

September 8, 2011

Dr. Thomas H. Newton
Director of Reactor Operations
Massachusetts Institute of Technology
Research Reactor
MITNRL-NW 12
138 Albany Street
Cambridge, MA 02139

SUBJECT: MASSACHUSETTS INSTITUTE OF TECHNOLOGY – NRC NON-ROUTINE
INSPECTION REPORT NO. 50-020/2011-202

Dear Dr. Newton:

On August 8-10, 2011, the U.S. Nuclear Regulatory Commission (NRC, the Commission) conducted an inspection at the Massachusetts Institute of Technology Research Reactor facility (Inspection Report No. 50-020/2011-202). The enclosed report documents the inspection results, which were discussed on August 10, 2011, with you, other members of your staff, and Dr. David Moncton, Director, Nuclear Reactor Laboratory (via telephone).

The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel. Based on the results of this inspection, no findings of significance were identified. No response to this letter is required.

In accordance with Title 10 of the *Code of Federal Regulations* Section 2.390, "Public inspections, exemptions, and requests for withholding," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC Public Document Room or from the NRC's document system (Agencywide Documents Access and Management System (ADAMS)). ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Should you have any questions concerning this inspection, please contact Craig Bassett at (301) 466-4495 or by electronic mail at Craig.Bassett@nrc.gov.

Sincerely,
/RA/

Johnny H. Eads, Jr., Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No.: 50-020
License No.: R-37

Enclosure: NRC Inspection Report No. 50-020/2011-202
cc: See next page

Massachusetts Institute of Technology

Docket No. 50-020

cc:

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Cambridge, MA 02139

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Mr. Robert Gallagher, Acting Director
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Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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*** concurrence via e-mail**

TEMPLATE #: NRC-002

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DATE	8/17/2011	8/18/2011	9/8/11

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U. S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION

Docket No.: 50-020

License No.: R-37

Report No.: 50-020/2011-202

Licensee: Massachusetts Institute of Technology

Facility: Nuclear Reactor Laboratory

Location: Cambridge, Massachusetts

Dates: August 8-10, 2011

Inspectors: Craig Bassett
Patrick Isaac

Approved by: Johnny H. Eads, Jr., Chief
Research and Test Reactors Oversight Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

EXECUTIVE SUMMARY

Massachusetts Institute of Technology
Nuclear Reactor Laboratory
NRC Inspection Report No.: 50-020/2011-202

The primary focus of this non-routine, announced inspection was the onsite review of various events that have occurred at the Massachusetts Institute of Technology (the licensee's) Class I six megawatt (MW) research and test reactor safety program since the last routine U.S. Nuclear Regulatory Commission (NRC) inspection in May. The events were identified by the licensee and corrective actions were initiated as a result.

Reactor Operations

- On June 4, 2011, the MIT research reactor was operated for more than 5 minutes at a power level greater than 100 kilowatts following the receipt of a "Loss of City Water Pressure" alarm which resulted in a minor violation involving failure to follow procedure. (Abnormal Operating Procedure 5.4.14 required that the reactor not be operated above 100 kilowatts (kW) for more than 5 minutes following loss of city water pressure.)
- On July 18, 2011, the MIT research reactor was started up with only one operable nuclear safety channel level scram (two are required by Technical Specification Section 3.2.3) which resulted in a Non-Cited Violation.

Design Change Functions

- The design change program satisfied NRC requirements.

Maintenance and Surveillance

- Approximately half of the facility nuclear safety channels were out of commission.
- One Inspector Follow-up Item was noted to review the licensee's use of the program that is in place to track to completion maintenance and repair work activities to include the use of the Job Work Book.

REPORT DETAILS

Summary of Facility Status

The Massachusetts Institute of Technology (MIT, the licensee) Nuclear Reactor Laboratory (NRL) six megawatt (MW) research and test reactor continued to be operated in support of experiments, research and service irradiations, reactor operator training, and periodic equipment maintenance and surveillance activities. The reactor is typically operated approximately 300 days per year with operations running 24 hours a day, 7 days a week, for about four weeks followed by a shutdown varying from 8 hours to two weeks in length. During the inspection, the reactor was not operated because a control blade was being changed out.

1. Reactor Operations

a. Inspection Scope (Inspection Procedure (IP) 69006, 69008)

To determine whether the licensee was conducting reactor operations in accordance with the Massachusetts Institute of Technology Reactor (MITR) Technical Specification (TS) and procedural requirements, the inspectors reviewed selected portions of the following:

- Reactor Logbook #123, February 22, 2011 to July 5, 2011
- Reactor Logbook #124, July 6, 2011 to present
- TS for the Massachusetts Institute of Technology, Revision (Rev.) 6, implemented through renewed Facility Operating License R-37, issued November 1, 2010
- Procedure Manual (PM) Section 5, "Abnormal Operating Procedures," which included Abnormal Operating Procedure (AOP) 5.4.14, "Loss of City Water Pressure," last revision dated September 15, 2010
- PM 3.2, "Shutdown Checklists," which included PM 3.2.1, "Shutdown from Operations at Power," latest revision dated December 21, 2010
- PM 3.5, "Daily Surveillance Check," latest revision dated February 8, 2011
- Unusual Occurrence Report - 2011-3, "Loss of City Water Pressure," date of occurrence June 4, 2011
- Reportable Occurrence Report – 2011-3, "Operation with Fewer than the Required Number of Nuclear Safety Channel Level Scrams," report submitted to the NRC on July 28, 2011

b. Observations and Findings

(1) Loss of City Water Pressure Occurrence

TS Section 3.3.4.1 requires that the reactor shall not be operated at power levels in excess of 100 kW unless the emergency core cooling system is operable and capable of providing the reactor core with a minimum total emergency cooling flow rate of 10 gallons per minute (gpm) within 5 minutes after a low flow level core tank scram.

TS Section 7.4.3 requires that written procedures be prepared for all operational activities described in the SAR to include startup, shutdown, and operation of the reactor.

Abnormal Operating Procedure (AOP) 5.4.14, Loss of City Water Pressure, states (in the Introduction Section but not in the Immediate Actions Section), that the alarm annunciates when the city water pressure falls below ~10 pounds per square inch gauge (psig). This alarm indicates a loss of city water, which in turn requires that the MITR not be operated above 100 kW for more than 5 minutes.

On the evening of June 4, 2011, routine operations were in progress and the reactor was operating at 5.0 MW with normal cooling of the reactor and related systems which included typical use of water supplied by the City of Cambridge. An alarm of "Loss of City Water Pressure" was received at 9:00 p.m. The Reactor Supervisor (RS) on duty checked the gauge which showed the city water pressure and found that it was reading approximately 8 psig, not the normal 50 to 60 psig. The loss of pressure was verified by testing the flow in a nearby sink. The RS contacted the MIT Facilities Operation Center and was told that other areas on campus had reported a problem with low water pressure.

At 9:09 p.m. the RS instructed the Reactor Operator (RO) to reduce reactor power by ramping down to 50 kW in compliance with AOP 5.4.14. While the RO was lowering power, an experimenter whose experiment would be affected by decreasing reactor power, was contacted. Because of the need to minimize thermal stress on the in-core experiments, the RS decided to lower power slowly. The power decrease from 5.0 MW to 50 kW was completed in 17 minutes which was not in accordance with the Introduction section of AOP 5.4.14. The licensee indicated that the RS felt that the 5 minute time frame was too short to gather sufficient information to comply with the procedure. It was acknowledged that it would be desirable to lower power to below the 100 kW threshold for increased safety.

As noted above, TS Section 3.3.4.1 requires that the reactor not be operated at a power level greater than 100 kW if the emergency core cooling system (ECCS) is not operable or capable of supplying a minimum of 10 gpm within 5 minutes of a low level core tank scram. It was noted that, in this instance, there was never a loss of core tank level and the ECCS could have been realigned to provide emergency cooling water from the reactor makeup water system had it become necessary. However, the AOP required that the reactor not be operated above 100 kW for more than 5 minutes upon loss of city water pressure.

The following week the licensee initiated a review of the event. The licensee concluded that the procedure was not clearly written and did not reflect the requirement stipulated in the TS. Also, the perceived need to

minimize the thermal stress on the in-core experiments resulted in RS taking the actions he did. An Unusual Occurrence Report (UOR) was written to document this event and corrective actions were identified. To correct this problem, AOP 5.4.14 was rewritten to clarify the immediate actions and to require the reactor to be scrammed with a continuous loss of city water pressure of greater than three minutes. In addition, a reactor scram was added to the scram circuitry to initiate an automatic scram upon a three minute loss of city water. It was also stipulated that the UOR was required reading for all operations personnel.

The inspectors reviewed the Loss of City Water Pressure event. The licensee was informed that it appeared that the RS was more concerned with the thermal stress and/or results of the in-core experiments than with the safety of the reactor. Although the TS requirements were not violated (i.e., the ECCS was operable and would have been capable of providing a cooling flow rate of 10 gpm within 5 minutes after a low level core tank scram), the procedure was not followed in that the reactor was operated above 100 kW for more than 5 minutes when normal of city water pressure was lost. The inspectors stressed that a procedure should be followed as written. If the procedure is not clear or does not reflect the appropriate requirements, then it should be changed with the change being reviewed and approved by the proper reviewing officials. The licensee indicated that they agreed that procedural compliance is very important and indicated that that was the major reason for revising AOP 5.4.14. The procedure was revised so that it would properly and adequately state the TS requirements and ensure the reactor had adequate core cooling. The licensee indicated further that reactor safety was their primary goal and that it did, indeed, take precedence over experimental results.

The inspectors reviewed the corrective actions taken by the licensee. Through interviews with personnel and review of the signoff form associated with this UOR and training records, the inspectors verified that the actions, with the exception of issuing the revised AOP 5.4.14, had been completed. The inspectors indicated that human error lead to the failure to follow procedure.

The inspectors determined that the problem had been identified by licensee personnel and reported to and reviewed by the management. Except as noted, the corrective actions had been completed as well. As a result, the licensee was informed that this licensee-identified and corrected violation would be treated as a violation of minor significance that is not subject to enforcement action in accordance with Section IV of the NRC Enforcement Policy.

- (2) Operation of the Reactor with Fewer than the Required Number of Nuclear Safety Channel Level Scrams Occurrence.

TS Section 3.2.3.1 requires that the reactor shall not be made critical unless the reactor protection system is operable in accordance with Table 3.2.3-1.

Table 3.2.3-1 stipulates that a minimum number of two neutron flux level safety channels is needed. (It should be noted that Channel Nos. 1, 2, and 3 are period safety channels and Channel Nos. 4, 5, and 6 are flux level safety channels.)

On July 18, following the completion of full power instrumentation and mechanical checklists, preparations were made to startup the reactor. It was noted that Nuclear Safety Channel Number (No.) 5, which is one of three channels that provide an automatic shutdown signal on high reactor power, had been undergoing maintenance and was considered out-of-commission (OOC). In addition, the detector signal cable of Channel No. 3, a period safety channel, had been replaced. Further, the detector for Channel No. 3 is located in the same instrumentation port (Port 3GV3) as the detector for Channel No. 6, a power level channel.

At about 9:40 a.m., the reactor was started up and reached a power level of 1.0 MW just after noon. It is at this power level that the flux level safety channels are expected to begin to give an indication of level response. At that point the RO noted that Channel No. 6 had not shown any response to the current power level. Because it is typically difficult to get a good power level indication at such "low" power, it was decided to increase power to 1.5 MW to check for a response on Channel No. 6. At 1.5 MW, it was determined that Channel No. 6 was not showing the proper indication and the reactor was scrammed at 12:45 p.m. Flux level safety Channel No. 4 was observed to have been operating properly during the entire startup.

The next day the licensee initiated an investigation and review of the event. The cables for Channel No. 6 were inspected. It was found that the signal cable for Channel No. 6 detector was connected to the Channel No. 3 picoammeter. Further investigation showed that the cables in Port 3GV3 were not labeled at the connection points which apparently caused confusion as to which cable should be connected to which detector. In addition, during the cable replacement for Channel No. 3 that had occurred earlier, there was apparent miscommunication between the Instrumentation Supervisor and the Control Room RO. The Instrumentation Supervisor got the mistaken impression that the Channel No. 3 detector was the only one operable in Port 3GV3.

The licensee made an initial report to the NRC by telephone on July 19, 2011. A written report was subsequently submitted to the NRC on July 28, 2011. Due to a clerical error, the MITR Reactor Safeguards Committee (MITRSC) did not receive a copy of the written report until August 9, 2011.

As a result of this event the licensee took various corrective actions as follows: 1) All period and level Channel's cables were labeled at all connection locations. 2) Channel No. 6 was recalibrated and verified to be operable. 3) Retraining sessions were required for licensed and maintenance personnel to highlight the importance of proper communication with the Control Room RO, as well as the important role of proper documentation and attention to detail.

The inspectors reviewed the event and the corrective actions taken by the licensee. Through interviews and review of the Reactor Console Logbook and training records, the inspectors verified that most of the actions had been completed. It was noted that the retraining of all licensed and maintenance personnel is still pending because some personnel were/are on vacation and have not had a chance to review the event and the corrective actions. The inspectors agreed that the root cause of the problem was human error.

The inspectors determined that the problem had been identified and reviewed by the licensee and reported to the NRC. Except as noted, corrective actions had been identified and completed as well. As a result, the licensee was informed that this non-repetitive, licensee-identified and corrected violation would be treated as a Non-Cited Violation (NCV), consistent with Section 2.3.2 of the NRC Enforcement Policy (NCV 50-020/2011-202-01).

c. Conclusion

One minor violation was identified for failure to follow procedure. One NCV was identified for operating the reactor with fewer than the required number of nuclear safety channel level scrams as required by TS Section 3.2.3.1.

2. Design Change Functions

a. Inspection Scope (IP 69007)

To ensure that facility changes were reviewed and approved as required by TS Section 7.2.2 and in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.59, the inspectors reviewed selected aspects of:

- Safety Review Form No. O-11-7, Item: AOP 5.4.14, "Loss of City Water Pressure" dated July 8, 2011
- Safety Review Form No. O-11-7, Item: PM 6.4.11, "Loss of City Water Pressure Alarm and Scram", dated July 8, 2011
- Records of the installation and calibration of the Loss of City Water Pressure Alarm and Scram functions completed on July 8, 2011

b. Observations and Findings

The inspectors reviewed the Safety Review Forms and associated safety evaluation documents of the review conducted prior to installing the scram for the loss of city water pressure. The completed forms showed that the proposal for the scram was acceptably reviewed in accordance with the procedure. It was noted that the proposal was designated as Class B and therefore no formal MITRSC approval was required. Also, the change was determined not to constitute a safety question or concern and did not require a license or TS amendment.

c. Conclusion

The design change program satisfied NRC requirements.

3. Maintenance and Surveillance

a. Inspection Scope (IP 69006, 69010)

To verify that the licensee was meeting the surveillance requirements specified in TS Section 4 and that maintenance was being conducted, the inspectors reviewed selected aspects of:

- MITR-II Job Workbook
- Reactor Logbook #123, February 22, 2011 to July 5, 2011
- Reactor Logbook #124, July 6, 2011 to present
- TS for the Massachusetts Institute of Technology, Revision (Rev.) 6, implemented through renewed Facility Operating License R-37, issued November 1, 2010

b. Observations and Findings

During the inspection, the inspectors inquired about the condition of all the nuclear safety channels. The licensee indicated that, although they had sufficient to operate safely, about half were OOC or in need of some type of maintenance. The inspectors then reviewed the program the licensee used to track and complete maintenance activities and needed repair work. One aspect of the system involved the use of the Job Work Book. It was maintained in the Control Room so that anyone who found an item of equipment that was OOC or other problem could enter that data in the Job Work Book to be tracked until the needed repairs were completed.

The inspectors reviewed the Job Work Book for references to the various safety channels. They found that the book was being used somewhat sporadically. The Job Work Book only contained references to two safety channels. The licensee indicated that they needed to make better use of the system in place to track items that had been taken out of service until the items were properly repaired and all associated checks and/or calibrations had been completed. The

licensee was informed that the issue of effectively using the Job Work Book would be considered by the NRC as an Inspector Follow-up Item (IFI) and would be reviewed during a future inspection (IFI 50-020/2011-202-02).

c. Conclusion

One IFI was noted to review the licensee's use of the program that is in place to track to completion maintenance and repair work activities to include the use of the Job Work Book.

4. Exit Interview

The inspection scope and results were summarized on August 10, 2011, with members of licensee management. The Director of the Nuclear Reactor Laboratory attended the exit interview via telephone. The inspectors described the areas inspected and discussed the preliminary inspection findings. The licensee did not offer any dissenting opinions or identify any information to be withheld from public disclosure.

PARTIAL LIST OF PERSONS CONTACTED

Licensee Personnel:

E. Block	Maintenance Supervisor
J. Foster	Superintendent of Reactor Operations
S. Hanvy	Instrumentation Technician
E. Lau	Associate Director, Reactor Operations
W. McCarthy	Reactor Radiation Protection Officer and Deputy Director, Environment, Health, and Safety Office, MIT
D. Moncton	Director, Nuclear Reactor Laboratory (via telephone)
T. Newton	Director of Reactor Operations
S. Tucker	Quality Assurance Supervisor
F. Warmasley	Training Supervisor

INSPECTION PROCEDURES USED

IP 69006	Class 1 Research and Test Reactors Organization and Operations and Maintenance Activities
IP 69007	Class 1 Research and Test Reactors Review and Audit and Design Change Functions
IP 69008	Class 1 Research and Test Reactors Procedures

ITEMS OPENED, CLOSED, AND DISCUSSED

OPENED:

50-020/2011-201-01	NCV	Operation of the reactor with fewer than the required number of nuclear safety channel level scrams as required by TS 3.2.3.1.
50-020/2011-201-02	IFI	Follow-up on the licensee's making effective using the Job Work Book to track and close-out maintenance items and items needing repair.

CLOSED:

50-020/2011-201-01	NCV	Operation of the reactor with fewer than the required number of nuclear safety channel level scrams as required by TS 3.2.3.1.
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LIST OF ACRONYMS USED

10 CFR	Title 10 of the <i>Code of Federal Regulations</i>
ADAMS	Agencywide Documents Access and Management System
AOP	Abnormal Operating Procedure
ECCS	Emergency Core Cooling System
gpm	Gallons per minute
IFI	Inspector Follow-up Item
IP	Inspection Procedure
MIT	Massachusetts Institute of Technology
MITR-II	Massachusetts Institute of Technology Reactor
MITRSC	Massachusetts Institute of Technology Reactor Safeguards Committee
No.	Number
NRC	U. S. Nuclear Regulatory Commission
NRL	Nuclear Reactor Laboratory
OOC	Out of commission
psig	Pounds per square inch gauge
PM	Procedure Manual
RO	Reactor Operator
RRPO	Reactor Radiation Protection Officer
RS	Reactor Supervisor
RSC	Reactor Safeguards Committee
TS	Technical Specification