



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**  
WASHINGTON, D.C. 20555-0001

January 10, 2020

Mr. John P. Foster  
Director of Reactor Operations  
Nuclear Reactor Laboratory  
Massachusetts Institute of Technology  
138 Albany Street, MS NW12-116A  
Cambridge, MA 02139

SUBJECT: MASSACHUSETTS INSTITUTE OF TECHNOLOGY – U.S. NUCLEAR  
REGULATORY COMMISSION ROUTINE INSPECTION REPORT  
NO. 05000020/2019202

Dear Mr. Foster:

From November 4-8, 2019, the U.S. Nuclear Regulatory Commission (NRC) conducted a routine inspection at the Massachusetts Institute of Technology Research Reactor. The enclosed report documents the inspection results which were discussed on November 8, 2019, with Dr. Kohse and members of your staff.

The inspection examined activities conducted under your license as they relate to public health and safety, compliance with the Commission's rules and regulations, and compliance with the conditions of your license. Within these areas, the inspection consisted of selected examination of procedures and representative records, observations of activities, and interviews with personnel. Based on the results of this inspection, no findings of non-compliance with NRC requirements 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, 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 <https://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Should you have any questions concerning this inspection, please contact Mr. Michael Takacs at (301) 415-2042 or electronic mail at [Michael.Takacs@nrc.gov](mailto:Michael.Takacs@nrc.gov).

Sincerely,

**/RA/**

Elizabeth Reed, Acting Chief  
Non-Power Production and Utilization  
Facility Oversight Branch  
Division of Advanced Reactors and Non-Power  
Production and Utilization Facilities  
Office of Nuclear Reactor Regulation

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

Enclosure:  
As stated

cc: See next page

Massachusetts Institute of Technology

Docket No. 50-020

cc:

City Manager  
City Hall  
Cambridge, MA 02139

Department of Environmental Protection  
One Winter Street  
Boston, MA 02108

Mr. Jack Priest, Director  
Radiation Control Program  
Department of Public Health  
529 Main Street  
Schrafft Center, Suite 1M2A  
Charlestown, MA 02129

Mr. John Giarrusso, Chief  
Planning and Preparedness Division  
Massachusetts Emergency Management Agency  
400 Worcester Road  
Framingham, MA 01702-5399

Test, Research and Training  
Reactor Newsletter  
Attention: Ms. Amber Johnson  
Dept. of Materials Science and Engineering  
University of Maryland  
4418 Stadium Drive  
College Park, MD 20742-2115

Ms. Sarah M. Don, Reactor Superintendent  
Massachusetts Institute of Technology  
Nuclear Reactor Laboratory  
Research Reactor  
138 Albany Street, MS NW12-116B  
Cambridge, MA 02139

SUBJECT: MASSACHUSETTS INSTITUTE OF TECHNOLOGY – U.S. NUCLEAR  
REGULATORY COMMISSION ROUTINE INSPECTION REPORT  
NO. 05000020/2019202 DATED: JANUARY 10, 2020

**DISTRIBUTION:**

PUBLIC	RidsNrrDanuUnpo	MTakacs, NRR
GCasto, NRR	XYin, NRR	NParker, NRR
EReed, NRR	PBoyle, NRR	BSmith, NRR

**ADAMS Accession No.: ML19360A241****\*concurred via e-mail****NRC-002**

OFFICE	NRR/DANU/UNPO/SS*	NRR/DANU/UNPO/LA*	NRR/DANU/UNPO/ABC
NAME	MTakacs	NParker	EReed
DATE	1/7/2020	1/7/2020	1/10/2020

**OFFICIAL RECORD COPY**

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

Docket No.: 50-020

License No.: R-37

Report No.: 05000020/2019202

Licensee: Massachusetts Institute of Technology

Facility: Nuclear Reactor Laboratory

Location: Cambridge, Massachusetts

Dates: November 4-8, 2019

Inspector: Michael Takacs

Approved by: Elizabeth Reed, Acting Chief  
Non-Power Production and Utilization  
Facility Oversight Branch  
Division of Advanced Reactors and Non-Power  
Production and Utilization Facilities  
Office of Nuclear Reactor Regulation

Enclosure

## **EXECUTIVE SUMMARY**

Massachusetts Institute of Technology  
Nuclear Reactor Laboratory  
Inspection Report No. 05000020/2019202

The primary focus of this routine inspection was the onsite review of selected elements of the Massachusetts Institute of Technology (MIT or the licensee) Class I, 6-megawatt (MW) research reactor safety program, starting from the time since the last U.S. Nuclear Regulatory Commission (NRC) inspection of these areas. The areas included: (1) organization and staffing, (2) review and audit and design change functions, (3) radiation protection, (4) effluent and environmental monitoring, and (5) transportation of radioactive materials. The licensee's program was acceptably directed toward the protection of public health and safety and was in compliance with NRC requirements. One inspection follow-up item (IFI) was identified.

### Organization and Staffing

- The organizational structure and staffing were consistent with the requirements specified in the technical specifications (TS).

### Review and Audit and Design Change Functions

- The MIT Reactor Safeguards Committee (RSC) was meeting as required and reviewing the topics outlined in the TS.
- Annual audits of facility programs were conducted as required.
- The design change program satisfied NRC requirements.
- One IFI was identified in regard to the newly installed structure identified as the cooling tower plume catcher.

### Radiation Protection

- Periodic surveys were completed and documented as required.
- Postings and notices met regulatory requirements.
- Personnel dosimetry was being worn as required and recorded doses were within the NRC's regulatory limits.
- Radiation survey and monitoring equipment was being maintained and calibrated as required.
- Radiation protection training was being conducted as required.
- The radiation protection and the as low as reasonably-achievable (ALARA) programs satisfied regulatory requirements.

#### Effluent and Environmental Monitoring

- Effluent monitoring satisfied license and regulatory requirements and releases were within the specified regulatory and TS limits.

#### Transportation of Radioactive Materials

- The program for transportation of radioactive materials (RAMs) satisfied U.S. Department of Transportation (DOT) and the NRC regulations.

## REPORT DETAILS

### Summary of Facility Status

The MIT Nuclear Reactor Laboratory (NRL) 6 MW research reactor is typically operated for 11 continuous weeks followed by a 2-week shutdown in support of reactor fuel handling, along with facility maintenance and repairs. During the operating period, the reactor is operated 24 hours a day, 7 days a week in support of educational experiments, research and service irradiations, and reactor operator training.

#### 1. Organization and Staffing

##### a. Inspection Scope (Inspection Procedure (IP) 69006)

The inspector reviewed the following regarding the MIT reactor organization, staffing, and management responsibilities to ensure that the requirements of TS Section 7, Revision 6, dated November 1, 2010, were being met:

- Management responsibilities
- Qualifications of facility radiation protection personnel
- The MIT NRL organization chart dated November 1, 2019
- Staffing requirements for operation of the research reactor
- The MIT annual report for the period January 1, 2018, to December 31, 2018
- Selected portions of the digital console log

##### b. Observations and Findings

The inspector reviewed the facility organization and staffing. It was noted that a new Level 1 staff member had been promoted to the position of Director for the MIT NRL, effective August 1, 2019. This was officially reported to the NRC in accordance with TS 7.7.3(a). This individual previously served as Deputy Director of Research and Services, and has been working at the NRL for over 40 years. The new Director has received briefings sufficient to provide an understanding of the general operational and emergency aspects of the reactor facility. The remainder of the organization was consistent with that specified in the TS.

The radiation protection organization staffing levels at the facility remained consistent with those noted during the last inspection of this facility. The inspector noted that the Deputy Director of Environment, Health, and Safety (EH&S) for the Reactor Radiation Protection (RRP) Program was responsible for radiation protection for the facility and advised the Director of Reactor Operations in all matters pertaining to radiation protection. The current RRP organization consisted of the Deputy Director of EH&S, two Radiation Protection Program Officers, a project technician, several part-time EH&S technicians and an administrative assistant. The Deputy Director was also a member of the facility RSC. It was noted that the RRP personnel provided assistance and job coverage for work done by Operations Group personnel.



c. Conclusion

The organizational structure, staffing, and staff responsibilities were in accordance with TS requirements.

**2. Review and Audit and Design Change Functions**

a. Inspection Scope (IP 69007)

To verify compliance with TS Sections 7.2.1, 7.2.2, 7.2.3, and Title 10 of the *Code of Federal Regulations* (10 CFR) 50.59, "Changes, tests and experiments," the following documents were reviewed:

- Minutes of the MIT RSC, Meeting No. 111, held October 2, 2018
- 10 CFR 50.59 evaluations completed since the last inspection
- The MIT annual report for the period January 1, 2018, to December 31, 2018
- MIT Research Reactor Administrative Procedure, PM 1.13, "Quality Assurance Program"
- MIT Research Reactor Administrative Procedure, PM 1.4, "Review and Approval of Plans, Procedures, and Facility Equipment and Changes Thereto"

b. Observations and Findings

(1) Review and Audit Functions

The MIT RSC was meeting annually as required and committee membership satisfied TS Section 7.2.1. The MIT RSC meeting minutes and audit records showed that safety reviews and an independent audit had been completed at the required frequency for the functional areas specified by TS Sections 7.2.2 and 7.2.3. The inspector noted that the audit topics included all the areas specified in TS Section 7.2.3.3. The inspector reviewed the results of the audit that had been completed and determined that the audit findings, and licensee actions taken in response to the findings, were acceptable.

(2) Design Change Functions

The licensee has an established design change review function. It includes the screening and safety review of changes, tests, or experiments to determine if, pursuant to 10 CFR 50.59, a change required NRC approval prior to being implemented. The inspector found procedures in place to control the review process and evidence of adherence to the procedures.

The inspector observed that MIT recently installed a large steel structure above the cooling towers identified as a cooling tower plume catcher. The structure is free-standing and not physically attached to the cooling towers. The cooling towers are the heat sink for the secondary cooling system and are not a safety-related system. The cooling towers are only

required during reactor operation at power and are not relied upon for emergency cooling. This new structure is part of a project to help minimize cooling water shortages in the future, and to recover up to 20 percent of the cooling tower water loss per year in the plume discharge from the cooling towers.

The water collection process of the plume catcher does not physically interfere with the operation of the cooling towers except that it has the potential to reduce the efficiency of the cooling tower heat removal capacity between 3 to 5 percent. However, the cooling towers have sufficient margin in their cooling capacity such that they will still be able to reject the entire heat load from the reactor and its facilities with no need to reduce power. The total heat removal capacity of all the facility's secondary cooling heat exchangers is approximately 7 MW. The cooling towers can reject up to 10 MW of heat removal to the atmosphere under the most adverse weather conditions (i.e., high humidity and temperature). In addition, the licensee also has the capability to immediately bypass the cooling tower plume catcher and, therefore, restore full cooling tower efficiency when necessary.

The licensee performed an internal review and approval for this cooling tower plume catcher project, as specified under their internal administrative procedure PM 1.4, "Review and Approval of Plans, Procedures, and Facility Equipment and Changes Thereto," and it was concluded that this project would not require a 10 CFR 50.59 safety evaluation since it did not change the function of the cooling towers as described in the licensee's Safety Analysis Report. However, the inspector noted that additional information was needed for this project to be thoroughly evaluated as stated in PM 1.13, "Quality Assurance Program." Specifically, PM 1.13 states, "The proposal should be detailed enough for a reviewer to understand how the change will affect plant operation and maintenance." Therefore, the inspector informed the licensee that the following additional information needs to be included with the initial Cooling Tower Plume Catcher Proposal (QA # 2019-19): (1) the impact of the three new electrical tie-ins to the 480 volt distribution panel in the cooling tower shed, (2) the impact to the compressed air system loading when operating (i.e., rotating) the plume catcher panels, (3) the seismic strength and wind resistance, which is listed on the structure's engineering drawings, (4) the structure's lightning protection, (5) worker safety issues regarding the 25,000 volt power to the plume catcher panels via step up transformers, (6) impact to the routine 24/7 reactor operations, and (7) potential hazard to birds and other wildlife (i.e., electrocution) along with increased debris on cooling tower surface from animal waste. This additional information to the proposal will be tracked as IFI-05000020/2019202-01.

c. Conclusion

The review and audit program was being conducted in compliance with the TS. The design change evaluation program was being implemented in accordance

with the TS requirements and NRC regulations. The Cooling Tower Plume Catcher Project will be further reviewed under IFI-05000020/2019202-01.

### 3. Radiation Protection

#### a. Inspection Scope (IP 69012)

To ensure that the licensee was following the requirements of TS Section 7.3 and 10 CFR Part 19, "Notices, Instructions and Reports To Workers: Inspection and Investigations," and 10 CFR Part 20, "Standards for Protection against Radiation," the inspector reviewed selected aspects of the following:

- Quarterly Landauer dosimetry reports since the last inspection
- Observations of facility areas, equipment, operations, and postings during facility tours
- Reportable Occurrence Reports, Unusual Occurrence Reports, and Operator Lessons Learned Reports related to radiation protection for the past year
- The MIT annual report for the period January 1, 2018, to December 31, 2018
- MIT ALARA program review for 2019
- MIT quarterly administrative audits for 2019
- MIT independent annual audit for 2018

#### b. Observations and Findings

##### (1) Surveys

Daily, weekly, monthly, and other periodic contamination and radiation surveys, outlined in the licensee's procedures, were completed in a timely manner by radiation protection staff members. Results of the surveys were acceptably documented and posted so that facility personnel would be knowledgeable of the radiological conditions that existed in the controlled areas of the facility.

##### (2) Postings and Notices

The inspector observed that NRC Form 3, "Notice to Employees," was the latest issue and was prominently posted as required by 10 CFR 19.11, "Posting of notices to workers." The forms were posted on the bulletin board in the main hallway and at the entrance to the reactor building. Radiological signs were also posted at the entrances to controlled areas. Caution signs, postings, and controls for radiologically controlled areas were as required in 10 CFR 20.1902, "Posting requirements."

##### (3) Dosimetry

The inspector observed that dosimetry was acceptably used by facility personnel. The inspector noted that the licensee used optically stimulated luminescent (OSL) dosimetry for whole body monitoring and thermoluminescent dosimeters (TLD) in the form of finger rings for extremity monitoring. The dosimetry was supplied and processed by a

National Voluntary Laboratory Accreditation Program accredited vendor (Landauer). An examination of the OSL results indicating radiological exposures at the facility for the past year showed that occupational doses, as well as doses to the public, were within 10 CFR Part 20 limits.

(4) Radiation Monitoring Equipment

Examination of selected radiation monitoring equipment indicated that the instruments had current calibration stickers attached. The instrument calibration records indicated that the calibration of certain portable survey meters was typically completed by licensee staff personnel. In the event that an instrument could not be calibrated by the licensee, it was taken out of service. Calibration frequency met procedural requirements and records were maintained as required. Licensee records for calibration and tracking were comprehensive and well maintained.

(5) Radiation Protection Training

The inspector reviewed the general employee radiation protection training given to MIT staff members, to those authorized to use the experimental facilities of the reactor, to students, and to visitors. It was noted that the training was available online through the EH&S website and reinforced with hands on, practical training. The training satisfied the requirements of 10 CFR Part 19 and the training program was acceptable. The inspector also noted that any specialized training, including Radiation Worker I and Radiation Worker II training, was provided on an individual basis by the Deputy Director of EH&S for those who needed it. No problems were noted. The refresher training given included topics such as the facility ALARA program results, safety culture, emergency response, and the importance of understanding the self-reading pocket dosimeter indications.

(6) Radiation Protection and ALARA Programs

The MIT ALARA efforts were well organized and continued to produce dose reduction results. ALARA goals were set and performance indicators were established. Each group in the MIT organization had an established ALARA goal for the year and the facility dose was tracked by group, as well as for each individual. The facility is proactively taking action to reduce doses to workers through job planning and equipment improvements. Through discussion with the Deputy Director of EH&S, it was noted that the silicon irradiation program has seen an increase in its workload for 2018 and 2019 and how this increased amount of work might impact the annual personnel exposure goals. The Deputy Director of EH&S stated that he and the Director of Reactor Operations are aware of this potential and closely monitor the individuals involved with this work. Two new personnel have been trained on the silicon processing so that no single individual will acquire too high a dose.

The inspector also noted that the Deputy Director of EH&S had completed the annual review of the Radiation Protection Program in

October 2019 in accordance with 10 CFR 20.1101, "Radiation protection program," paragraph (c). In addition, the annual independent audit of the ALARA Program had also been conducted in April of 2019.

c. Conclusion

The inspector determined that: (1) surveys were completed and acceptably documented to permit evaluation of the radiation hazards present, (2) postings and notices met regulatory requirements, (3) personnel dosimetry was being worn as required and recorded doses were within the NRC's regulatory limits, (4) radiation survey and monitoring equipment was being maintained and calibrated as required, (5) the radiation safety training program was acceptable, and (6) the radiation protection and ALARA programs satisfied regulatory requirements.

**4. Effluent and Environmental Monitoring**

a. Inspection Scope (IP 69004)

To determine that the licensee was complying with the requirements of 10 CFR Part 20 and TS Section 3.7, the inspector reviewed selected aspects of:

- Facility records of measurements and analysis of effluent samples
- The MIT annual report for the period January 1, 2018, to December 31, 2018
- Procedure RRP 6002, "Air Gas Samples – Ar41," dated March 2015
- Procedure RRP 6003, "Core Purge Gas Sampling and Analysis," dated December 2002
- Procedure RRP 5002, "Primary Coolant Sampling and Analysis," dated August 2012
- Procedure RRP 5003, "Heavy Water Reflector Sampling and Analysis," dated April 2007
- Procedure RRP 5005, "Fuel Storage Pool Water Sampling and Analysis," dated December 2002

b. Observations and Findings

Environmental radiation monitoring was accomplished by use of TLDs placed at five different monitoring stations within a quarter mile of the reactor. All doses were well within all regulatory limits. The TLDs are in place continuously throughout the year and are exchanged on a quarterly basis.

The inspector noted that gaseous releases are discharged to the atmosphere from the containment exhaust stack and continued to be monitored as required, calculated according to procedure, and acceptably documented in the annual report. The predominant environmental release from the facility was due to Argon-41. The airborne concentrations of the gaseous releases were well within the concentrations stipulated in 10 CFR Part 20, Appendix B, Table 2. The inspector observed a radiation protection technician perform the weekly air sample from the containment building exhaust stack. The technician was

knowledgeable and performed the task successfully. The inspector also observed a second radiation protection technician perform various liquid and gas sampling evolutions including: (1) primary coolant water sample, (2) heavy water reflector sample, (3) fuel storage pool water sample, and (4) core purge gas sample. The technician was also knowledgeable and successfully performed all the sampling evolutions.

The licensee reported the total annual activity of liquid effluent released from the facility to the sanitary sewer. The combined sources of all liquid effluent releases are determined to be from the cooling towers, liquid waste storage tanks, and a sink in a restricted area lab. The total activity was reported in terms of both tritium and all other remaining radionuclides combined. The releases were well within the monthly average concentration limits established in 10 CFR Part 20, Appendix B, Table 3.

c. Conclusion

Effluent release measurements, liquid and gas sampling analysis, and environmental monitoring measurements, demonstrated compliance within regulatory and TS limits.

**5. Transportation of Radioactive Materials**

a. Inspection Scope (IP 86740)

The inspector reviewed the following documents to determine compliance with NRC and DOT regulations governing the transportation of RAM as specified in 10 CFR Part 20 and 10 CFR Part 71, "Packaging and Transportation of Radioactive Material," and in 49 CFR Parts 171-178:

- RAM shipping papers and related records
- Training records for individuals designated as "shippers"
- Annual DOT RAM shipping audit for 2018 completed by the Deputy Director of EH&S, completed March 2019
- The MIT annual report for the period January 1, 2018, to December 31, 2018
- MIT quarterly administrative audits for 2019

b. Observations and Findings

Through records review and discussions with licensee personnel, the inspector determined that the licensee had shipped various types of RAM since the last inspection of this area. The records indicated that the radioisotopes and quantities involved were calculated and dose rates measured as required. The records also indicated that the shipping containers were appropriate and had been labeled as required. The RAM shipment records reviewed by the inspector had been completed in accordance with DOT and NRC regulations.

The inspector verified that the licensee was maintaining copies of consignees' RAM possession licenses as required. If the current copy of the license was not available, the licensee was aware that they were required to contact the

consignee and obtain a current copy before a shipment could be made. The licensee also maintained on file the certificates of compliance pertaining to those shipping containers that were used to ship RAM as required. In addition, the inspector verified that the licensee staff members assigned to complete and/or review the shipping paperwork were trained and that refresher training was being completed as required.

c. Conclusion

The program for transportation of RAMs satisfied the DOT and the NRC regulations.

**6. Exit Interview**

The inspection scope and results were summarized on November 8, 2019, with members of licensee management. The inspector described the areas inspected and discussed the preliminary inspection findings. The licensee acknowledged the inspection findings and did not identify any information to be withheld from public disclosure.

## **PARTIAL LIST OF PERSONS CONTACTED**

### Licensee Personnel

G. Kohse	Director, Nuclear Reactor Laboratory
E. Lau	Associate Director, Reactor Operations
S. Don	Superintendent of Reactor Operations
S. Tucker	Quality Assurance Supervisor
W. McCarthy	Deputy Director, Environment, Health, and Safety
D. Cormier	Radiation Project Technician
M. Mahowald	Radiation Protection Program Officer, EH&S
R. Stoute	Radiation Protection Technician
E. Block	Manager, Engineering and Information Technology

## **INSPECTION PROCEDURES USED**

IP 69004	Class I Research and Test Reactor Effluent and Environmental Monitoring
IP 69006	Class I Research and Test Reactors Organization and Operations and Maintenance Activities
IP 69007	Class I Research and Test Reactor Review and Audit and Design Change Functions
IP 69012	Class I Research and Test Reactors Radiation Protection
IP 86740	Inspection of Transportation Activities

## **ITEMS OPENED, CLOSED, AND DISCUSSED**

### Opened:

IFI 05000020/2019202-01	Additional information needs to be provided for the Cooling Tower Plume Catcher Proposal (QA # 2019-19) regarding any impacts to plant operation and maintenance activities.
-------------------------	--

### Discussed:

None

### Closed:

None



## LIST OF ACRONYMS USED

10 CFR	Title 10 of the <i>Code of Federal Regulations</i>
ALARA	As Low as Reasonably Achievable
DOT	Department of Transportation
EH&S	Environmental Health and Safety
IP	Inspection Procedure
MIT	Massachusetts Institute of Technology
MW	Megawatt
NRC	U.S. Nuclear Regulatory Commission
NRL	Nuclear Reactor Laboratory
OSL	Optically Stimulated Luminescent
RAM	Radioactive Material
RRP	Reactor Radiation Protection
RSC	Reactor Safeguards Committee
TLD	Thermoluminescent Dosimeters
TS	Technical Specification(s)