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 1 | 0 5 0 0 0 3 6 9 | 1 OF 0 8 |

TITLE (4)

Upper Head Injection Accumulator Instruments Installed Incorrectly

| 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) |
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| 1 1 | 0 1 | 8 4 | 8 4 | — 0 3 0 | — 0 0 | 1 2 | 0 3 | 8 4 | | 0 5 0 0 0 |

| OPERATING MODE (9) | | THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more of the following) (11) | | | |
|---|---|---|---|---|---|
| 3 | | 20.402(b) | 20.405(c) | 50.73(a)(2)(iv) | 73.71(b) |
| POWER LEVEL (10) | | 20.405(a)(1)(i) | 50.36(c)(1) | X 50.73(a)(2)(v) | 73.71(c) |
| 0 0 0 | | 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 |
| Scott Gewehr - Licensing | 7 0 4 3 7 3 - 7 5 8 1 |

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 |
|---|---|---|---|---|---|
| X YES (If yes, complete EXPECTED SUBMISSION DATE) | X NO | | 0 1 | 0 1 | 8 5 |

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

On October 31, 1984, four Upper Head Injection (UHI) Isolation Valves failed to close automatically as the UHI water accumulator was drained. The cause of this failure was discovered on November 1 to be incorrect installation of the accumulator level transmitters, which are intended to provide a "close" signal to the valves at a water level of 76.25 inches. Additionally, when the installation errors were corrected, it was discovered that the level switches were incorrectly calibrated. The cause of this event is considered to be personnel error. Contributing causes are an Administrative Deficiency, which resulted in inadequate testing of the installation modification; and a deficient transmitter calibration procedure, that contained incorrect setpoint data. Corrective Actions which have been completed include reinstallation and recalibration of the level transmitters, recalibration and verification of Unit 2 instruments, verification of correct installation of similar instruments throughout the station, and a review of modifications scheduled for the upcoming outage to ensure appropriate testing requirements.



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

INTRODUCTION: On October 30, 1984, samples from the Unit 1 Upper Head Injection Accumulator indicated a high gas (nitrogen) content, as described in LER 369/84-29. While draining the accumulator to correct the high nitrogen problem, Operations personnel discovered that the accumulator isolation valves failed to close automatically when the level reached 76.25 inches from the inside bottom surface of the tank. An investigation showed that the Rosemount Differential Pressure (DP) Transmitters used to detect accumulator level were installed incorrectly. After the installation errors were corrected, testing revealed that the four level switches were calibrated using the wrong setpoints.

A Personnel Error is considered the major cause of this incident for incorrect installation and inadequate verification of the Rosemount Transmitter installation. A Administrative/Procedural Deficiency is also associated with this incident. An Administrative Deficiency resulted in inadequate testing of a Station Modification. A Procedural Deficiency is assigned because the level system calibration procedure had incorrect setpoint data.

EVALUATION:

Improperly Connected Instruments

On October 31, 1984, while draining the Unit 1 Upper Head Injection (UHI) Accumulator to correct the high nitrogen concentration problem described in LER 369/84-29, it was discovered that the accumulator isolation valves 1NI-244B, 1NI-242B, 1NI-243-A, and 1NI-245A failed to close when the water level reached 76.25 inches from the inside bottom surface of the accumulator tank. Instrument and Electrical personnel began troubleshooting the UHI level switch system and found that all four Rosemount level transmitters had outputs less than the minimum 4 ma required with zero differential pressure (DP).

The UHI accumulator level system is shown in Enclosure 1.0. The Rosemount level transmitter is connected to the UHI tank with a water filled reference leg on the High Pressure (HP) port and a variable tank level signal on the Low Pressure (LP) port. In this application, the level transmitters are connected as "direct acting" response instruments. Direct acting response means that as the differential pressure increases, the transmitter output (milliamps) will also increase. In normal operation, as the tank level decreases, the transmitter output should increase from 4 milliamps (ma) (tank full) to 20 ma (tank empty).

On November 1, 1984, IAE personnel discovered that the instrument impulse lines to the HP and LP ports were crossed on all four level transmitters. This error had been made in March 1984 when the original Barton level switches were replaced with the Rosemount level transmitter systems.

The replacement of Barton level switches with Rosemount level transmitters was done to improve the reliability of the UHI system. Several problems with accuracy and repeatability had occurred during calibration of the mechanical Barton differential pressure (DP) switches, creating questions about their reliability.

The history of the UHI level switches is described in the following paragraphs.

The orginal design of the Unit 1 UHI level switches used a standpipe with instrument taps from the standpipe connected to the Barton 288A level switches with a DP range of 0-60 inches of water. This had the impulse line from the bottom of the tank going to the right side of the manifold block and the right side of the Barton level switch. This is a "normal" method of tubing a differential pressure (DP) switch since "most" Barton DP instruments have the high pressure side on the left when facing the instrument.

This design was recognized to be incorrect during the review of the instrumentation. A full accumulator tank would cause the line from the upper standpipe tap to the level switch to be filled, and the water then would not have a drain path during the blowdown. This would give an effective filled reference leg (ref leg) to the top instrument tap on the standpipe. The instrument had to be "reverse acting" also, and "reverse acting" Barton level switches have the "high" side on the right side of the instrument when facing the instrument. The "direct acting" Barton was replaced with a 0-60 inches of water "reverse acting" Barton. This installation was incorrectly tubed up with LP to HP and HP to LP. During the Unit 1 functional test in 1977, the instrument was retubed to allow the instrument to be reverse acting.

Also during the Unit 1 functional testing, it was determined that the standpipes were to be deleted and the reference legs were to be moved to the top of the tank and the lower taps were to be connected to a "water box" arrangement in the bottom of the tank. The manifold valves and the tubing to the switches were not changed; however, the Barton switches were replaced with new switches that had a range of 0-120 inches of water DP and were reverse acting.

When Unit 2 was constructed, it was realized that the instruments were to be tubed with the high pressure connection on the right side of the instrument and therefore, the high pressure impulse line was brought into the right side of the manifold block. This was connected opposite to the Unit 1 manifold.

When it was determined that the Barton switches were the source of "drift" or setpoint change, a decision was made to replace them with Rosemount transmitters and current alarm modules for the switching. Unit 2 switches were changed first.

The high pressure side of the Rosemount transmitter is on the left while the high pressure side of the Barton switch was on the right. In order to connect the tubing properly, the impulse lines had to be crossed under the transmitter. This occured in January 1983.

The Rosemount installation on Unit 1 was physically completed in March 1984. The impulse lines to the Barton switches were already crossed at the switch and had been that way since the functional test in 1977. To be installed correctly, the impulse lines on Unit 1 should have been uncrossed. The major point of confusion during installation appears to have been the way that the manifold was tubed up to the process. The Unit 1 manifold is connected opposite to the Unit 2 manifold. Another factor that could have contributed to the confusion during the Rosemount installation was incorrectly labeled manifold valves. It is not a common practice to mark HP or LP on or near a manifold valve but at some point in time, marks were placed on the wall at the Unit 1 manifolds and were incorrect for this installation.

When the Rosemount transmitters were installed, they were installed with the wrong range sensors. The model installed had a range of 0-750 inches of water DP. All four transmitter sensors were replaced by IAE personnel during the calibration of the instruments. The new sensors have a range of 0-150 inches of water. (This instrument range is suppressed electronically to 120 inches of water for this application). This sensor change was investigated and found to have been done in the correct manner to insure that the high pressure port was on the left, facing the transmitter, in the same orientation as a new standard Rosemount.

The removal and replacement of the Barton switches was performed using the following steps:

1) Craftsmen noted the HP and LP markings on the Barton switch.
2) They disconnected and removed the Barton switches.
3) They mounted the new Rosemount transmitter.
4) They connected the HP line from the Barton to the HP port on the Rosemount.
5) They connected the LP line from the Barton to the LP port on the Rosemount.

This is a standard practice for replacing instruments that were already in service. Quality Control inspectors do not observe these replacements as they would an original installation. The craftsmen stated that they did not use the markings on the wall but did use the markings on the Barton switch for installation. For the craftsman to see the HP and LP markings on the Barton switch prior to removal, he would have to use a flashlight and put his head on the floor and look up at the bottom of the sensor. Obstructions in front of the switches make this very difficult.

The Rosemount modification package drawings were adequate to insure that the instruments were installed correctly.

There were 29 other installation types (approximately 120 instruments) that were identified by Duke Design I&C that may have the potential for installation errors with swapped impulse lines. These were examined by site personnel and determined that either "indications" during normal process variations or during various functional tests that manipulated the process would detect installations with crossed impulse lines. This included flow, level, and other differential pressure instruments. The only case that was identified that might not have been detected by "indicators" was the containment pressure interlocks to the containment spray system, since these do not have "indicators" in the circuit. These were physically examined and determined to be correct.

Also 39 Nuclear Station Modifications and Nuclear Problem Reports, which modified the plant in the past two years, were examined following the same criteria as above and no problems were discovered.

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

Testing The Rosemount Modification

The method chosen to functionally verify the new UHI level switch system was the IAE calibration procedure, UHI Tank Level With Transmitter Current Loop Calibration. This procedure involved valving the individual transmitter out of the system at the manifold valve and applying instrument air signals to the HP port. This test was adequate for checking the instrument loop operation, transmitter, Rochester alarm module, and power supply, but did not check the lines going to the process taps on the tank, and did not reveal the instrument lines being connected incorrectly. The transmitter was calibrated and placed back in service with the output current reading 4 ma with a full tank as it should.

As incorrectly connected during the UHI tank drain-down on October 31, 1984, the Rosemount transmitters responded in reverse to the required action and the current alarm modules never received the increasing current signal required to activate the closing of the UHI isolation valves.

During the period from April 23, 1984 to November 1, 1984, the Unit 1 UHI isolation valves would not have closed automatically as the UHI accumulator tank was emptied during a design event.

Unit 1 and Unit 2 UHI Level Switch Miscalibration

The four Unit 1 transmitters were tubed up correctly on November 1, 1984 and during recalibration, using a "wet calibration" method for verification, an error in the previously calculated setpoint was discovered.

The wet calibration method involves valving the transmitter out at the Hi and Low "root" valves instead of at the manifold valves, and using the actual filled reference leg on one side of the transmitter while varying the water level in a piece of tubing on the opposite side of the transmitter to simulate the tank level changing. This process verifies that the tubing is correct and checks the instrument loop operation as close as possible to the process taps.

The setpoint discrepancy occurred when measurements were made to determine the reference leg height above the bottom of the tank. A reference mark had been placed on the wall next to the tank, 24 inches above the bottom of the tank, to facilitate calibration. The measurement to determine the reference leg height was made between this mark and the reference leg instrument line. The 24 inches below the reference mark was omitted from the total reference leg height in determining the calibration setpoints. This 24 inch setpoint error was also incorporated on the Unit 2 UHI level switches. The miscalibration of both units occurred in February and March of 1983 when the first "dry calibration" procedure was used.

The result of the incorrect setpoint on tank operation during an event would have been an automatic premature closing of the UHI isolation valves, 100.25 inches above the bottom of the tank instead of 76.25 inches. Technical Specification limits are 72.95 inches to 79.55 inches. The error would have caused the isolation valves to close 20.7 inches above Technical Specification limits.

The "dry calibration" method (UHI Tank Level with Transmitter Current Loop Calibration) used to functionally verify the operation of the instrument loop after the modification was made, did not use any of the actual process variables (reference leg or simulated tank level) during the calibration. The instrument was isolated from the system at the manifold valves and calibrated with simulated instrument air signals proportional to the inches of water process inputs on the high side of the transmitter. This is a standard practice for instrument calibration but did not reveal that the instruments were connected to the process incorrectly.

Gas Found in Unit 2 Reference Legs

As a precaution, following the Unit 1 UHI gas entrainment problem, a gas sample was taken from the Unit 2 UHI accumulator tank and excessive entrained nitrogen was found in this sample also. The Unit 2 UHI tank was being drained to replace the water on November 1, 1984 at the same time that IAE personnel were recalibrating the Unit 1 UHI level transmitters. The Unit 2 level transmitters were checked earlier that day to insure they were tubed up correctly. IAE made plans to observe the Unit 2 level transmitter outputs as the tank was being depressurized and drained. The transmitters were found to be reading less than 4 ma output at ~550 psi with the tank still full. The reference line was vented and gas was discharged during the process. The transmitter output returned to 4 ma after venting.

On November 2, 1984, IAE personnel returned to the Unit 2 level transmitters to verify their operation. Again the output current was less than 4 ma with the tank near empty and tank pressure less than 200 psi. The reference leg was vented, and again, a gas discharge was observed. After venting, the transmitter outputs were ~18.5 ma.

The question of gases in the UHI reference legs for the Barton level switches was first raised in July, 1982 and were transmitted to Westinghouse for their evaluation and recommendations.

The reply received from Westinghouse implied that Duke should adopt the Sequoyah method of calibration using air supply and measured differential pressure (dry calibration) to set the Barton level switches. This would eliminate the reference leg as a source of error causing the apparent drift or change in setpoint from one calibration to the next. The drift in setpoint has since been seen using the Sequoyah calibration method and the reference leg variations have been discounted as being the major source of setpoint change. The Barton switches were changed to Rosemount transmitters as a result of this discovery. The question of what the reference leg height would be during a blowdown was not answered. The question was resubmitted to Westinghouse.

The reply received from Westinghouse stated that their calculations showed that the nitrogen would not come out of solution during a blowdown and therefore was not a problem. To calibrate the switches, the Fluid Systems Design (Westinghouse) gave their opinion that the reference leg would remain filled and therefore Duke should use the centerline of the horizontal half-inch instrument line above the reference pot as the height of the reference leg for calibrations.

Rough calculations show that during a blowdown the effects of nitrogen coming out of solution are not as severe as when the reference leg is vented to atmospheric pressure:

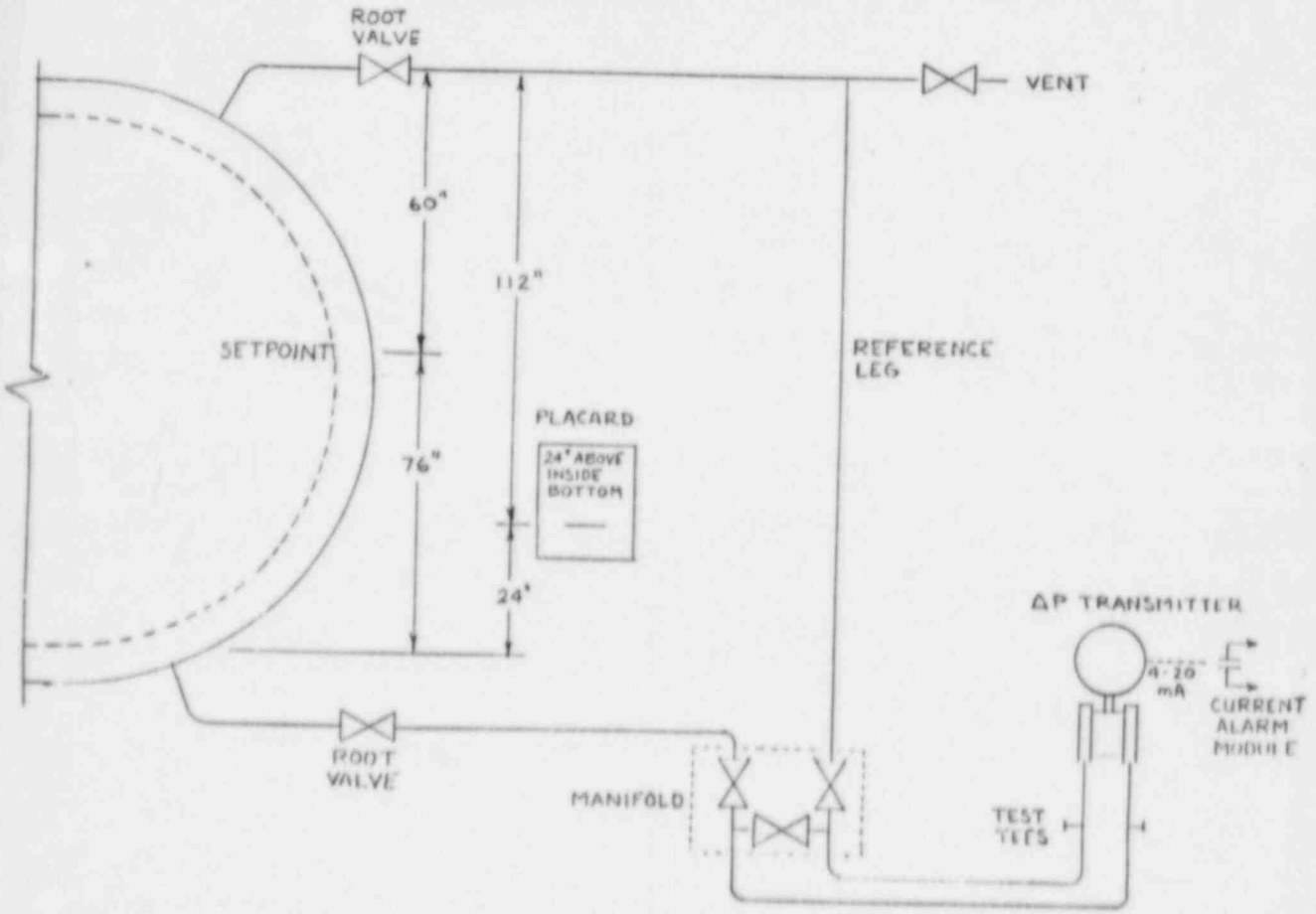
> Using the gas law P1*V1 = P2*V2 (ignoring temperature changes), and knowing the pressure drops from 1255 psia to 680 psia during a blowdown until the switches actuate, any gas bubbles would approximately double in volume. Also, according to Westinghouse calculations, the nitrogen dissolved in the reference leg would still remain in solution at the blowdown pressure where the switches are required to actuate.
>
> When the reference leg is vented to atmospheric pressure (~15 psia), the volume of any gas bubbles would grow to approximately 84 times (1255/15 = ~84) their pressurized volume. This forces out water and gases through the vent lines. This makes it appear that there is a lot of gases trapped in the reference leg. It also has the effect of degassing the water in the reference leg.

The major source of entrapped gases in the reference legs is the bubbles that may be generated during pressure changes and then migrate up the side of the UHI tank and into the instrument lines. Pressurizing the reference line from atmospheric pressure to 1255 psia reduces the size of any bubbles and also dissolves most of the gases back into solution.

Corrective actions have been completed which correct and/or verify correct installation of Units 1 and 2 level transmitters and similar instrumentation installations throughout the station. The procedure used to calibrate the transmitters, UHI accumulator tank level loop calibration, was rewritten and used to recalibrate Units' 1 and 2 level transmitters, using the correct setpoints. All safety-related modifications to be performed during the upcoming outage have been reviewed to determine/verify appropriate testing requirements. Future modifications to safety-related equipment will be reviewed by appropriate members of the McGuire Safety Review Committee to determine testing requirements. In addition, a procedure has been written for installation of Instruments and Instrument Lines, which will be used on future modifications involving installation of instruments.

All affected working groups either have reviewed or will review this event to emphasize the possibility of, and thereby preclude recurrence of, such events.

ENCLOSURE 1.0



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December 3, 1984

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

Subject: McGuire Nuclear Station, Unit 1
Docket No. 50-369
LER 369/84-30

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a)(1) and (d), attached is Licensee Event Report 369/84-30 concerning the improper installation of Upper Head Injection (UHI) Water Accumulator Level Transmitters which is submitted in accordance with §50.73(a)(2)(v). Initial notification of this event was made pursuant to §50.72 Section (b)(2)(ii) with the NRC Operations Center via the ENS on November 1, 1984. In addition, this event was discussed with Region II in Atlanta on November 14, 1984.

A complete safety analysis of this event is being prepared and is expected to be submitted shortly.

The discovery of this incident was prompted by a discovery of a high concentration of nitrogen in the UHI accumulators. For a discussion of that event, see LER 369/84-29, dated November 29, 1984.

Very truly yours,

H.B. Tucker /BW

Hal B. Tucker

SAG:slb

Attachment

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Section File: MC-801.02
Section File: MC-815.02