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November 8, 2001

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 414/2001-001 Revision 0

Attached please find Licensee Event Report 414/2001-001
Revision 0, entitled "Main Feedwater Isolation Valve 2CF60
Failed to Close."

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. K. Strickland at 803-831-3585.

Sincerely,

G. R. Peterson

Attachment

IE 22
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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 | | | | |
| LICENSEE EVENT REPORT (LER) (See reverse for required number of digits/characters for each block) | | 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. | | | | | | |
| 1. FACILITY NAME | | | 2. DOCKET NUMBER | | | 3. PAGE | | |
| Catawba Nuclear Station, Unit 2 | | | 05000 414 | | | 1 OF 7 | | |
| 4. TITLE | | | | | | | | |
| Main Feedwater Isolation Valve 2CF60 Failed to Close | | | | | | | | |
| 5. EVENT DATE | | | 6. LER NUMBER | | 7. REPORT DATE | | 8. OTHER FACILITIES INVOLVED | |
| MO | DAY | YEAR | YEAR | SEQUENTIAL NUMBER | REV NO | MO | DAY | YEAR |
| 09 | 14 | 2001 | 2001 | - 001 - | 00 | 11 | 8 | 2001 |
| | | | | | | | FACILITY NAME DOCKET NUMBER | |
| | | | | | | | FACILITY NAME DOCKET NUMBER | |
| 9. OPERATING MODE | | 11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check all that apply) | | | | | | |
| 1 | | 20.2201(b) | | 20.2203(a)(3)(ii) | | 50.73(a)(2)(ii)(B) | | 50.73(a)(2)(ix)(A) |
| 10. POWER LEVEL | | 20.2201(d) | | 20.2203(a)(4) | | 50.73(a)(2)(iii) | | 50.73(a)(2)(x) |
| 17% | | 20.2203(a)(1) | | 50.36(c)(1)(i)(A) | | 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 Specify in Abstract below or in NRC Form 366A |
| | | 20.2203(a)(2)(iii) | | 50.46(a)(3)(ii) | | 50.73(a)(2)(v)(C) | | |
| | | 20.2203(a)(2)(iv) | | 50.73(a)(2)(i)(A) | | 50.73(a)(2)(v)(D) | | |
| | | 20.2203(a)(2)(v) | | X 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. K. Strickland, Regulatory Compliance | | | | | 803-831-3585 | | | |
| 13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT | | | | | | | | |
| CAUSE | SYSTEM | COMPONENT | MANUFACTURER | REPORTABLE TO EPIX | CAUSE | SYSTEM | COMPONENT | MANUFACTURER |
| N2e | CF | 2CFLGA0060 | Borg Warner | Yes | | | | |
| 14. SUPPLEMENTAL REPORT EXPECTED | | | | | 15. EXPECTED SUBMISSION DATE | | MONTH | DAY |
| YES (If yes, complete EXPECTED SUBMISSION DATE). | | | | | X NO | | | |
| 16. ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) | | | | | | | | |
| <p>On September 14, 2001, during the shutdown for the refueling outage, the main feedwater isolation valve 2CF60 failed to close from the control room. Technicians locally closed the valve in accordance with Technical Specification 3.6.3 and 3.7.3. Prior to September 14, 2CF60 was considered operable and within its surveillance testing frequency.</p> <p>The valve 2CF60 failure was due to the hydraulic solenoid valves being stuck in their energized position. The solenoid valves failure was due to hydraulic fluid unintentionally entering the coil section of the solenoids forming a sticky adhesive bond between the coil rod and coil housing. The solenoid valves were replaced and valve 2CF60 is operable.</p> <p>The exact time of the valve 2CF60 failure could not be determined but an evaluation concluded that the condition most likely existed longer than the 72 hours allowed by the Limiting Condition for Operation of Technical Specifications 3.6.3 and 3.7.3. This event is being reported as a condition prohibited by Technical Specifications 10CFR50.73(a)(2)(i)(B).</p> | | | | | | | | |

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

Background

This event is being reported under 10CFR50.73(a)(2)(i)(B), any operation or condition which was prohibited by the plant's Technical Specifications. NUREG-1022 Revision 2, Event Reporting Guidelines 10 CFR 50.72 and 50.73, states a Licensee Event Report is required if there is firm evidence a condition existed for a time longer than permitted by the Technical Specifications even if the condition was not discovered until after the allowable time had elapsed and the condition was rectified immediately upon discovery.

The purposes of the main feedwater [EIIS:SJ] isolation valves [EIIS:ISV] are to restrict reactor coolant [EIIS:AB] system thermal transients following a secondary system high energy line break inside or outside containment, isolate forward feedwater flow to the steam generators on a high-high level to prevent overfill, and prevent flooding of the main steam/feedwater penetration room and the consequential disablement of safety related equipment due to a pipe rupture in the main steam/feedwater penetration room. The main feedwater isolation valves are arranged with 2CF33 aligned to the steam generator A, 2CF42 aligned to the steam generator B, 2CF51 aligned to the steam generator C, and 2CF60 aligned to the steam generator D.

The main feedwater isolation valves are flex wedge gate valves with pneumatic-hydraulic piston cylinder operators. Hydraulic fluid is pumped into the opening side of the piston cylinder to open the main feedwater isolation valves. At the same time, nitrogen from the closing side of the piston cylinder is compressed into a nitrogen accumulator as the piston retracts into the cylinder. Hydraulic solenoid valves control application of hydraulic pressure to the piston. The solenoids are energized to block fluid flow to the reservoir and allow the hydraulic pump to force the main feedwater isolation valve open. The hydraulic solenoid valves are de-energized to allow hydraulic fluid flow to the reservoir. Nitrogen from the accumulator works against the piston to force the hydraulic fluid to the reservoir and close the main feedwater isolation valve.

The main feedwater isolation valves are included in the Catawba preventive maintenance program. Main feedwater isolation valve actuators, including both hydraulic solenoid valves, are replaced on a six refueling outage frequency. This practice is to improve system reliability and prevent

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unexpected failures during plant operation. This practice has been in effect for many years.

Main feedwater isolation is accomplished by one of three redundant features - a) main feedwater isolation valve closure, b) main feedwater control valve and bypass valve closure, and c) main feedwater pump trip. Each redundant feature consists of an A and B train isolation. The main feedwater control valves and bypass valves are air operated valves and operate in a throttled position during normal plant operations. The air operated valves are not susceptible to the same failure mechanism as the hydraulic solenoids for the main feedwater isolation valves.

The main feedwater isolation valves are required to be operable in Modes 1-4 for Technical Specification 3.6.3, Containment Isolation Valves and modes 1-3 for Technical Specification 3.7.3, Main Feedwater Isolation Valves, Main Feedwater Control Valves, Associated Bypass Valves, and Tempering Valves. Both Technical Specifications action statements require the inoperable main feedwater isolation valve to be closed or isolated within 72 hours. Contrary to the action statement, valve 2CF60 was suspected to be inoperable and open for longer than the allowed 72 hours.

At the time of the discovery of the failed valve, Catawba was conducting a controlled unit shutdown for the End-of-Cycle 11 refueling outage and was operating at approximately 17 percent power. Catawba remained at 17 percent power until the valve was closed locally. This event did not result in any plant transients. With the exception of the valve 2CF60 failure, no systems, structures, or components were out of service that had any significant effect on the event.

Event Description (dates and approximate times)

9-14-01 Unit shutdown initiated for the start of the
1400 scheduled End-of-Cycle 11 refueling outage.

2245 Reactor power was approximately 17 percent.

Main feedwater isolation valve 2CF60 failed to close during the steam generator nozzle transfer operation. The transfer of feedwater flow from the main feedwater nozzles to auxiliary feedwater nozzles is a normal

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activity for unit shutdown.

Unit operators entered Limiting Conditions for Operations for Technical Specifications 3.6.3, Containment Isolation Valves, and 3.7.3, Main Feedwater Isolation Valves, Main Feedwater Control Valves, Associated Bypass Valves and Tempering Valves. The Technical Specifications action statements require inoperable valves to be closed within 72 hours.

- 9-15-01
0407 Technicians locally closed the main feedwater isolation valve 2CF60.
- 9-17-01
1653 Unit operators exited Limiting Conditions for Operations for Technical Specifications 3.6.3 and 3.7.3 upon entry into Mode 5.
- 9-18-01 Engineering evaluation of the failed valve 2CF60 could not conclusively determine the time of failure. The valve 2CF60 failure most likely occurred earlier than the 72 hour Technical Specifications action time limit.

Causal Factors

The valve 2CF60 failure was due to the hydraulic solenoid valves being stuck in their energized position. The solenoid valves failure was due to hydraulic fluid unintentionally entering the coil section of the solenoids and the normally energized coil baking the hydraulic fluid to cause a sticky adhesive bond between the coil rod and coil housing.

The hydraulic fluid was able to surround the solenoid plunger due to seepage past the sealing surface (quad ring) which occurred during the manufacturer's proof testing at an elevated hydraulic pressure of > 6000 psig. In 1997, the manufacturer modified their test procedures to perform a post-test visual inspection to ensure no hydraulic fluid entered the coil area.

Another contributor to the hydraulic oil seepage past the sealing surface was a manufacturer initiated seal design change from an O-ring to quad ring in the late 1980's. Valves with the earlier O-ring design did not

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experience hydraulic fluid leakage. Therefore, the population of solenoid valves susceptible to this failure mechanism is restricted to after the quad ring design change and prior to the improved inspection procedure.

The valve failure is an EPIX reportable equipment failure. Reference Catawba Nuclear Station Unit 2 EPIX report 297.

Corrective Actions

Immediate

1. Valve 2CF60 was placed in the closed position. Operations personnel complied with Technical Specifications 3.6.3 and 3.7.3.

Subsequent

1. Valve 2CF60 actuator and hydraulic solenoids were replaced and tested during the End-of-Cycle 11 refueling outage. Valve 2CF60 is operable.
2. Engineering previously reviewed all main feedwater isolation valves and concluded another valve, 2CF51, may be susceptible to the same failure as valve 2CF60. The hydraulic solenoids for suspect main feedwater isolation valve 2CF51 were replaced and tested during the End-of-Cycle 11 refueling outage. Valve 2CF51 is operable.

Engineering previously reviewed the remaining Unit 1 and 2 feedwater isolation valves. It was determined that the remaining Unit 2 solenoids were manufactured following the manufacturer improved inspection practices. The Unit 1 valves were evaluated as not susceptible to the same failure mechanism, were inspected, or were replaced during the previous refueling outage.

Planned

1. The procurement description will include the requirement to inspect the hydraulic solenoids after proof testing even though this is the normal practice.

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Safety Analysis

There was no safety significance to this event. In the event of a transient that would have required feedwater isolation, the redundant isolation features of closing the main feedwater control valves, closing the bypass control valves, and tripping the main feedpumps would have fulfilled the safety feature of terminating feedwater flow to each steam generator.

The main and bypass feedwater control valves are high quality valves designed to fail closed on loss of air or signal. The isolation logic for the valves consists of both train A and train B protection grade signals.

Surveillance testing was performed on the feedwater control valves several days after the valve 2CF60 failure. The testing verified the main and bypass feedwater control valves isolated on both train A and train B actuation logic. Also, the remaining three main feedwater isolation valves isolated on both train A and train B actuation logic.

The feedwater isolation function was judged to be of low significance and overall high reliability and therefore is not explicitly included in the Catawba Probabilistic Risk Assessment. No quantitative evaluation of the core damage frequency impact of a failure of 2CF60 is available. Qualitatively, the redundant isolation features for terminating feedwater flow assures that the overall failure probability for this function is very low. The failure of valve 2CF60 has an insignificant impact on the Catawba core damage frequency estimate.

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

Additional Information

Operating experience was reviewed for the past 36 months to determine if this event was similar to previous events.

In December 1999, the main feedwater isolation valve 2CF51 failed due to the nitrogen solenoid spool shuttling to the energized position and the

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nitrogen pressure holding the spool piece in place. This event was not similar to the valve 2CF60 failure described in this report.

In January 2000, while performing post modification testing, the main feedwater isolation valve 2CF33 successfully closed but experienced a delayed stroke time for the B-train actuation. After the initial slow valve stroke, all subsequent valve stroke times met the acceptance criterion and the valve was operable. A decision was made to gag all the nitrogen solenoid valves to assure that no inadvertent shuttling of the valves could occur as previously experienced by valve 2CF51. All feedwater isolation valves passed post modification stroke time testing. While entering the refueling outage in March 2000, valve 2CF33 again experienced a slow B-train stroke time. The actuator, including hydraulic solenoids, for 2CF33 was replaced during the refueling outage as a scheduled preventive maintenance activity. None of the other feedwater isolation valves exhibited abnormal stroke times.

In August 2000, as part of the root cause investigation of valve 2CF51, a failure of the hydraulic solenoids was identified at another station. This failure mode was confirmed by disassembly of the B-train hydraulic solenoid valve previously installed on valve 2CF33. Engineering performed an operability evaluation for all feedwater isolation valves and concluded that any suspect valves could be inspected or replaced during the next refueling outage. This decision was based on the different hydraulic configuration at the other station that experienced the failure, none of the other Catawba valves exhibited abnormal valve operation, no previously identified problems with the hydraulic solenoid valves in the plant lifetime, additional benchmarking of successful valve operation at other stations, and the letter from the manufacturer stating, "The possibility of additional failures is minimal." Based on these inputs, immediate corrective actions were not warranted but actions were scheduled for the next opportunity. The valve 2CF33 B-train intermittent slow stroke times was similar to the valve 2CF60 failure in September 2001.

The manufacturer has informed Catawba that following valve proof testing, the manufacturer now performs a partial disassembly to inspect for and remove hydraulic fluid in the coil.

Energy Industry Identification System (EIIS) codes are identified in the text within brackets [].