next start. This step is performed in the control room at Panel CB-20 and there is no control room indication to verify that the governor has been reset to its idle position. The only verification that this step was performed, other than actually starting Emergency Diesel Generator 1, is to observe the movement of the governor speed setting knob locally at its governor. Step 47 had been signed by a licensed operator as being completed on August 16.

However, the licensee's investigation revealed doubts that Step 47 had successfully been performed. There were three things that were abnormal about the Emergency Diesel Generator 1 start following the reactor trip on August 24, 1995. One was that Emergency Diesel Generator 1 started and accelerated to full speed. The others were as follows:

- The generator frequency would normally be approximately 61.7 cycles per second after an automatic start. After the automatic start on August 24, the generator frequency was between 59.3 and 59.7 cycles per second, which was similar to the frequency at the time Emergency Diesel Generator 1 was shut down on August 16. This would occur if the emergency diesel generator governor switch had not been properly manipulated to lower the engine speed prior to shut down.
- When Emergency Diesel Generator 1 was shut down on August 16, the generator voltage was between 4180V and 4200V. However, after the plant trip on August 24, the generator voltage was between 3952V and 3995V. This indicated that the voltage regulator switch had been lowered after Emergency Diesel Generator 1 was shut down.

These conditions led the licensee to conclude that Control Switch CS-90/D1, "Diesel Generator Voltage Regulator," had been lowered instead of the governor Switch CS-65/D1. The inspector noted that the two switches were identical in

all aspects except labelling and were physically located on the same control room panel approximately 18 inches apart. The licensee interviewed the operator that shut down Emergency Diesel Generator 1 on August 16. The operator was confident that he had manipulated the correct switch, but noted that the evidence pointed to the contrary. The licensee concluded that the operator had manipulated the incorrect switch. The failure of a licensed operator to follow the requirements of Procedure OP-ST-DG-001 is an apparent violation of NRC requirements (285/9517-01).

2.3 Conclusions

The failure of Emergency Diesel Generator 1 to accelerate to idle speed following the reactor trip on August 24, 1995, was due to the governor being in the full speed position prior to starting. A licensed operator on August 16 failed to follow an approved procedure and manipulated the voltage regulator control switch instead of the governor control switch.

3 HISTORY OF SIMILAR EVENTS

A review of the incident report history revealed two instances where emergency diesel generator starts resulted in an unexpected acceleration to full speed. One occurred on September 29, 1990, and the other on March 27, 1995.

3.1 September 29, 1990, Event

The licensee was performing a controlled shutdown on September 29, 1990. When the turbine was tripped, the emergency diesel generators started as designed, but Emergency Diesel Generator 1 started and accelerated to 900 rpm. Incident Report 900431 was written to investigate the cause. The licensee's investigation determined that the likely cause was that the governor switch was not held in the lower position during the performance of OI-DG-1, "Diesel Generator 1 (DG 1) Normal Operation," on September 25, 1990. It was concluded that the cause was operator error in not completing the required step. However, the Plant Review Committee did not recognize or question the operability of Emergency Diesel Generator 1 with the governor switch incorrectly positioned. No action was taken by the licensee to determine whether idle starting speed was critical to emergency diesel generator operability.

3.2 March 27, 1995, Event

The licensee was performing Surveillance Test Procedure OP-ST-ESF-0002, "Diesel Generator No. 1 and No. 2 Auto Operation," during a refueling outage on March 27, 1995. The licensee was testing the automatic operation of Emergency Diesel Generator 2 when it accelerated to full speed after an automatic start signal was inserted. An offsite power low signal was generated which should have resulted in load shedding. Instantaneously, all of the 4160V motors breakers opened as designed. However, the 480V operating loads on the safeguards buses did not shed prior to the closing of the Emergency Diesel Generator 2 output breaker. Thus, 480V loads such as

charging pumps, component cooling waters pumps, ventilation fans, and nonsafety-related loads were immediately loaded onto Emergency Diesel Generator 2. The licensee concluded from trouble-shooting this event that the governor switch had not been lowered after completion of a prior surveillance test due to a refueling test procedural inadequacy. Operating Procedure OP-FT-DG-0001, "183 Master Electrical Switch (183/MES) Functional test," had been performed prior to the March 27 event, but the procedure was lacking the instruction to run the governor back to its idle speed position. The finding was that the 480V loads did not have time to shed before Emergency Diesel Generator 2 energized 4160V Bus 1A4. However, the licensee concluded that the failure to load shed did not cause the loss of Emergency Diesel Generator 2. Attachment 2 provides a licensee time line for a normal start of an emergency diesel generator with proper load shedding, in addition to a start where the governor switch was left in the full speed position.

3.2.1 Corrective Actions for March 27, 1995 Event

System engineering initiated Engineering Assistance Request 95-040 on March 27, 1995, to answer questions concerning the cause of the event on that same day. The system engineer recognized at that time that it was a possible design basis issue and considered it a startup issue. The engineering assistance request stated that, following the actuation of the offsite power low signal relays, the associated 4160V loads shed as designed. Another set of relays would load shed the 480V loads after a built-in delay. In the March 27 event, the Emergency Diesel Generator 2 output breaker was closed before the 480V loads were shed due to the built-in delay and the engine starting at full speed. The system engineer requested design engineering to answer the following questions via Engineering Assistance Request 95-040:

- Is there a design basis problem in the assumptions for emergency diesel generator loading?
- Would nonsafety-related loads remaining on the emergency diesel generators exceed engine loading assumptions?
- Should the position of the emergency diesel generator governor be administratively controlled?

Design engineering responded to the engineering assistance request on April 4, 1995, and concluded that the immediate loading of normally sequenced 480V engineered safeguards loads and loading of normally not loaded 480V nonsafety-related loads were unanalyzed conditions. In addition, it was concluded that some administrative control for governor position was needed.

The Plant Review Committee met on April 5, 1995, to discuss the startup issue related to Engineering Assistance Request 95-040. The Plant Review Committee was informed of the following:

- Procedure OP-FT-DG-0001 was only performed during a refueling outage and had only been performed one previous time. This was the only procedure that did not have the requirement to lower the governor setting;
- There was no supervisory circuit to ensure that the governor was set at its lowest setting; and
- Existing procedures were adequate to assure that this event would not occur at power operation and, thus, was not reportable.

10 CFR 50.72, Section (b)(2)(i), states that the licensee shall notify the NRC within 4 hours of any event, found while the reactor is shut down, that, had it been found while the reactor was in operation, would have resulted in the nuclear power plant, including its principal safety barriers, being in an unanalyzed condition.

The Plant Review Committee recommended action items which included revising Procedure OP-FT-DG-0001 and performing an evaluation to assess whether a supervisory circuit was needed for the governor position.

On June 5, 1995, the Plant Review Committee again discussed the issue. It was confirmed that Procedure OP-FT-DG-0001 had been revised to require the governor to be held in the lower position for 15 seconds. The Plant Review Committee questioned system engineering as to whether the March 27 event could occur again if a procedure step was missed. System engineering responded that if it did occur, the emergency diesel generator was capable of handling the additional loads, contrary to the unanalyzed condition determined by Design Engineering on April 4.

The licensee recognized that to have positive indication of governor position in the control room was important. However, the potential of the event occurring at power was not considered likely. Thus, the corrective action proposed did not receive the priority it should have. The failure by the licensee to take timely corrective action to prevent a similar event occurring on August 24, 1995, is an apparent violation of NRC requirements (285/9517-02).

Further, the licensee's decision to not report the event was incorrect. The licensee only considered the cause of the event (inadequate procedure used only during an outage) and not the event itself in determining reportability. This failure constitutes a violation of minor significance and is being treated as a noncited violation, consistent with Section IV of the NRC Enforcement Policy.

Although operations management was present at the above Plant Review Committee meetings, the information on the importance of the emergency diesel generators starting at idle speed was not relayed to the operating crews. The inspector

interviewed several operators and they stated that they were not aware of the significance of an emergency diesel generator starting at idle speed until after the August 24, 1995, event.

3.3 Conclusions

The licensee failed to recognize the importance of the emergency diesel generators starting at idle speed as an operability concern after the event on September 29, 1990. The licensee's decision, after the March 27, 1995, event, that the event was not likely to occur at power was incorrect and resulted in the failure to make proper notification to the NRC at that time. The licensee failed to take timely corrective action to prevent a recurrence at power operation, which subsequently occurred on August 24, 1995. The licensee failed to relay the information on the importance of idle speed starting of the emergency diesel generators to the operating crews. System engineering's questioning attitude and design engineering's responsiveness, after the March 27, 1995, event, to an engineering assistance request, resulted in the determination that the emergency diesel generators would be in an unanalyzed condition if started at idle speed. This conclusion was not appropriately characterized to licensee management and was not resolved in a timely fashion.

4 ROOT CAUSE ANALYSIS OF AUGUST 24, 1995, EVENT

On September 12, 1995, the licensee completed a root cause analysis of the August 24, 1995, event when Emergency Diesel Generator 1 started and accelerated to full speed. The licensee concluded that the root causes and contributing factors were:

- The inability to detect governor position from the control room;
- The administrative controls to ensure governor position were inadequate;
- The incorrect switch was most probably manipulated by the operator;
- The design documentation did not state that starting at idle speed was critical to proper emergency diesel generator operation; and
- The corrective actions identified by the Plant Review Committee on April 5, 1995, were not implemented in a timely manner.

The licensee's root cause analysis made six recommendations which were:

- Provide positive governor position indication in the control room;
- Require independent and or remote verification that the governor is run back when shutting down an emergency diesel generator;
- Evaluate the human factors aspect associated with the control room switches for the emergency diesel generators;

- Update design basis documents to provide detailed discussion of the emergency diesel generator operation and idle start requirements;
- Review all emergency diesel generator operating procedures and testing procedures to insure that the operability of the generators are adequately addressed;
- Update training documents to provide detailed discussion of idle speed start requirements; and
- Provide operator training on the importance of the emergency diesel generator circuitry to the proper operation of the generator.

5 SAFETY SIGNIFICANCE OF AUGUST 24, 1995, EVENT

5.1 Emergency Diesel Generator 1 Operability Determination

The licensee performed an operability determination on August 28, 1995. The loading of normally sequenced safety-related loads and the normally shed nonsafety-related loads were both unanalyzed conditions. The licensee concluded that Emergency Diesel Generator 1 was inoperable from August 16, 1995, when the governor switch had not been lowered, until August 24, when the problem was disclosed by the plant trip.

The safety significance of the inoperability of Emergency Diesel Generator 1 for approximately 8 days was increased because safety-related equipment on redundant 4160V Bus 1A4 (supplied by Emergency Diesel Generator 2) had been out of service for maintenance or testing while Emergency Diesel Generator 1 was inoperable.

The licensee performed an analysis of the potential consequences of having safety-related equipment, such as Component Cooling Water Pump AC-3B and Raw Water Pumps AC-10B and AC-10D, that would be supplied by Emergency Diesel Generator 2, out of service at the same time Emergency Diesel Generator 1 was considered inoperable. The licensee's engineering judgment was that the design basis limit for containment pressure could have been exceeded for certain accident sequences during this time.

The licensee subsequently contracted an outside source (Stone & Webster Engineering Corporation) to perform an extensive analysis to calculate whether Emergency Diesel Generator 1 was inoperable August 16-24, 1995. Engineering Analysis EA-FC-95-027, "Diesel Generator Offnormal Loading Due to a Full Speed Start ETP-6.5-DGT," was completed and reviewed by the licensee on October 2. The results of the transient load analysis indicated that the 480V safety-related and nonsafety-related loads that did not shed as designed would trip off due to their undervoltage relays, after a 1 to 2 second delay, during which the diesel generator load would be greater than design but within its ultimate capacity for that short time. These loads would then sequence on to Emergency Diesel Generator 1 at their normal sequence times. The licensee

concluded that Emergency Diesel Generator 1 was operable to fulfill its safety function with the governor left in the full speed position.

5.2 Probabilistic Risk Assessment Determination

Prior to the completion of Engineering Analysis EA-FC-95-027, the licensee performed a probabilistic risk assessment to evaluate the condition the plant would be in due to the inoperability of Emergency Diesel Generator 1 for 8 days, coincident with other unavailable equipment. The licensee concluded that the plant configuration had a nonrisk significant impact upon both the mean core damage probability and the large early release probability.

The licensee determined that the inoperability of Emergency Diesel Generator 1 and coincident outage of Component Cooling Water Pump AC-3B was the most significant event in relation to severe core damage frequency. The inoperability of Emergency Diesel Generator 1 for 8 days would double the severe core damage frequency. The inoperability of Component Cooling Water Pump AC-3B for 12 minutes, while Emergency Diesel Generator 1 was inoperable would further increase the severe core damage frequency by fifty percent.

5.3 Generic Implications

The licensee performed a search of industry information to determine if other plants operate their emergency diesel generators at idle speed. The results were that there were four nuclear plants that presently or plan to operate their emergency diesel generators in the idle speed mode. However, the Fort Calhoun Station was unique in that no positive control or indication existed as to governor position.

5.4 Lack of Determining As-Found Conditions During Surveillance Testing

The inspector noted that the licensee's surveillance procedures for testing the emergency diesel generators had a step which would prevent the discovery that the governor had been left in the full speed position. Specifically, a step was present in all the applicable procedures which required the operator to lower the governor setting prior to starting the emergency diesel generator. The licensee stated that this step had been included to prevent the emergency diesel generators from starting at full speed during testing to reduce engine wear. This prevented the licensee from knowing whether the prior surveillance test procedure had been properly performed to leave the governor in the design-basis-required position. The inspector noted the significance of the only three documented discoveries of an emergency diesel generator starting at full speed. All of the discoveries were at times other than routine surveillance testing. One occurred during a controlled plant shutdown, one during refueling outage testing, and the last one after a reactor trip. Thus, the licensee could not know how many times the emergency diesel generators' governors were left in the full speed position after routine monthly testing. The licensee was in the process of revising all applicable procedures to eliminate this requirement. The safety significance of this was minimal since the surveillance procedures, if followed, were

adequate to assure that the emergency diesel generators would start at the idle speed as designed. However, this procedural requirement, and the lack of positive indication of governor speed setting, prevented the licensee from obtaining as-found data regarding this condition during testing.

5.5 Conclusions

The licensee's analysis determined that Emergency Diesel Generator 1 was operable during the time that the governor was left in the full speed position. A routine procedure step prior to starting the emergency diesel generators for testing prevented the licensee from knowing what position the governor was in at the beginning of the test. Thus, the licensee could not know how many times an emergency diesel generator governor was left in the full speed position after its routine monthly surveillance testing.

ATTACHMENT 1

1 PERSONS CONTACTED

1.1 Licensee Personnel

- *J. Chase, Plant Manager, Fort Calhoun Station
- *R. Conner, Assistant Plant Manager
- *G. Cook, Supervisor, Station Licensing
- *R. DeMeulmeester Sr., Shift Supervisor
- *S. Gambhir, Division Manager, Production Engineering
- *W. Gates, Vice President, Nuclear
- *R. Jaworski, Manager, Station Engineering
- *B. Kindred, Acting Supervisor, Nuclear Security Operations
- *L. Kusek, Manager, Nuclear Safety Review Group
- #*E. Matzke, Licensing Engineer
- *J. O'Connor, Manager, Electrical Design
- *W. Orr, Manager, Quality Assurance and Quality Control
- #*T. Patterson, Division Manager, Nuclear Operations
- *R. Phelps, Acting Division Manager, Production Engineering
- #J. Skiles, Acting Manager, Design Engineering
- *M. Tesar, Manager, Corrective Actions
- #*D. Trausch, Manager, Nuclear Licensing and Industry Affairs

2.2 NRC Personnel

- *V. Gaddy, Resident Inspector, Fort Calhoun Station
- #R. Kopriva, Project Engineer, Projects Branch A
- #J. Pellet, Acting Chief, Projects Branch A
- *L. Yandell, Chief, Plant Support

- * These personnel attended the exit meeting on September 12, 1995.
- # These personnel attended the re-exit meeting on October 19, 1995, via telephone.

In addition to these personnel, the inspector contacted other personnel during this inspection period.

2 EXIT MEETING

An exit meeting was conducted on September 12, 1995, and a reexit held via telephone on October 19. During these meetings, the inspector reviewed the scope and findings of the report. The licensee did not express a position on the inspection findings documented in this report. The licensee did not identify as proprietary any information provided to, or reviewed by, the inspectors.

ATTACHMENT 2

EMERGENCY DIESEL GENERATOR START Followed by Offsite Power Low Signal Governor Switch in Correct Position

Time
(Seconds)

- T=0 - Emergency Diesel Generator receives idle speed start signal
- T=3 - Emergency Diesel Generator reaches idle speed (500 rpm)
- T=3.5 - Offsite Power Low Signal setpoint reached (3.5 seconds assumed for this time line)
- T=9.5 - Offsite Power Low Signal actuates after 6 second delay
 - Emergency Diesel Generator receives signal to accelerate to full speed (900 rpm)
- T=12.65 - 480V load shed occurs
- T=17.7 - Emergency Diesel Generator reaches full speed
- T=19.7 - Emergency Diesel Generator breaker closes

EMERGENCY DIESEL GENERATOR START Followed by Offsite Power Low Signal With Governor Switch Left in Full Speed Position

Time
(Seconds)

- T=0 - Emergency Diesel Generator receives full speed (900 rpm) start signal
- T=3.5 - Offsite Power Low Signal setpoint reached (3.5 seconds assumed for this time line)
- T=8.2 - Emergency Diesel Generator reaches full speed
- T=9.5 - Offsite Power Low Signal actuates after 6 second delay
- T=11.5 - Emergency Diesel Generator breaker closes
- T=12.65 - 480V load shed should occur but does not due to Emergency Diesel Generator closing