NRC Form 366
(9-83)

U.S. NUCLEAR REGULATORY COMMISSION
APPROVED OMB NO. 3150-0104
EXPIRES: 8/31/85

# LICENSEE EVENT REPORT (LER)

| FACILITY NAME (1) | DOCKET NUMBER (2) | PAGE (3) |
|---|---|---|
| McGuire Nuclear Station, Unit 2 | 0 5 0 0 0 3 7 0 | 1 OF 0 9 |

TITLE (4) Reactor Trip Occurred Due To Reversed Wiring On Generator Stator Cooling D/P Switch Circuity Combined With Calibration Drift Of D/P Switch And Gauge

| 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 NAMES | DOCKET NUMBER(S) |
| 1 1 | 3 0 | 8 7 | 8 7 | 0 2 1 | 0 0 | 1 2 | 3 0 | 8 7 | | 0 5 0 0 0 |
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| OPERATING MODE (9) | 1 | THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11) | | | |
|---|---|---|---|---|---|
| POWER LEVEL (10) | 1 0 0 | 20.402(b) | 20.405(c) | X 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) | 50.73(a)(2)(vii) | OTHER (Specify in Abstract below and in Text, NRC Form 366A) |
| | | 20.405(a)(1)(iii) | 50.73(a)(2)(i) | 50.73(a)(2)(viii)(A) | |
| | | 20.405(a)(1)(iv) | 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 AREA CODE |
|---|---|
| Steven E. Le Roy, Licensing | 7 0 4 3 7 3 - 6 2 1 3 |

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

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


On 11/30/87 at approximately 1730, the Unit 2 Main Generator breakers opened, shortly after a Unit 2 Generator Stator Cooling (KG) Flow Differential Pressure (D/P) Low alarm was displayed on the Operator Aid Computer (OAC); the turbine then tripped on overspeed, and a Reactor Trip resulted. The Reactor Trip was due to reversed wiring on the Low and Emergency Low Generator KG D/P switch circuitry, combined with calibration drift on the Low Generator KG D/P switch and D/P gauge. Unit 2 stabilized from the Reactor Trip by 1830. Instrument and Electrical (IAE) corrected the wiring problem on December 1, 1987, and Unit 2 was returned to power operation. This event is assigned a cause of Other because the origin of the incorrect wiring configuration on the Low and Emergency Low Generator KG Flow D/P switch circuits could not be determined and because the calibration drift of the Low Generator KG Flow D/P switch and pressure gauge was due to equipment malfunction. Unit 1 will be checked and wiring correction will be made as necessary. Previously planned KG system modification will be reviewed to ensure critical KG pressure switches are replaced. Loop calibrations for the Generator KG Flow D/P Low and Emergency Low Circuitry will be developed.


IE22,1,

INTRODUCTION:

On November 30, 1987 at approximately 1730, the Unit 2 Main Generator breakers opened, shortly after a Unit 2 Generator Stator Cooling (KG) [EIIS:TJ] Flow Differential Pressure (D/P) Low alarm was displayed on the Operator Aid Computer (OAC) [EIIS:CPU]; the turbine then tripped on overspeed, and a Reactor Trip resulted. Operations (OPS) and Instrumentation and Electrical (IAE) determined during the post-trip investigation that the Reactor Trip was due to reversed wiring on the Low and Emergency Low Generator KG D/P switch circuitry, combined with calibration drift on the Low Generator KG D/P switch and D/P gauge.

Unit 2 stabilized from the Reactor Trip by approximately 1830. IAE corrected the wiring problem by approximately 0330 on December 1, 1987. Unit 2 was returned to power operation on December 1, 1987 at 1028.

Unit 2 was in Mode 1, Power Operation, at 100% power when the Reactor Trip occurred.

This event is assigned a cause of Other because the origin of the incorrect wiring configuration on the Low and Emergency Low Generator KG Flow D/P switch circuits could not be determined and because the calibration drift of the Low Generator KG Flow D/P switch and pressure gauge was due to equipment malfunction.

EVALUATION:

Background

The KG system is a closed loop cooling system that circulates high purity water to maintain the stator conductors of the Main Generator within an acceptable temperature range whenever the Main Generator [EIIS:GEN] is carrying load. The system consists of a 700 gallon tank [EIIS:TK], two pumps [EIIS:P], two heat exchangers [EIIS:HX], two filters [EIIS:FLT], two demineralizers [EIIS:FDM], and necessary controls, all assembled on a skid.

Normal D/P of the KG cooling water across the Main Generator is approximately 29 psid. By design, if D/P decreases to 21 psid, a pressure switch [EIIS:PS] (2KGPS5191 on Unit 2) closes a set of contacts and energizes relay [EIIS:RLY] R7. This relay actuates a Generator KG Flow D/P Low computer [EIIS:CPU] alarm [EIIS:AA] instantaneously and energizes a time delay relay which after 5 seconds initiates a Turbine [EIIS:TRB] Runback to 10% power level. According to the electrical drawing, Unit 2 Generator Stator Cooling and Excitation Control System, at the time of this event, the Digital Input Point to the OAC for the Generator KG Flow D/P Low alarm was point D0486/DKG026. By design, if D/P decreases to 17 psid, a pressure switch (2KGPS5192 for Unit 2) closes a set of contacts and energizes relay R8. This relay actuates a Generator KG Flow D/P Emergency Low computer alarm instantaneously and energizes a time delay relay which after 45 seconds initiates a Main Generator Trip which results in a Turbine Trip. The

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

Turbine Trip results in a Reactor [EIIS:RCT] Trip above 48% power. According to the electrical drawing at the time of this event, the Digital Input Point to the OAC for the Generator KG Flow D/P Emergency Low was point DO487/DKG028.

Description of Event

On November 30, 1987, at approximately 0800, an OPS Nuclear Equipment Operator (NEO) on routine rounds noticed high pressure (approximately 7 psig) on the Unit 2 KG Cooling Water Tank pressure indication. The NEO lowered tank pressure to approximately 4 psig to restore the pressure within the acceptable 2 psig to 4.5 psig range. The Generator KG D/P was approximately 29 psid before and after the KG Cooling Water Tank pressure was decreased.

At approximately 1000, the NEO checked the KG skid and noticed a KG Cooling Water Tank Level High alarm. Tank pressure remained at approximately 4 psig and Generator KG D/P was still approximately 29 psid. The NEO consulted with Control Room personnel to determine the appropriate action to take. Control Room personnel advised him, after consulting with an Operations Engineer, to decrease level but to be careful to not allow tank pressure to decrease to 0 psig. The NEO bled tank level down approximately 2 inches, and tank pressure decreased to approximately 1 psig. Generator KG D/P decreased to approximately 27 to 28 psid. The KG Cooling Water Tank Level High alarm cleared. Control Room personnel, after again checking with the Operations Engineer, gave permission to leave tank pressure at approximately 1 psig.

At 1126:46, the Unit 2 Generator KG Flow D/P Low alarm displayed on the OAC screen in the Control Room and cleared within 1 second. At 1500:55, the same alarm displayed again and cleared 1 minute and 6 seconds later. The alarm came in 22 additional times for intervals varying from less than 1 second to 44 seconds between 1500:55 and 1657:28. The Unit 2 Nuclear Control Operator (NCO) at the controls noticed the alarm but did not notice how long the alarm stayed in. The first time he noticed the alarm he sent the NEO who had previously decreased the tank pressure to check the Generator KG D/P and other KG parameters. The NEO found the Generator KG D/P was approximately 27 to 28 psid, tank pressure was approximately 1 psig, and no inordinate local KG alarms. He informed the NCO of the KG system status. The NCO believed the alarm to be the result of the low tank pressure and was not concerned that the alarm continued to come in on the OAC because the Generator KG D/P was well above the 21 psid setpoint which would cause a Turbine Runback. An Assistant Shift Supervisor advised that the Generator KG Flow D/P Low had alarmed frequently in the past.

At 1726:28, the Generator KG Flow D/P Low alarm again displayed on the OAC. At 1727:24, the Unit 2 Main Generator breakers opened. A Stator Coolant Water Turbine Trip alarm then sounded in the Control Room. At 1727:24, the Unit 2 turbine tripped and a Reactor Trip resulted.

Operations implemented the Unit 2 Reactor Trip procedure. At 1727:42, OPS manually started the Auxiliary Feedwater (CA) [EIIS:BA] Motor [EIIS:MO] Driven Pumps 2A and 2B to help maintain Steam Generator (S/G) [EIIS:SG] levels. Main Feedwater (CF) [EIIS:SJ] isolation occurred on a Reactor Trip With Low T-average signal at 1727:58. Operations started a CF pump, and then secured the CA motor driven pumps by 1805:12. Approximately 30 minutes after the Reactor Trip occurred, Pressurizer [EIIS:PZR] level had reached no-load condition. S/G level and pressure and Reactor Coolant T-average reached no-load values within 1 hour after the Reactor Trip.

The Reactor Trip was attributed to problems with wiring in the KG system panel and calibration drift on the D/P switch and pressure gauge which were discovered and corrected during the post-trip investigation. Unit 2 returned to Mode 1 on December 1, 1987 at 1028.

Conclusion

During the post-trip investigation, OPS and IAE discovered that the wires leading from pressure switches 2KGPS5191 and 2KGPS5192 to relays R7 and R8 were reversed. Pressure switch 2KGPS5191 was wired to relay R8; therefore, when Generator KG D/P decreased to the setpoint of 2KGPS5191, relay R8 energized, which in turn energized the 45 second time delay relay and initiated the trip of the Main Generator breakers [EIIS:MJB]. (By design, pressure switch 2KGPS5191 should have been wired to relay R7, which if energized would in turn energize a 5 second time delay relay and then initiate a Turbine Runback to 10% power.)

Pressure Switch 2KGPS5192 was wired to relay R7, which if energized at the pressure switch setpoint of 17 psid, would energize a time delay relay which initiates a Turbine Runback to 10% power level. (By design, pressure switch 2KGPS5192 should have been wired to relay R8, which if energized would in turn energize a 45 second time delay relay and then initiate a trip of the Main Generator breaker.)

The wiring from the two pressure switches to relays R7 and R8 was originally assembled and supplied to McGuire Nuclear Station by Westinghouse. It could not be determined during the investigation if the wiring had been replaced since the original installation of the KG skid. Westinghouse drawings and original and subsequent revisions of Duke Power drawings show the correct wiring configuration. Documentation on work requests completed on the pressure switches since 1980 makes no mention of replacement of the wiring. IAE personnel who discovered the problem stated that the wiring did not appear to be original. The two wires were not bundled together with the remainder of the wires and did not appear to be the same type of wire as the other vendor supplied wires in the panel. Therefore, this event is assigned a cause of Other since the origin of the incorrect wiring configuration could not be determined.

If the wires had been reversed by the vendor, the type of startup test conducted on the KG systems at McGuire would not have identified the wiring error. Also, after calibrations of pressure switches 2KGPS5191 and 5192, functional testing only included verifying the appropriate computer alarm came in on the OAC. Due to a wiring error on the Digital Input Points, the reversed wiring from the pressure switches to the relays would not have been revealed during these functionals. The McGuire Maintenance Management Procedure, Functional Verification, is currently under significant revision which is part of a commitment to the Institute of Nuclear Power Operations.

This event has been assigned a cause of Other due to the calibration drift of pressure switch 2KGPS5191 and pressure gauge 2KGPS5190. When IAE personnel checked the pressure switch during post-trip troubleshooting, they found the calibration had drifted approximately 2 psid above the setpoint so that the Pressure Switch setpoint was approximately 23 psid. Pressure gauge 2KGPG5190 was found to be reading approximately 4 psid high. This gauge is used by OPS to set up Generator KG D/P by throttling a recirculation valve. Therefore, with a positive 4 psid gauge error, OPS personnel checking Generator KG D/P believed the D/P was approximately 27 to 28 psid when D/P was actually 23 to 24 psid. The specified tolerance for the pressure switch, a United Electric Controls Model J27KB, is $\pm$0.9 psid. The specified tolerance for the ITT Barton pressure gauge is $\pm$0.25 psig.

The most recent calibrations of pressure switch 2KGPS5191 and pressure gauge 2KGPG5190 were performed on July 5, 1987. The calibrations were performed according to a work request which was written because of frequent Generator KG Flow D/P Low alarms displaying on the OAC in the Control Room. In the last 2 years, seven work requests were written to repair, replace, and/or calibrate this pressure switch. All of these work requests appear to have been written because the Generator KG Flow D/P Low alarm on the OAC or the Stator Coil Water Flow Low alarm on the KG local panel were alarming at a higher D/P than the pressure switch setpoint.

IAE had initiated a Station Problem Report prior to this event to have pressure switch 2KGPS5191 replaced with a different type because of the frequent problems with drift from the calibrated setpoint. IAE speculate that some of the drift problems may be occurring as the pressure switch is valved back in after calibration, as there is no equalization valve on the tubing for this pressure switch.

In addition to the reversed wiring and pressure switch and gauge drift, it was also determined during the post-trip troubleshooting that the Digital Input Points were reversed on the Generator KG Flow D/P Low and Emergency Low circuits. During this event, when relay R8 energized due to incorrect wiring from pressure switch 2KGPS5191, Generator KG Flow D/P Low was displayed on the OAC from Digital Input Point D0487/DKG028. According to the electrical drawing, this Digital Input Point displays the Generator KG Flow D/P Emergency Low alarm.

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TEXT (If more space is required, use additional NRC Form 366A's) (17)

Projects personnel had noticed 2 or 3 weeks prior to this trip, that the Unit 1 Digital Input Point Summary listed Digital Input Point D0486/DKG026 as the Generator KG Flow D/P Emergency Low alarm and Point D0487/DKG028 as the Generator KG Flow D/P Low alarm in contrast to the electrical drawing, Unit 1 Generator Stator Cooling and Excitation Control System. He informed IAE and OPS of the discrepancy and began preparing modifications to affected drawings. He later determined that Unit 2 drawings required the same modification because of discrepancies with the Unit 2 Digital Input Point Summary List. IAE personnel troubleshooting the circuit after the Reactor Trip also discovered the reversed computer points. They corrected the Unit 2 computer indication by wiring relay R7 to Digital Input Point D0487/DKG028 and relay R8 to Digital Input Point D0486/DKG026. Appropriate modification documentation and drawing revisions were completed by Projects personnel.

Original drawings and subsequent revisions show the Digital Input Points for Generator KG D/P reversed. Therefore, the computer points were apparently incorrect on the circuits because of a design error.

It could not be determined during this investigation why the Main Generator breakers did not trip when the Generator KG Flow D/P Low alarm came in at 1500:55 for 1 minute and 6 seconds. The time delay relay was found to be timing out in approximately 50 seconds when IAE checked during post-trip troubleshooting and was recalibrated.

Operations Management believe the response of the NCO to the Generator KG Flow D/P Low alarm was appropriate given the circumstances at the time of the event. The NCO sent a NEO to the KG skid to check KG D/P as soon as the NCO noticed the alarm. Standard practice in the past, upon receiving this alarm, has been to check the KG D/P and write a work request to check/calibrate pressure switch 2KGPS5191. Control Room personnel would have initiated a work request on the pressure switch later on November 30, had the Reactor Trip not occurred. At the time of this event, Control Room personnel believed the alarm to be due to a combination of slightly decreased KG D/P as a result of the morning KG Cooling Water Tank pressure manipulations, normal D/P gauge fluctuations (2 to 4 psig), and either faulty indication or pressure switch problems. Since the event, OPS has determined that the best response to the alarm is to check D/P, and if D/P is acceptable on all indications, OPS personnel will try to elevate the D/P as a precautionary measure by throttling the recirculation valve. However, the short time delay of 5 seconds may initiate a Turbine Runback prior to allowing time for any corrective action if the Generator KG Flow D/P Low pressure switch setpoint is reached.

There were few anomalies noted during the Unit 2 Reactor Trip. The Steam Dump to Condenser valves responded properly and modulated as necessary to provide a heat sink for the Reactor. Two Steam Dump to Condenser valves [EIIS:LOV], valves 2SB-6 and 2SB-27, did not indicate open on the OAC. Performance personnel wrote work requests to investigate this recurring problem. Steam pressure on S/G D reached a maximum of 1137.5 psig, which is slightly above the open setpoint for S/G Power

Operated Relief Valve (PORV), valve 2SV-1 [EIIS:RV]; however, the valve did not open. Performance wrote a work request to investigate this problem. All other S/G pressures were below the open setpoints of the S/G PORVs, and the valves did not open. The Overpower Delta T setpoint response on Reactor Coolant (NC) [EIIS:AB] Loop B was slightly inconsistent with respect to NC system T-average and the other three loops. A work request was written to investigate. IAE investigated the response prior to unit startup and found the response to be within tolerance with no apparent problems.

The Unit 2 Events Recorder [EIIS:XR] did not provide adequate information for the trip initiating signal. A new Events Recorder has been installed at McGuire which lacks the necessary points to provide the accurate sequence of events and times that had been possible with the old Events Recorder. An evaluation of the need to reconnect the old Events Recorder points was initiated as a result of a previous Licensee Event Report (LER) 370/87-19.

The secondary and primary system key parameters responded as expected during this Reactor Trip. Primary system pressure reached 2282.8 psig, which is below the open setpoints of the PORV and Pressurizer Code Safety Valves, and the valves did not open.

OPS responded to the transient in a timely manner to stabilize the unit. Approximately 30 minutes after the Reactor Trip, Pressurizer level had achieved no-load condition. S/G pressure, S/G level, and T-average reached no-load values within approximately 1 hour after the Reactor Trip. Operations personnel had manually started the CA motor driven pumps approximately 15 seconds after the Reactor Trip to control S/G level. CF isolation occurred on low Reactor Coolant [illegible]rage approximately 30 seconds after the Reactor Trip.

A review of McGuire LERs revealed numerous Reactor Trips; however, there have been no Reactor Trips in the last 3 years which were attributed to KG System problems. Therefore, this event is not recurring.

This event is not reportable to the Nuclear Plant Reliability Data System (NPRDS).

CORRECTIVE ACTIONS:

Immediate: OPS implemented the Reactor Trip Procedure, AP/2/A/5500/01.

Subsequent:

1) IAE corrected the wiring from 2KGPS5191 and 2KGPS5192 to the appropriate relays. The entire circuit was tested including pressure switches, timing relays, alarms, and annunciators and was found to be functioning correctly.

2) OPS initiated a Special Order providing instructions for OPS shift personnel regarding the handling of KG alarms.

3) IAE corrected the wiring of the Unit 2 Computer Digital Input Points for the Low and Emergency Low Generator KG Flow D/P alarms, and Projects corrected the appropriate drawings.

Planned:

1) IAE will check and correct as necessary the wiring on the Unit 1 Low and Emergency Low Generator KG Flow D/P circuits.

2) IAE will correctly wire the Unit 1 Computer Digital Input Points for the Low and Emergency Low Generator KG Flow D/P alarms.

3) The previously planned modifications to the KG system, NSMs MG12043 and MG22043, will be reviewed by Projects consulting with Operations, to assure that all critical KG pressure switches are replaced. They will also evaluate an additional modification to institute 2 out of 3 trip and runback logic to the KG circuitry and to add equalization valves on the tubing to pressure switches 1 and 2KGPS5191 and 1 and 2KGPS5192.

4) IAE will develop a method to perform loop calibrations of the Generator KG Flow D/P Low and Emergency Low circuitry.

5) IAE will reword the OAC alarm point for Generator KG Flow D/P Low to indicate runback potential, and the Emergency Low alarm will be reworded to indicate trip potential.

6) IAE will add D/P pressure gauges 1 and 2KGPG5190 to the periodic preventive maintenance program.

SAFETY ANALYSIS:

The Reactor Trip was caused by a Turbine Trip above 48% reactor power. The turbine tripped on overspeed after the Main Generator breakers opened. This Reactor Trip initiating transient is bounded by the "Loss of External Load" and the "Turbine Trip" events of the McGuire Final Safety Analysis Report Accident Analysis, the latter resulting in the more limiting transient due to the more rapid loss of steam flow caused by the more rapid turbine valve closure.

The majority of the conservatism afforded by the accident analysis for a Turbine Trip event is in the assumption that the reactor is not tripped until the first Reactor Protection setpoint is reached. By actuating the anticipatory trip above 48% power, the severity of the resulting transient is greatly reduced.

CA motor driven pumps were manually started approximately 15 seconds after the trip in order to avoid reaching low levels in the S/Gs. Minimum level reached was 15% in S/G B. CF isolation occurred in approximately 30 seconds after the Reactor Trip. Manual actuation of the CA motor driven pumps contributed to S/G pressure and $T_{ave}$ being slightly below target values. All other parameters were at or

approaching no-load conditions 30 minutes after the trip. The initial steam pressure peak did not cause the actuation of any secondary side PORVs or Code Safety Valves, although the setpoint of S/G D PORV was reached. Primary side PORVs or Code Safety Valves were not challenged.

Emergency core cooling and electrical power were not required and were not actuated. Residual heat was removed by the CA system to the condenser.

Since the Turbine/Generator Trip resulted in a Reactor Trip from full power, alternative conditions with respect to power level would be less severe. The same scenario occurring below 48% power would not result in a direct Reactor Trip and the response would be covered by the Turbine/Generator Trip procedure.

This Turbine Trip/Reactor Trip presented no hazard to the integrity of the NC system or the Main Steam System [EIIS:SB]. There were no radiological consequences as a result of this event.

There were no personnel injuries, personnel overexposures, or releases of radioactive material as a result of this event.

This event is considered to be of no significance with respect to the health and safety of the public.

DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
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December 30, 1987

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: McGuire Nuclear Station, Unit 2
Docket No. 50-370
Licensee Event Report 370/87-21

Gentlemen:

Pursuant to 10CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report 370/87-21 concerning a reactor trip on November 30, 1987. This report is being submitted in accordance with 10CFR 50.73(a)(2)(iv). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

SEL/201/jgc

Attachment

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