# Post-Examination Comments

(Green Paper)

McGuire 2007-301

March 29, 2007

Licensee Submitted Post-Examination Comments

[X] Comments Attached

[ ] None Submitted

**MCGUIRE MARCH 2007 EXAM**

**EXAM NOS. 05000369, 370/2007301**

**MARCH 19 - 22, 2007**

**MARCH 29, 2007 - WRITTEN**

Duke Power®
A Duke Energy Company

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April 4, 2007

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Subject: Duke Power Company LLC d/b/a
Duke Energy Carolinas, LLC
McGuire Nuclear Station
Initial Written Licensing Examination Comments
50-369/2007-301 and 50-370/2007-301

The enclosed initial written examination comments are provided in accordance with NUREG-1021, Section 402. These formal comments are associated with the McGuire Nuclear Station initial written licensing examination administered on March 29, 2007.

The following attachments are also provided:

1) Justification for deletion of Question 91
2) Lesson plan documentation

Also enclosed are the required examination materials per NUREG-1021, Section 501. The Security Agreement will be mailed separately when all signatures have been obtained.

Questions or comments should be directed to Mr. Alan Orton at (704)875-5397 or Mr. Charles Sawyer at(704)875-5248.

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Attachment 1

After further investigation we propose that Question 91 be deleted due to no correct answer.

Our original assumption was that a thermocouple open circuit would read off scale high. However, a thermocouple open circuit will cause it to fail low. Therefore, B and D distractors are incorrect.

Research indicates a thermocouple short circuit will fail to a value close to the temperature of the shorted location. We can find no circumstance where the thermocouple could fail off scale high. How could the short location temperature be higher than the core exit temperature? Therefore, A and C are also incorrect.

Attachments 2 are documents from the McGuire Basic Nuclear Training and Nuclear Basic Maintenance Training lessons.

| Examination Outline Cross-reference: | Level | RO | SRO |
|---|---|---|---|
| | Tier # | | 2 |
| | Group # | | 2 |
| | K/A # | 017 A2.01 | |
| | Importance Rating | | 3.5 |

Ability to (a) predict the impacts of the following malfunctions or operation on the ITM system; and (b) based on those predictions, use procedures to correct, control, or mitigate the consequences of those malfunctions or operations: Thermocouple open and short circuits

Proposed Question: SRO 91

Given the following:

| TIME | DATE | CONDITION |
|---|---|---|
| 0600 | 3/11/2007 | 1 required channel of Core Exit thermocouples was declared inoperable in quadrant 2 due to CETs reading off-scale high. |
| 1130 | 3/14/2007 | 1 required channel of Core Exit thermocouples was declared inoperable in quadrant 4 due to CETs reading off-scale high. |
| 1200 | 3/17/2007 | Quadrant 2 was returned to full operability. |
| 1400 | 3/18/2007 | 1 additional required channel of Core Exit thermocouples was declared inoperable in quadrant 4 due to CETs reading off-scale high. |

Which ONE (1) of the following describes the LATEST time that the unit is required to be in Mode 3, and the reason why?

*REFERENCE PROVIDED*

A. 2000 on 3/18/2007 due to inoperability because of shorted thermocouples.

B. 2000 on 3/18/2007 due to inoperability because of open thermocouples.

C. 2000 on 3/25/2007 due to inoperability because of shorted thermocouples.

D. 2000 on 3/25/2007 due to inoperability because of open thermocouples.

Proposed Answer: D

Explanation (Optional):

A. Incorrect but credible because it allows for 6 hours to hot standby, just doesn't allow for the initial 7 days. Shorted TCs would indicate low

B. Incorrect. Credible for same reason as A and also gives indication of open thermocouples.

C. Correct time but shorted thermocouples would indicate low

D. Correct. Cannot meet minimum, 7 days is time. If cannot meet 7 days, Hot Standby in 6 hours. Off-Scale high indication is a result of open thermocouples

Technical Reference(s): TS 3.3.3 (Attach if not previously provided)

Proposed references to be provided to applicants during examination: TS 3.3.3 and Table 3.3.3-1

Learning Objective: IC-ENB-19 (As available)

Question Source:
- Bank # _____
- Modified Bank # _____ (Note changes or attach parent)
- New X

Question History: Last NRC Exam _____

Question Cognitive Level:
- Memory or Fundamental Knowledge _____
- Comprehension or Analysis X

10 CFR Part 55 Content:
- 55.41 _____
- 55.43 2

Comments:

Attachment 2

2) Prevents current flow between the thermocouples and reduces measurement errors.

2.7 Thermocouple Troubleshooting

A. Thermocouple Failure Indication

1. **IF** thermocouples fail to an **open** condition, indication will **fail low**.

2. **IF** thermocouples wires **short**, indication will fail to a value approximately at the temperature of the shorted location.

B. Review the Thermocouple Rules found on Attachment C.

C. Check for frayed insulation or broken wiring.

**PP-23**

1. Frayed insulation may result in the following:

   a. Extension wires touching thus creating a false measuring junction resulting in an error reading.

   b. Extension wires may only touch periodically depending on conditions thus causing intermittent reading errors.

2. Broken wiring would indicate zero reading.

D. Check terminal block to ensure the thermocouple wires and the extension wires are properly connected.

1. Ensure proper polarity (Review Attachment B to determine proper polarity based on the type of thermocouple being used).

2. **IF** extension wire insulation is frayed and color cannot be determined, check wires using a magnet (the positive wire is usually more magnetic than the negative wire).

E. Check protection tube for damage.

F. If you think the thermocouple itself is bad, before replacing the thermocouple, place a short between the screws in the terminal block.

1. **IF** zero reading is seen on the meter, **THEN** the problem may be a broken extension wire.

### 2.6.1 RTD - WHEATSTONE BRIDGE MEASUREMENT

The most common method of using the change in resistance of an RTD for temperature measurement is the Wheatstone bridge.

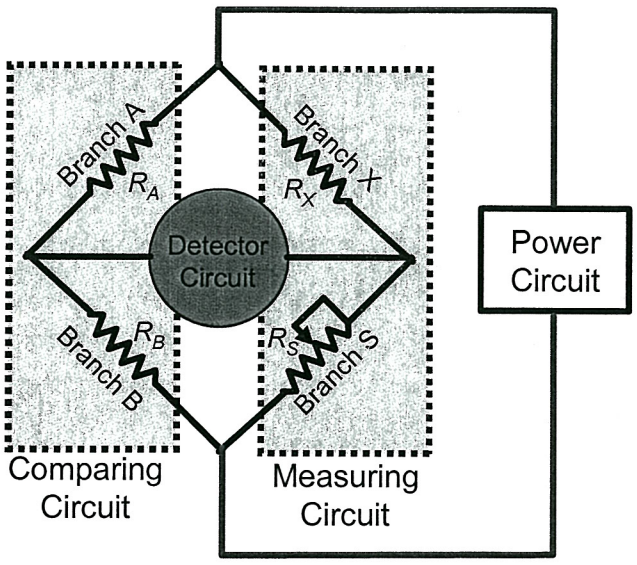


**Figure 10 Wheatstone Bridge Circuit**

Figure 10 represents a diagram of a typical Wheatstone bridge used for resistance temperature measurement. A DC power supply provides current flow through the comparing circuit leg ($R_A$ and $R_B$) and the measuring circuit leg ($R_S$ and $R_X$). $R_X$ is the RTD, a resistance that changes with temperature. The resistor $R_S$ is set during calibration to provide a set voltage difference between the two connections to the detector circuit. When placed in service after calibration, the temperature at the RTD location determines the resistance of the RTD. Current flow through the measuring circuit leg depends on this resistance. The voltage differential across the detector circuit, then, depends on the resistance of the RTD as well. This voltage differential is measured by the detector circuitry and displayed as a temperature indication.

## 2.7 FAILURE INDICATIONS

**Objective 4A, 4B, 4C**

### 2.7.1 MECHANICAL FAILURES

Although the temperature measurement devices just discussed are accurate and reliable over a wide range of temperatures, the operator needs to be sensitive to instrument failures. Mechanical failures in liquid-in-glass thermometers, filled-system thermometers, and bimetallic strip thermometers are easy to determine. Failures in the filled-system are primarily due to a leak in the filled-system tubing causing the instrument to fail low. Failures of the bimetallic strip thermometers are primarily due to a break between the connections of the dissimilar metals, also causing the instrument to fail low.

### 2.7.2 ELECTRICAL FAILURES

Thermocouples operate on the principle that a voltage is developed when two dissimilar metals are joined and there is a temperature difference between the sensing junction and the reference junction. The voltage created causes current to flow. If an open circuit develops, a path for current flow is no longer available and therefore the output fails to a low temperature indication.

For a short circuited thermocouple, the nature of the short circuit determines how indication is affected. If external leads short together, the indicated voltage goes to zero which causes the indication to fail low. If a short develops to an external location, the EMF generated by the shorted location causes the indicated temperature to be inaccurate. Indication is typically lower than actual temperature at the sensed location.

The reference junction provides a fixed voltage (controlled temperature location) for comparison to the voltage created by the thermocouple. If the reference junction temperature changes independently of the measured junction, the indication becomes inaccurate. The reference junction EMF increases if its temperature increases. The hot junction voltage comparison results in a lower difference between the two and indication becomes lower than actual temperature.

If a RTD fails open, the Wheatstone bridge sees a large resistance, which is comparable to a high temperature. Therefore a maximum temperature is indicated. Conversely, if a RTD develops a short circuit, the bridge network sees a low resistance and indicates a temperature lower than the actual temperature.

## 2.8 COMPARISON OF TEMPERATURE SENSORS

For remote reading temperature indications the choice between using a thermocouple and a resistance temperature detector can be based on several considerations. The advantages of a RTD over a thermocouple include:

- RTDs are better suited for small temperature bands.
- RTDs operate with an applied voltage which means less auxiliary equipment required to boost output signals.
- RTDs do not require reference junctions.
- RTDs circuitry is more tolerant to electrical noise.
- RTDs have an increased sensitivity to small changes in temperature.
- RTDs are more accurate than thermocouples.

The primary advantages of thermocouples include:

- Thermocouples are more rugged than RTDs.
- Thermocouples are well suited for large temperature bands.
- Thermocouple sensing wires can be drawn very thin, giving a very fast response to temperature changes.
- Thermocouples (in general) are less expensive than RTDs.
- Thermocouples do not require an external power supply