Duke Power
A Duke Energy Company

Gary R. Peterson
Vice President

Duke Power
Catawba Nuclear Station
4800 Concord Road
York, SC 29745
(803) 831-4251 OFFICE
(803) 831-3426 FAX

August 30, 2000

U. S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555-0001

SUBJECT: Duke Energy Corporation
Catawba Nuclear Station Unit 1
Docket No. 50-413
Licensee Event Report 413/99-016 Revision 1

Attached please find Licensee Event Report 413/99-016 Revision 1, entitled "Operation Prohibited by Technical Specification 3.8.1 and 3.7.8 Due to Inoperable Diesel Generator 1B for Greater than 72 Hours".

Questions regarding this Licensee Event Report should be directed to R. D. Hart at (803) 831-3622.

There are no commitments in this Licensee Event Report.

Sincerely,

FOR

G. R. Peterson

Attachment

IE22

xc:

L. A. Reyes
U. S. Nuclear Regulatory Commission
Regional Administrator, Region II
Atlanta Federal Center
61 Forsyth St., SW, Suite 23T85
Atlanta, GA 30303

C. P. Patel
NRC Senior Project Manager (CNS)
U. S. Nuclear Regulatory Commission
Mail Stop O-8H12
Washington, DC 20555-0001

D. J. Roberts
Senior Resident Inspector (CNS)
U. S. Nuclear Regulatory Commission
Catawba Nuclear Site

NRC FORM 366 U.S. NUCLEAR REGULATORY COMMISSION
(6-1998)

LICENSEE EVENT REPORT (LER)

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

APPROVED BY OMB NO. 3150-0104 EXPIRES 06/30/2001

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TITLE (4)

Operation Prohibited by Technical Specification 3.8.1 and 3.7.8 Due to Inoperable Diesel Generator 1B for Greater than 72 Hours

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 NAME	DOCKET NUMBER
									NA	
11	19	99	99	016	01	08	30	00	FACILITY NAME NA	DOCKET NUMBER

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

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

	20.2201(b)		20.2203(a)(2)(v)	X	50.73(a)(2)(i)		50.73(a)(2)(viii)
	20.2203(a)(1)		20.2203(a)(3)(i)		50.73(a)(2)(ii)		50.73(a)(2)(x)
	20.2203(a)(2)(i)		20.2203(a)(3)(ii)		50.73(a)(2)(iii)		73.71
	20.2203(a)(2)(ii)		20.2203(a)(4)		50.73(a)(2)(iv)		OTHER
	20.2203(a)(2)(iii)		50.36(c)(1)		50.73(a)(2)(v)		
	20.2203(a)(2)(iv)	X	50.36(c)(2)		50.73(a)(2)(vii)		

LICENSEE CONTACT FOR THIS LER (12)

NAME	TELEPHONE NUMBER (Include Area Code)
R. D. Hart, Regulatory Compliance	(803) 831-3622

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

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX		CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO EPIX
D1	EK	65	W290	Y						

SUPPLEMENTAL REPORT EXPECTED (14)				EXPECTED	MONTH	DAY	YEAR
	YES (If yes, complete EXPECTED SUBMISSION DATE).	X	NO	N/A			

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

On November 16, 1999 at 0415, with Unit 1 at 100% power, diesel generator (DG) 1B was declared inoperable to perform maintenance activities. This placed Unit 1 in a 72-hour action statement for DG 1B and Nuclear Service Water System (NSWS) pump 1B. During the post maintenance test of the DG 1B, the DG breaker tripped on overcurrent. Trouble shooting and repair activities were unsuccessful in restoring operability to DG 1B within 72 hours. A Notice of Enforcement Discretion (NOED) was requested from the NRC so that the completion times of the Required Actions for TS LCO 3.8.1 and 3.7.8 could be extended from 72 hours by an additional 48 hours. This was requested to allow necessary repairs and testing activities to be completed. The NRC granted the NOED on November 19, 1999 at 0200. The DG 1B electronic governor (EGA) was replaced, tested, and DG 1B was declared operable at 2309 on November 20, 1999. The replaced EGA was sent back to the manufacturer for analysis. The manufacture found no problems with the replaced EGA. They concluded that the EGA installed on DG 1B was not properly tuned to compensate for the changes that were made to DG 1B during maintenance. Appropriate procedure revisions have been made to correct the root cause. The event is being reported as any operation or condition prohibited by TS, 10 CFR 50.73(a)(2)(i)(B), and TS LCO not met, 10 CFR 50.36(c)(2).

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

Background

Catawba Nuclear Station Unit 1 is a four loop Westinghouse Pressurized Water Reactor. Unit 1 has two emergency diesel generators (DGs) 1A and 1B [EIIS: EK]. Each DG is utilized as the standby emergency power source for each 4160-volt emergency bus. DGs 1A and 1B are dedicated to busses ETA and ETB [EIIS: EB], respectively. The DGs will start automatically on a safety injection signal or on a bus loss of voltage or degraded voltage signal. Loads will be automatically connected to the bus as required by the respective load sequencer [EIIS: EK]. In parallel operation (i.e., with the DG paralleled to the grid), the electronic governor [EIIS: EK] controls generator load or real output power (watts), and the voltage regulator controls power factor and reactive power output (VARs) from the generator. The speed control is used to increase generator load, and the voltage control is used to increase or decrease reactive power output.

The speed control consists of two pushbuttons used to control the magnitude of the output signal from the Digital Reference Unit (DRU) [EIIS: EK]. The DRU provides a reference signal to the electronic governor. In parallel operation, the magnitude of the DRU reference signal determines the generator load (watts). The electronic governor monitors generator output voltage and current to calculate generator load. Based on generator load and the DRU reference signal, the electronic governor provides a signal to the hydraulic actuator in the mechanical governor to control the amount of fuel supplied to the engine and, thus, maintain constant generator load.

Technical Specification (TS) Limiting Condition for Operation (LCO) 3.8.1 governs AC Sources - Operating for Modes 1, 2, 3, and 4. LCO 3.8.1 requires in part that two DGs be operable. Condition B for this LCO states that with one DG inoperable, the DG must be restored to operable status within 72 hours, in addition to the other Required Actions that must be performed. Condition G states that with the Required Action and associated Completion Time of Condition B not met, the unit must be in Mode 3 within 6 hours and in Mode 5 within 36 hours. The inoperability of DG 1B results in the inoperability of associated Nuclear Service Water System (NSWS) Pump 1B [EIIS: BI]. LCO 3.7.8 requires that in Modes 1, 2, 3, and 4 two NSWS trains be operable. Condition A for this LCO states that with one NSWS train inoperable, the NSWS train must be restored to operable status within 72 hours. Condition B states that with the Required Action and associated Completion Time of Condition A not met, the unit must be in Mode 3 within 6 hours and in Mode 5 within 36 hours.

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DG 1B was declared inoperable on November 16, 1999 at 0415 to perform various maintenance activities. This placed Unit 1 in a 72-hour action statement for DG 1B and NSWS pump 1B.

During the post maintenance test of DG 1B, the DG breaker tripped on overcurrent (50 DGT relay). DG 1B was shutdown and trouble shooting began.

Trouble shooting and repair activities were unsuccessful in restoring operability to DG 1B within 72 hours. Therefore, a Notice of Enforcement Discretion (NOED) was requested from the NRC so that the completion times of the above Required Actions for TS LCO 3.8.1 and LCO 3.7.8 were extended from the current 72 hours by an additional 48 hours, for a total of 120 hours. This was requested to allow necessary repairs and testing activities to be completed. The NRC granted the NOED on November 19, 1999 at 0200 and DG 1B was repaired and declared operable on November 20, 1999 at 2309.

Unit 1 operated in Mode 1, "Power Operation" during this event. No additional structures, systems, or components were out of service at this time that contributed to this event. The event is being reported as any operation or condition prohibited by TS, 10CFR50.73(a)(2)(i)(B), and TS LCO not met, 10CFR50.36(c)(2).

Event Description

11-16-99

0415 DG 1B was declared inoperable for various maintenance activities. Part of these activities involved replacing fuel control rack linkage assemblies. They were being replaced with a new style for improved reliability.

1742 During running of DG 1B, the DG breaker tripped on overcurrent (50GDT relay) while attempting to load the DG from the 2500 kW plateau to the 4000 kW plateau. It was noted that DG 1B power was swinging about 200 kW at a load of 4000 kW.

11-16-99

2100 Engineering and Maintenance Technical Support were consulted concerning the unexpected DG breaker trip. Preliminary examination of the trip data indicated a power swing prior to the trip could have been caused by a sticking fuel rack. Fuel control rack linkage assembly replacements had been performed on the fuel rack mechanisms going to several cylinders. Maintenance was instructed to inspect the replacement sites and assure free movement of these mechanisms. Following completion of this work, the Operations performance test (PT) would be performed. Per discussion with Engineering, DG 1A successfully passed its Operability PT upon completion of fuel control rack linkage assembly replacement. Therefore, no common cause failure was assumed to exist at that time.

11-17-99

0240 After fuel control rack linkage assembly inspection, the DG 1B operability PT was completed satisfactorily. In order to complete a root cause evaluation of the failure, a decision was made to delay declaring the DG operable until Engineering had a chance to review the test data.

1209 Upon completion of the review of the data from the test, a Failure Investigation Process (FIP) team was initiated to investigate the cause of the unexpected DG breaker overcurrent trip.

1632 New fuel control rack linkage assemblies were obtained from the warehouse and some were observed to have stiff joints. The FIP team surmised that one or more of the fuel control rack linkage assemblies in DG 1B had stiff internals that eventually loosened during the DG load increase section of the operability performance test. A decision was made to remove and reinspect the fuel control rack linkage assemblies in DG 1B.

11-18-99

0300 The inspection was completed. Three fuel control rack linkage assemblies were replaced. (One was replaced due to sluggish operation and two were replaced due to rough surfaces.)

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11-18-99

0420 The DG 1B operability PT was performed. During the test, the DG breaker again tripped on overcurrent (50DGT relay) while the DG was being unloaded at the end of the test during power factor adjustments. The FIP team was called in to investigate.

1200 FIP Team recommended a replacement of the power driven potentiometer (PDP) and the Voltage raise / lower pushbutton. Problems were noted in both of these components during the investigation. Contingency Plans were made for electronic governor replacement in the event that additional testing indicated that the problem was not resolved by these replacements. Consultation with the Vendor indicated that the most likely cause, based upon industry failure data and description of the data obtained from the tests, is the PDP followed by the electronic governor.

2130 A functional test plan was developed to run the DG and exercise the PDP by both increasing and decreasing loads. A PT would follow successful running of the DG indicating confirmation that the PDP was the likely cause of the DG breaker overcurrent trip.

2310 Following replacement of the PDP and DG load/unload pushbutton, DG 1B was tested. An overcurrent trip of the DG breaker on the 50 DGT relay occurred following a successful full loading of the DG. This occurred as the operator was reducing load on the DG. Station Management present during test. Regulatory Compliance was requested to setup a conference call with NRC Region II to request a Notice of Enforcement Discretion (NOED).

11-19-99

0200 The NRC granted a NOED covering TS LCO 3.8.1 and TS LCO 3.7.8 (extending the allowable outage time from 72 hours to 120 hours). The NOED allowed additional time to complete repair activities on DG 1B(replace the electronic governor).

1707 Following review of the data and further consultation with the Vendors involved, a decision was made to replace the electronic governor and have Vendors dispatched to site to oversee checkout and tuning of the components.

11-20-99

0442 Following replacement installation, the governor was tuned and functionally tested through a DG run and no problems were found.

0900 A Plant Operating Review Committee (PORC) meeting to review PT/1/A/4350/12B, "Diesel Generator 1B Governor and Voltage Regulator Test" was held. This procedure was used to perform the post maintenance testing after DG 1B governor replacement.

1630 PT/1/A/4350/12B was completed satisfactorily. This test is one of the required retests for a governor replacement or adjustment.

2309 Operations completed the DG 1B operability PT and DG 1B was declared operable. Unit 1 exited TS 3.8.1 and 3.7.8.

Causal Factors

A FIP team was formed to determine the cause of the DG overcurrent trip. Based on the available data, the team concluded that the root cause of the DG breaker overcurrent trips was that the DG electronic governor was not able to handle the change in the fuel system response with the new fuel control rack linkage assemblies.

During the investigation the FIP team identified four (4) potential root causes for the overcurrent trips:

1. Fuel Control Rack Linkage [EIIS: EK]
2. Voltage Raise/Lower Pushbutton [EIIS: EK]
3. Power Driven Potentiometer (PDP) [EIIS: EK]
4. Electronic Governor (EGA) [EIIS: EK]

Binding of a fuel control rack linkage assembly may create a condition where the DG output load either does not increase or lags behind the demand signal from the governing system. When the binding linkage assembly becomes free, the engine output load will immediately increase to the value of the demand signal. This rapid increase in load may cause a current increase above the breaker overcurrent trip setpoint.

New linkage assemblies were installed on cylinders 1, 6, 7 and 8 in both the left and right banks during diesel work performed on 11/16/99. The failure occurred on the first start following installation.

As a result, the fuel linkage replacements were initially considered a possible cause of the failures. Subsequent investigation and testing indicated that while the linkage replacements may have contributed to the breaker overcurrent trips when the DG was run, this was not the root cause.

During parallel operation, the Voltage Raise/Lower pushbutton controls VAR loading on the DG. Prior to the overcurrent breaker trip occurring on 11/18/1999, the voltage regulator was controlling DG voltage as required at varying levels as demanded by the Operations PT. Upon pressing the Voltage Raise Pushbutton to adjust power factor to .95 lagging, a sudden and rapid decrease occurred. A decrease in power factor in such a dramatic fashion is indicative of a large surge in VAR load (and its associated current). Data from the Operator Aid Computer (OAC) confirmed that the VAR load and current had suddenly increased. This would have certainly caused the setpoint of the overcurrent relay (50DGT) to be reached. The only components that physically change in position (in response to operator action) to reduce this setting are the pushbutton itself, and the Voltage Regulator PDP.

The contacts of the Raise/Lower pushbutton were checked with a voltmeter. The Lower pushbutton operated satisfactorily. The Raise pushbutton appeared to have a slight hesitation between the time the button was released and when the contacts would return to the open position.

The operation of the motor on the PDP is not fast enough to cause the rapid decrease as that seen during the event. However, the sluggish operation was questionable and this pushbutton assembly was replaced. While some of these repairs were in progress, the 50DGT overcurrent relay and the 4 kV DG output breaker were checked and found to be operating properly.

The Power Driven Potentiometer (PDP)(sometimes called a Motor Operated Potentiometer) receives a demand signal from the Voltage Raise/Lower pushbutton to allow the motor to rotate a potentiometer in either the clockwise or counter-clockwise direction. The potentiometer provides an input to the voltage regulator to vary the DC voltage output to the generator field. Testing was performed on the PDP by placing an analog resistance meter across the output. Several small spikes were observed during the process of spanning the potentiometer back and forth. This raised concern that there may have been a problem with this device.

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Discussions with a vendor expert, confirmed that based on the information given by the operator (dramatic dip of power factor and a surge in VARs), the PDP was a possible cause of the DG breaker trip on overcurrent. The PDP was replaced and a DG test run was conducted. The DG ran satisfactorily at full load, but when the operator was decreasing load, the DG breaker tripped on overcurrent.

The breaker trip that occurred following PDP and voltage raise/lower pushbutton replacement occurred at ~ 4800 kW while reducing load. Traces of data taken when the latest trip occurred were faxed to the vendor. The vendor stated that the input provided indicated problems with the EGA. The vendor was requested to come on site to assist with the work related to the EGA. The station decided to proceed with replacement of EGA and to have it ready for tuning when the vendor arrived. A crew also inspected the current transformer that initiates the 50DGT relay and checked for any wiring connection problems. No problems were found from this inspection. The EGA was replaced and the vendor directed the setup and tuning.

Early on 11/20/99, test equipment was connected to monitor a number of selected parameters in order to observe the response of the new governor. The control system performed well during these runs and the signal oscillations noted on the earlier test equipment traces could not be seen. A variety of DG loading scenarios was executed, including a number of power reductions near the power level where the trips had occurred. No breaker trips occurred after the EGA was replaced and tuned. DG 1B passed the retest requirements and its Operability PT. The trips that were captured on the chart recorder exhibited the same increase in EGA output oscillation immediately prior to the trip occurring. Extensive testing confirmed that the overcurrent breaker trips that were occurring when load was being changed no longer occurred with the newly installed EGA.

The EGA removed from DG 1B was returned to the governor manufacturer for a failure analysis. The manufacturer's analysis of the EGA governor from DG 1B did not reveal an equipment failure. The governor was tested for 2 separate extended periods (24 and 48 hours) and the output drift was well within specification. It would not be possible for them to address the exact tuning settings for this governor, since tuning settings are different for every application and cannot be duplicated on a bench test. However, since no subcomponent related problems were found on this EGA and it had been operating satisfactory prior to the maintenance performed on the fuel rack control linkage, it is their conclusion that the unit was not properly tuned to match the changes that were made to the fuel rack control linkages.

This caused the combined mechanical and electrical gains to be high resulting in the system going into an uncontrollable oscillation and eventual overcurrent breaker trip. The vendor for the DG engines was contacted and they supported this conclusion. They stated in their response that new fuel control rack linkages should be tighter than those replaced and will change the dynamics of fuel control rack linkage motion. The fuel control rack linkages should have been checked for freedom of movement and governor response to the new linkage should have been evaluated in the post maintenance testing with some expectation that adjustments may be necessary.

From the discussions above, it was concluded that the root cause of the DG Breaker overcurrent trips was that the EGA installed on DG 1B was not properly tuned to compensate for the changes that were made to the fuel control rack linkages. This caused the combined mechanical and electrical gains to be excessive resulting in the system going unstable and causing the overcurrent breaker trips.

This event is EPIX reportable. A review of licensee reports for the past twenty-four months indicates no similar events that were reported as LERs. In August 1999, DG 1A experienced load swings during its operability PT. This event was documented in Problem Investigation Process (PIP) C-99-3288. The evaluation of the August 1999 event did not identify a root cause. The DRU on DG 1A was replaced since it was recently installed during the last refueling outage. After the August 1999 event, DG 1A was placed on a bimonthly test interval through October 1999. During this time period, DG 1A has successfully passed its operability PT without any recurrence of the August 1999 event. Therefore, it is believed that the cause of the events is not similar.

A search of the corrective action database found that there have been 10 documented instances of overcurrent breaker trips on the DGs at Catawba. Six of these occurred prior to 1996 (at least one on all 4 DGs) and were caused by a variety of problems. Some examples were protective relaying calibration issues, operator errors, and transients (that are expected) during new EGA setups. Since then, there have been 4 overcurrent trips (including the one documented in this LER), and all of these have occurred on DG1B. The first one occurred on 10/4/96 (PIP # 1-C96-2697). It was discovered that a fuel linkage assembly was installed incorrectly, and was causing the rack to bind at a specific point in its travel. When this load could not be achieved, the governor output oscillated around this point which led to the overcurrent trip.

Corrective actions from this event provided more detailed instructions in the maintenance procedures for removing/replacement of fuel control rack linkages. This was effective in ensuring the correct orientation of the fuel control rack linkage.

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The next overcurrent trip on DG 1B occurred on 8/26/97, and was attributed to a failed Motor Operated Potentiometer (MOP) for the EGA governor (PIPs 1-C97-2796 and 1-C97-3076). This failure could not be duplicated during offsite testing. The casing for the potentiometer was found cracked, which could have led to a momentary spike in the reference signal to the EGA. The MOP for DG 1B has been subsequently replaced with a DRU per Minor Mod CE-9522.

The 3rd overcurrent trip on DG 1B (since 1996) occurred on 5/2/99 when NSWS Pump 1B was started during an Operability PT (1-C99-1648). Testing following that event showed that the starting of a NSWS Pump while the DG is paralleled can cause a current spike on the essential bus large enough to place the DG in an overcurrent condition. Steps were added to Operations' procedures to prevent a NSWS Pump from being started while a DG is paralleled to the essential bus.

The EGA governor for DG 1B had been replaced on 8/10/96 during the 1EOC9 outage. These breaker trips occurred after that time. Therefore, it is possible that this governor was not as finely tuned as it could have been, making this particular DG more susceptible to transient related overcurrent conditions than the other 3 DGs have been. The replacement governor installed on 11/19/99 was setup and tuned with the assistance of a vendor. The DG 1B Overcurrent Trip occurred during post-maintenance testing following the fuel rack linkage replacement. Therefore, the DG was already inoperable at the time this event occurred. No past or present operability is affected on DG 1B. The other DGs were not affected. This was a detectable situation that occurred 3 times following this maintenance. Prior to this maintenance, DG 1B has been performing properly during its monthly Operability PT and during Engineering Safety Features (ESF) Testing during the previous two refueling outages (1EOC10 and 1EOC11). These same fuel rack linkages had already been replaced on DG 1A and no problems were noted during its post maintenance testing or during any Operability PTs since that time. The DG 1A linkages were inspected for freedom of movement and no problems were found. No fuel linkage replacements have been performed on DG 2A or DG 2B. Based on the above, at this time the event is considered not recurring.

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Corrective Actions

Immediate

1. After the overcurrent trip of the DG 1B breaker, Operations initiated work request (W/R) 98104891 and PIP C-99-04675.

Subsequent

1. A FIP team was formed to investigate the cause of the DG 1B breaker overcurrent trip. The team investigated several potential root causes and identified a failure of the EGA as the most probable root cause.

2. The EGA was replaced, setup and tuned. Test equipment was connected to a number of selected parameters to observe the response of the new EGA. Post maintenance testing was completed on DG 1B with no overcurrent trips of the DG 1B breaker occurring. Operations completed their PT and declared the 1B DG operable on November 20, 1999.

3. The failed EGA was sent back to the manufacturer for failure analysis. There were no problems found with this device when tested over the period of several days at their facility. The manufacturer concluded that the governor installed on DG1B was not properly tuned to compensate for the changes that were made to the fuel rack linkages.

4. The EGA tuning procedure was revised to include vendor recommended enhancements for tuning and setup of an EGA.

5. Appropriate DG maintenance procedures have been revised to include requirements to perform a governor response test following maintenance on any part of the fuel system that could affect engine stability.

Safety Analysis

An evaluation was performed from a probabilistic risk standpoint concerning the extended inoperability of DG 1B and found that the incremental increase in risk would be acceptable. The evaluation was performed with the assumption of no maintenance on the Standby Shutdown System, the Auxiliary Feedwater System, or the Nuclear Service Water System. During the time period that DG 1B was inoperable, DG 1A and the Train A safety related components that rely on DG 1A for onsite AC Emergency power were fully operable and capable of fulfilling their required safety functions.

This event had no effect on the health and safety of the public.