Duke Power
A Duke Energy Company

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February 4, 2002

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

SUBJECT: Duke Energy Corporation
Catawba Nuclear Station, Unit 2
Docket Nos. 50-414
Licensee Event Report 414/2001-003 Revision 0

Attached please find Licensee Event Report 414/2001-003 Revision 0, entitled "Electrical Fault in Reactor Coolant Pump Motor Stator Causes Automatic Reactor Trip, Autostart of Emergency Diesel Generator, and Autostart of Auxiliary Feedwater".

This report does not contain any corrective actions required for regulatory compliance with any licensing documents, NRC rules, or regulations. Therefore, this report does not contain any commitments.

Questions regarding this Licensee Event Report should be directed to G.D. Gilbert at 803-831-3231.

Sincerely,

G. R. Peterson

Attachment

IE22

xc:

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NRC FORM 366 (7-2001) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB NO. 3150-0104 EXPIRES 7-31-2004

Estimated burden per response to comply with this mandatory information collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records Management Branch (T-6 E6), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to bjs1@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202 (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

# LICENSEE EVENT REPORT (LER)

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

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| Catawba Nuclear Station, Unit 2 | 050- 00414 | 1 OF 7 |

**4. TITLE**
Electrical fault in reactor coolant pump motor stator causes automatic reactor trip, autostart of emergency diesel generator, and autostart of auxiliary feedwater.

| 5. EVENT DATE | | | 6. LER NUMBER | | | 7. REPORT DATE | | | 8. OTHER FACILITIES INVOLVED | |
|---|---|---|---|---|---|---|---|---|---|---|
| MO | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REV NO | MO | DAY | YEAR | FACILITY NAME | DOCKET NUMBER |
| | | | | | | | | | None | |
| 12 | 07 | 2001 | 2001 | – 003 | – 00 | 02 | 04 | 2002 | FACILITY NAME | DOCKET NUMBER |

| 9. OPERATING MODE | 1 |
|---|---|
| 10. POWER LEVEL | 100 |

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply)

| | | | |
|---|---|---|---|
| 20.2201(b) | 20.2203(a)(3)(ii) | 50.73(a)(2)(ii)(B) | 50.73(a)(2)(ix)(A) |
| 20.2201(d) | 20.2203(a)(4) | 50.73(a)(2)(iii) | 50.73(a)(2)(x) |
| 20.2203(a)(1) | 50.36(c)(1)(i)(A) | X 50.73(a)(2)(iv)(A) | 73.71(a)(4) |
| 20.2203(a)(2)(i) | 50.36(c)(1)(ii)(A) | 50.73(a)(2)(v)(A) | 73.71(a)(5) |
| 20.2203(a)(2)(ii) | 50.36(c)(2) | 50.73(a)(2)(v)(B) | OTHER |
| 20.2203(a)(2)(iii) | 50.46(a)(3)(ii) | 50.73(a)(2)(v)(C) | Specify in Abstract below or in NRC Form 366A |
| 20.2203(a)(2)(iv) | 50.73(a)(2)(i)(A) | 50.73(a)(2)(v)(D) | |
| 20.2203(a)(2)(v) | 50.73(a)(2)(i)(B) | 50.73(a)(2)(vii) | |
| 20.2203(a)(2)(vi) | 50.73(a)(2)(i)(C) | 50.73(a)(2)(viii)(A) | |
| 20.2203(a)(3)(i) | 50.73(a)(2)(ii)(A) | 50.73(a)(2)(viii)(B) | |

**12. LICENSEE CONTACT FOR THIS LER**

| NAME | TELEPHONE NUMBER (Include Area Code) |
|---|---|
| G.D. Gilbert, Regulatory Compliance | 803-831-3231 |

**13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT**

| CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX | CAUSE | SYSTEM | COMPONENT | MANU-FACTURER | REPORTABLE TO EPIX |
|---|---|---|---|---|---|---|---|---|---|
| X2 | AB | MR | W120 | Yes | | | | | |

| 14. SUPPLEMENTAL REPORT EXPECTED | | | 15. EXPECTED SUBMISSION DATE | MONTH | DAY | YEAR |
|---|---|---|---|---|---|---|
| YES (If yes, complete EXPECTED SUBMISSION DATE). | X | NO | | | | |


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

On December 7, 2001 at 2350 hours with Catawba Unit 2 operating in Mode 1 "Power Operation" at 100% power, an automatic reactor trip occurred. The reactor trip was caused by low flow in the D loop when the 2D reactor coolant pump (RCP) 6900VAC feeder breaker opened in response to protective relay actuation caused by an electrical fault internal to the RCP motor. The electrical fault in the RCP motor also caused protective relaying to open the normal feeder breaker supplying power to the essential bus 2ETB, creating an undervoltage condition on 2ETB. The associated emergency diesel generator (EDG) automatically started and powered the bus and required equipment as designed. The 2B motor-driven and the turbine driven auxiliary feedwater pumps automatically started in response to the 2ETB blackout as designed. The 2A motor-driven auxiliary feedwater pump automatically started in response to lo lo water level in the 2D steam generator (S/G). All systems responded as designed to shut down the reactor and maintain it in a safe shutdown condition. Corrective actions included replacing the failed 2D RCP motor and verification of proper operation of the protective relaying associated with the breakers that opened. The RCP motor failure was determined to be a "turn-to-turn" failure of a single coil. The damaged coil is on the line end of the stator core and appears to be the first coil in the Z-phase (T3) coil group. A possible cause of the coil failure is a manufacturing defect of the magnet wire.

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

BACKGROUND

Catawba Nuclear Station Unit 2 is a four loop Westinghouse pressurized water reactor [EIIS: RCT]. Each reactor coolant pump (RCP) motor [EIIS: MO] is provided power from the 6900VAC normal auxiliary power system [EIIS: EA]. The 6900VAC normal auxiliary power system distributes power to unit auxiliaries required during normal operation and serves as the preferred power supply to the 4160VAC essential auxiliary power system [EIIS: EB] through a 6900/4160VAC transformer [EIIS: XFMR].

The 6900VAC system consists of four switchgear assemblies [EIIS: SWGR] of the split-bus design. One section of each switchgear assembly (cubicles 1-6) supplies one RCP motor and serves as part of the preferred power supply to the 4160VAC essential auxiliary power system as indicated below:

6900VAC switchgear 2TA - Normal source for 4160VAC switchgear 2ETA

6900VAC switchgear 2TB - Alternate source for 4160VAC switchgear 2ETB

6900VAC switchgear 2TC - Alternate source for 4160VAC switchgear 2ETA

6900VAC switchgear 2TD - Normal source for 4160VAC switchgear 2ETB

The other section of each switchgear assembly (cubicles 8-16) supplies balance-of-plant loads such as the condenser circulating water pump motors.

The 6900VAC feeder breakers to RCP motors and 4160VAC essential switchgear have protective relying for differential current [EIIS: 61] and ground fault [EIIS: 64].

Each of the four 6900VAC switchgear assemblies supplies power to its associated RCP motor via an additional separate and independent 6900VAC switchgear assembly. These additional switchgear assemblies are provided for RCP motor electrical penetration [EIIS: PEN] protection and are located in the auxiliary building.

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Each train of the 4160VAC essential auxiliary power system is also provided with a separate and independent emergency diesel generator (EDG) [EIIS: DG] to supply the class 1E loads required to safely shutdown the unit following a design basis accident.

Each of the redundant 4160VAC essential buses is provided with undervoltage protection to monitor bus voltage with three under voltage relays [EIIS: 27] which are utilized in a two-out-of-three logic scheme. Upon a loss of voltage on the 4160VAC essential bus, this relaying actuates the load sequencer [EIIS: EK]. The sequencer starts the associated EDG, load sheds the essential bus, powers the bus from the EDG, and sequences on the required loads.

Plant conditions immediately prior to this event were: reactor power 100% in MODE 1, turbine load 1230 Mwe, reactor coolant system [EIIS: AB] Tavg 587.2 degrees F., reactor coolant system pressure 2231 psig, reactor coolant system boron concentration 1196 ppm, and cycle burnup 45.0 effective full power days. There were no systems, structures, or components out of service at the time of this event that contributed to the event.

This event is being reported under 10CFR50.73(a)(2)(iv)(A) (any event or operation that resulted in manual or automatic actuation of a safety system).

EVENT DESCRIPTION
(Dates and times are approximate)

12/7/2001 2350 A phase to ground fault occurred in the stator of the 2D RCP motor.

· Protective relaying automatically opened the 6900VAC breaker supplying power to the 2D RCP motor.

Protective relaying automatically opened the 6900VAC breaker supplying power to the 2ETB 4160VAC essential bus.

A unit 2 reactor trip occurred because of low RCS flow in the 2D loop with power >P8 (49%).

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

Operations entered procedure EP/2/A/5000/E-0 "Reactor Trip or Safety Injection".

The 2B EDG automatically started and supplied power to the 2ETB 4160VAC essential bus. All loads required for this situation were automatically sequenced on as designed. This included the 2B motor-driven auxiliary feedwater pump and the turbine driven auxiliary feedwater pump. Operations entered procedure AP/2/A/5000/007 "Loss of Normal Power".

The 2A motor-driven auxiliary feedwater pump automatically started because of lo lo level in the 2D steam generator. The lo lo level was expected as a result of shrink caused by reverse flow in that loop when the RCP tripped.

An automatic main feedwater isolation occurred as a result of the reactor trip and lo T-ave as designed.

12/8/2001 0050 Stable no-load conditions were established with the unit in MODE 3.

12/8/2001 0152 Required 4-hour notification to the NRC was made.

12/8/2001 0200 A plant recovery team was formed to investigate the reactor trip.

12/8/2001 0252 Essential bus 2ETB was realigned to an offsite power supply and the 2B EDG was shut down.

12/8/2001 2151 Electrical testing was completed on the 2D RCP motor and it was determined that the ground was internal to the motor on the Z phase. The decision was made to replace the motor with the available spare.

12/9/2001 0256 A cooldown of Unit 2 to MODE 5 was commenced to allow replacement of the RCP motor.

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12/19/2001 Testing and calibration of protective relaying associated with the two 6900VAC feeder breakers that tripped was completed. An evaluation of the results concluded that all relaying functioned as designed and within established setpoints and allowable tolerances.

12/22/2001 0856 Unit 2 was placed on line.

12/23/2001 1034 Unit 2 returned to 100% power.

CAUSAL FACTORS

To determine the source of the ground fault, testing was performed on the circuit from the 6900VAC RCP motor breaker through the RCP motor stator. Testing performed included phase-to-phase and phase-to ground measurements of the cables, electrical penetration, and the stator windings of 2D RCP motor.

Winding resistance was measured at 0.091 ohms from X-to-Y, Y-to-Z, and X-to-Z phases. This indicated that there was no open circuit between the safety breaker and the motor windings. This also confirmed that there were no high impedance connections within the circuit.

Impedance measurements at 1 kHz identified a change in Z-phase capacitance to ground.

Z-phase insulation resistance (phase-to-ground) was only 284 Kohms with an applied voltage of 1 kVDC. This is unacceptable (well below the IEEE 43 acceptance criteria) and was the source of the ground fault.

Preliminary inspection after disassembly of the motor revealed a "turn-to-turn" failure of a single coil. The damaged coil is on the line end of the stator core and appears to be the first coil in the Z-phase (T3) coil group. A possible cause of failure is a manufacturing defect of the magnet wire.

The motor was rewound by the original equipment manufacturer in 1998 and had been in service for less than 3 years. The stator is being shipped back to the original equipment manufacturer for further investigation and analysis.

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

The RCP motors are included in the Catawba preventive maintenance program. The motor parameters are monitored during operation and refurbished motors are periodically installed based on performance monitoring and trending. This practice is to improve system reliability and prevent unexpected failures during plant operation. This practice has been in effect for many years.

An investigation was conducted into the cause for the trip of the 6900VAC feeder breaker that supplies power to essential switchgear 2ETB. It was determined that the breaker was tripped by the actuation of the ground fault relay. The ground fault relay operates on the principle that a balanced three-phase load current will result in zero current to the relay. Given that the RCP motor stator failure resulted in a large fault current, it was concluded that this produced an imbalance in the 6900VAC system that exceeded the setpoint of this ground fault relaying and the relay operated as designed.

There have been two other reactor trips within the previous 36 months. One was the result of a degraded electrical connector of the turbine electrical trip solenoid valve. The other was caused by inadequate oversight of a modification to the turbine building roof. Corrective actions for these previous events would not have prevented this event. This event is not a recurring event.

CORRECTIVE ACTIONS

Subsequent:

1. The failed 2D RCP motor was replaced with a refurbished spare.
2. The testing and calibration of protective relaying associated with the two 6900VAC feeder breakers that tripped was performed. An evaluation of the results concluded that all relaying functioned as designed and within established setpoints and allowable tolerances.

Planned:

1. Results of the inspection of the failed RCP motor stator by the vendor will be reviewed to identify any additional actions.

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

SAFETY ANALYSIS

The conditional core damage probability (CCDP) of this event has been evaluated using the PRA. This reactor trip was complicated by the resulting loss of power to the operating essential 4160VAC train. However, plant systems worked as designed as the EDG started and re-powered the bus. The other train of essential power was not affected. Operators restored off-site power to the bus in about 3 hours. Based on operations simulations and plant walkdowns of the scenario, it was concluded that off-site power could have been restored in less than 1 hour had it been required. Therefore, the CCDP for the event being evaluated is on the order of 5.4E-07. This value is less than the accident sequence precursor threshold of 1.0E-06.

The dominant core damage sequences associated with this event would have containment safeguards systems available which included hydrogen igniters and containment air return fans. These types of sequences contribute insignificantly to the large early release frequency (LERF) which is dominated by ISLOCA and seismic initiating events. Therefore, this event is judged to have no significance with respect to LERF for Catawba.

This event was not a Safety System Functional Failure. The health and safety of the public were not affected by this event. There were no radiological events or consequences associated with this event.