Department of Mechanical Engineering

THE UNIVERSITY OF TEXAS AT AUSTIN

Nuclear Engineering Teaching Laboratory · http://www.me.utexas.edu/~nuclear/index.php/netl
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February 15, 2012

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

Subject: Docket 50-602, License no. R-129 Licensee Event Report 47625 Corrected Followup Report

Ref:

1. The University of Texas at Austin Facility License R-129, Docket 50-602
2. Licensee Event Report 47625
3. Letter, Docket 50-602, License no. R-129 Licensee Event Report 47625 (02/10/2012)

This letter corrects a typographical error (the date "Conditions for restart were met," incorrectly recorded as January 21) and misidentification of one of the teleconference participants (Jessie Quichocho) in the February 10, 2012 report.

On Friday January 27, 2012 a potential Technical Specification violation was identified. A prompt notification was made by telephone to the USNRC on Monday January 30, 2012, with details of the event sent via email to the Operations Center. In accordance with the UT TRIGA reactor Technical Specifications, information regarding the circumstance of the event is provided. Included are (1) an Event Description, (2) results of the Investigation, (3) assessment of Reportability, (4) Analysis of the Cause of the event, and (5) Corrective Actions that will prevent recurrence.

EVENT DESCRIPTION

The annual maintenance outage was conducted for the University of Texas TRIGA II research reactor during the first two weeks in January 2012, with the biennial fuel inspection occupying most of the effort during the outage. On January 11, the instrumented fuel elements were disconnected from the safety system for routine biennial surveillance which tests for unacceptable changes in fuel element length and bend. The surveillance was completed and the safety system restored on the same day. Maintenance was completed and normal operations resumed on January 23. Two non-routine maintenance items remain to be completed, installation of a 3rd fuel temperature measuring channel that will provide indication over the range of the safety limit, and replacement of an instrument rack in the control room to accommodate additional equipment supporting a facility security upgrade.

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On Monday January 23 the reactor was operated to support experiment operations coincident with reactor operator training. The preoperational checkout indicated satisfactory operation of the safety system, including the fuel temperature channels. Shutdown fuel temperatures were within tolerance for ambient conditions. Preoperational checks were completed at 9:32, with startup to 50 watts initiated at 09:33. Critical checks at 50 watts were accomplished normally, followed by ascension to 100 kW at 10:00. Records of 100 kW Operating data (status window print files) indicated 18°C on fuel temperature channel 1 and 83°C on fuel temperature channel 2; the senior reactor operator who performed the operation did not recognize the difference in temperature. The reactor was shutdown on completion of the experiment at 10:40.

The next reactor operation occurred on January 27. Shutdown fuel temperatures prior to startup were within tolerance for ambient conditions. Preoperational checks were completed at 9:09 with 50 watt critical data obtained at 9:13. Reactor power of 100 kW was achieved at 9:21, and 500 kW at 9:54. Records (multiple status window print files) show fuel temperature channel 1 did not change from approximately 18°C at 100 kW and 500 kW. The senior reactor operator who performed the operation did not recognize the difference in temperature between fuel temperatures indicated on channel 1 and channel 2. The reactor was shutdown at 11:16. Prior to the next planned startup, the minor deviation between fuel temperatures at shutdown was noted to be unusual which prompted recognition of the previous 500 kW operating temperature. A preoperational check was performed, with no indication of abnormalities. Operations were terminated for investigation.

INVESTIGATION

The output of the thermocouple at fuel temperature channel 1 was noted to be erratic when the wires at the pool side terminal were moved. The nylon braid insulation was observed to be frayed, and electricians tape insulating the lead wire was degraded.

Resistance readings confirmed that perturbing the thermocouple lead wire causes the resistance of the detector loop to vary erratically, and that an alternate thermocouple loop is stable when the wires are moved.

A functional response test was performed using the chill water system to cool the pool below ambient, and fuel temperature 2 was observed to fall significantly below ambient (about 13°C) while fuel temperature channel 1 dropped slightly, to about 17°C. There are three thermocouples in each instrumented fuel element, although the fuel temperature monitoring channel uses only one of the three. Fuel channel 1 temperature monitoring channel was connected to an alternate thermocouple and the

indication came into agreement with fuel temperature channel 2 and the pool water temperature channel.

The plug and socket connector for fuel channel 1 was inspected; the wires entering the plug were degraded enough to facilitate a short circuit and therefore an alternate thermocouple junction. It is not possible to unambiguously identify the short circuit path, but there is a metal identification tag and a metal strain relief device in contact with the thermocouple lead wire assembly. Therefore the thermocouple junction sensed by fuel temperature channel 1 was an inadvertent connection at the plug assembly measuring ambient air temperature. The wires at the fuel temperature channel 2 plugs were fabricated with sleeves over the wires, preserving the insulation, providing additional electrical isolation between the wires, and inhibiting sharp bends in the wires.

With the alternate thermocouple connected to fuel temperature channel 1, resistance readings indicating no short circuits, the laboratory Director issued a restart letter with compensatory measures to be implemented pending development of permanent corrective action.

ANALYSIS OF REPORTABILITY

Technical Specifications 6.6.2 identifies as a reportable occurrence "Operation in violation of limiting conditions for operations established in technical specifications unless prompt remedial action is taken." Technical Specifications 3.2.3 requires that two safety system scrams be operable to scram at ≤ 550°, and 3.2.4 requires that two fuel temperature measuring channels be operable. During this event, fuel temperature channel 1 was not operable. Prompt remedial action was taken when the condition was discovered, although the reactor was operated under conditions that did not meet the limiting conditions for operation.

Technical Specifications 6.6.2.c identifies as a reportable occurrence "A reactor safety system component malfunction which renders or could render the safety system incapable of performing its intended safety function unless the malfunction or condition is discovered during maintenance tests or periods of reactor shutdown." The safety basis for 3.2.3 (A.3.2.3) is that "Scrams for limiting safety system settings consist of signal trips that monitor fuel temperature and power level." The safety basis for 3.2.4 (A.3.2.4) states "The minimum measuring channels are sufficient to provide signals for automatic safety system operation." Although the Technical Specifications requires two fuel temperature channels, scram logic for the UT TRIGA is single channel actuation. Fuel temperature channel 2 remained operable during this event. The safety basis is not

challenged by this event, and the safety system remained capable of performing its intended safety function.

Technical Specifications 6.6.2.f indicates "An observed inadequacy in the implementation of administrative controls such that inadequacy causes or could have caused the existence or development of an unsafe condition with regard to reactor operations." Preoperational checks are not adequate to detect this type of failure. Although the direct cause may not be unequivocally identifiable, it is likely that this condition is related to the fuel inspection. Retest requirements following fuel inspection of the instrumented fuel elements are not adequate to identify this type of failure. Technical Specifications 6.5.2, Action to be Taken in the event of a reportable occurrence, indicates:

a.1 Reactor conditions will be returned to normal or the reactor shutdown (completed)

a.2 If it is necessary to shutdown the reactor to correct the occurrence, operations hall not be resumed unless authorized by the Director or his designated alternate.

The reactor was administratively secured on 27 January 2012. The NETL Director issued authorization for restart with compensatory measures on 30 January 2012. Conditions for restart were met on January 31, 2012.

b.1. Occurrence shall be reported to the Director or his designated alternate and (completed)

b.2 to the Nuclear Regulatory Commission as required

The event was reported to the Director on 27 January 2012, and to the Nuclear Regulatory Commission.

The event was reported to USNRC Operations Center (John Konoke) at 16:02 EST on 30 January 2012 following courtesy notification of Craig Basset (USNRC inspector) and Paulette Torres (USNRC program manager). A description of the event was transmitted to the Operations Center immediately following phone notification.

A phone bridge was conducted at the request of the NRC on 1/31/2012 with Pat Issacs, Al Adams, Craig Basset, Paullette Torres , Jessie Quichocho, S. Biegalski, M. Krause and P. M. Whaley to review the event.

Section 6.6.2 requires "A report to the NRC Operations Center by telephone not later than the following working day and confirmed in writing by telegraph or similar conveyance to be followed by a written report within 14 days that describes the circumstances of the event of any of the following..."

This communication provides required report.

(Other reportable occurrences) c. Occurrence shall be reviewed by the Nuclear Reactor committee at the next regularly scheduled meeting.

ANALYSIS OF CAUSE

ROOT CAUSE

The root cause of this event was a short circuit in the thermocouple lead wire for fuel temperature channel 1.

CONTRIBUTING CAUSES

Contributing causes include two procedural and one design inadequacies, and a personnel error.

A. This short circuit could have been identified during maintenance with an adequate retest; there are no specific retest requirements in the fuel inspection procedure that would identify this failure. Therefore, MAIN-5 (Fuel Maintenance and Inspection) is deficient.

B. Procedure OPER-3, Reactor operation Modes, section II Procedure, part A. Manual Mode, step 3 indicates that "A printout of the Status Window should be done: (i) After each power change, and (ii) at ≈ 30 minutes intervals while at steady state power level," and step 4 indicates Monitor operation of system; Monitor power level, control rod positions, and other data; print data logs at recommended intervals" but does not offer guidance for the monitoring. If a clear expectation for a routine channel check of the fuel temperature channels had been in place and completed as required, this failure would have been identified during a post maintenance test operation.

C. The wires terminating in the connectors for fuel temperature channel 1 were not adequately protected to prevent degradation, a design deficiency.

D. As indicated above, the operator at the controls is tasked with monitoring operations. Although specific directions for monitoring are not provided, it is a reasonable expectation that the operator at the controls should be aware of very large deviations between instruments monitoring similar parameters. Therefore, a contributing cause to this event was personnel error, inattention to detail.

CORRECTIVE ACTIONS

1. The Facility Director suspended operations on discovery, and provided restart authorization (attached) and direction for restart.

   See attached letter, "Restart after Fuel Temperature 1 Malfunction," S. Biegalski. Actions completed.

2. The fuel inspection procedure will be revised to require a channel check on the fuel temperature channel during a post maintenance operational test if instrumented fuel elements are inspected.

   A channel check is adequate to identify that a thermocouple short has developed.

3. The annual instrument calibration procedure will be revised to require visual inspection of instrumented fuel element terminations at the connector panel, and visual examination of the fiberglass braid (or alternate material used in protection of the thermocouple lead wire).

   Visual inspection will identify degraded insulation.

4. Procedure OPER-3 will be revised to provide guidance for performing channel checks when the status window is recorded.

   Channel checks are a standard way to identify when measuring channels are not operating properly.

5. This event will be reviewed with all licensed operators; attention to detail will be addressed in the requalification program training.

6. Terminations for the connectors of the instrumented fuel element used in fuel temperature channel 1 will be refabricated, using shrink wrap tubing or an alternative method to protect the wiring.

Completed January 31, 2012 for the in-service thermocouple. The 2 unused thermocouple connectors were refabricated on 02/07/2012.

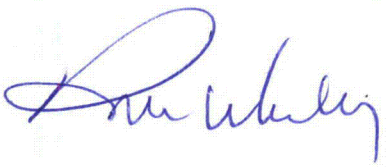
7. The problematic thermocouple will be tested to determine if the issue is resolved following connector refabrication.

   Resistance checks were completed on January 31, 2012. Testing indicated the short circuit was resolved. The thermocouple is considered restored to service, pending routine calibration checks conducted in accordance with approved operating/maintenance procedures.

8. This event will be reviewed by the Reactor Oversight Committee (Nuclear Reactor Committee) at the next scheduled meeting as specified in Technical Specifications 6.5.2(c).

Please contact me by phone at 512-232-5373 or email whaley@mail.utexas.edu if you require additional information.

Thank you,



P. M. Whaley
Associate Director
Nuclear Engineering Teaching Laboratory
The University of Texas at Austin

1. Letter, S. Biegalski to NETL Reactor Operations Staff, "Restart after Fuel Temperature 1 Malfunction"

2. Pwr & FT vs Time with repaired TC 1/31/2012

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To: NETL Reactor Operations Staff
From: Steven Biegalski, Director, NETL Steven Biegalski
Date: January 30, 2012
Subject: Restart after Fuel Temperature 1 Malfunction

On Friday January 27, 2012 a problem was discovered regarding the the thermocouple associated with Fuel Temperature 1 on the University of Texas TRIGA reactor.

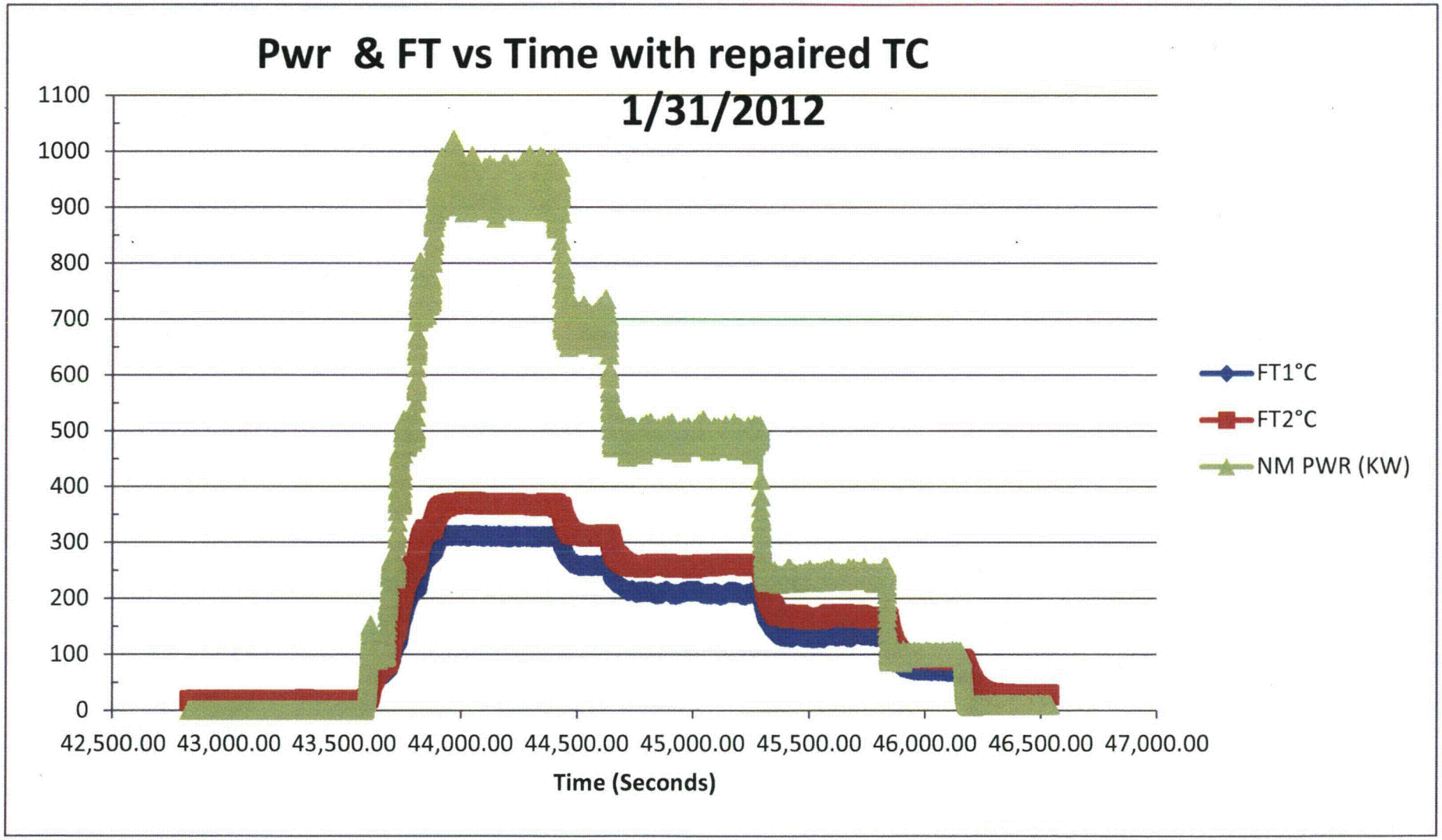
After this event, the following actions were taken:

1) Reactor operations were suspended and the reactor has remained in a shutdown state.
2) Problem was identified.
3) The faulty thermocouple has been taken out of service.
4) A working thermocouple has been attached and verified to be in working order.
5) A review of the event has been conducted between among NETL management and reactor operators.
6) Individual counseling has been conducted with the SRO in charge during this event.
7) The Nuclear Regulatory Commission has been notified of the event by phone.

With this letter, I would like to re-initiate reactor operations starting Tuesday January 31, 2012. These operations may commence providing that:

1) Two working fuel temperature channels are verified to be in working order and properly displayed on the reactor console.
2) Licensed operators understand this event and the lessons learned.
3) Licensed operators review procedures and diligently review reactor parameters during operation.
4) The first runs should be up to 950 kW. A digital log should be made of Fuel Temperature 1, Fuel Temperature 2, and Reactor Power during rise to power. If abnormal or unexpected conditions arise, the reactor should be shutdown and secured immediately. A plot shall be made of these three parameters together to:
    a. Demonstrate the operation of the new fuel temperature thermocouple.
    b. Provide an understanding of how Fuel Temperature 1 relates to Fuel Temperature 2, and Reactor Power. Licensed operators should familiarize themselves with this relationship.

Please let me know if you have any questions, comments, or concerns regarding this re-start.


Pwr & FT vs Time with repaired TC
1/31/2012
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