DOCKET: 70-938

LICENSEE: Massachusetts Institute of Technology
Cambridge, Massachusetts

SUBJECT: SAFETY EVALUATION REPORT: LICENSE RENEWAL APPLICATION DATED APRIL 29, 2004, FOR MASSACHUSETTS INSTITUTE OF TECHNOLOGY SPECIAL NUCLEAR MATERIAL LICENSE SNM-986

BACKGROUND

The Massachusetts Institute of Technology (MIT) was first issued a Special Nuclear Material (SNM) License in 1966, SNM-986. The license was subsequently renewed in 1969, 1985, 1994 and most recently was granted an extension from April 1999 to May 2004. During the term of the 1994 renewed license, three amendments were issued. The current license was scheduled to expire on May 31, 2004. On April 29, 2004, the MIT submitted an application for renewal. The U.S. Nuclear Regulatory Commission (NRC) acknowledged receipt of the application on May 25, 2004. Consequently, the license has remained in effect in accordance with the timely renewal provision of 10 CFR 70.38(a)(1).

The NRC staff reviewed the renewal application and issued requests for additional information (RAI) by letter dated December 22, 2004, June 24, 2005, November 8, 2005, and February 28, 2006. The MIT provided responses dated March 30, September 28, November 30, and December 21, 2005, and January 9 and March 20, 2006.

In addition to the SNM license, other licenses have been issued to the MIT by the NRC. While these licenses are not the subject of this renewal, some of the information is relevant because SNM material may be stored or used in the MIT reactor facility. The MIT's reactor is licensed as Facility Operating License R-37 under the 10 CFR Part 50 regulations for research and test reactors (also called non-power reactors). The NRC staff reviewed parts of the MIT's Facility Operating License R-37 for consistency with the provisions and conditions of SNM-986, as well as the Physical Security Plan (PSP) approved for R-37. Another MIT license, Broadscope Materials License Number 20-01537-02, was transferred to the Commonwealth of Massachusetts when the state became an Agreement State on March 21, 1997. Subsequently, License 20-01537-02 was terminated and the Commonwealth of Massachusetts issued a new broadscope license to the MIT.

SCOPE OF REVIEW

The safety review of the MIT's renewal application included a review of the application dated April 29, 2004, and the RAI responses dated March 30, September 28, November 30, and December 21, 2005, and January 9 and March 20, 2006, as well as the licensee's compliance history. The review included an evaluation of the applicant's organization and radiation safety, security, and nuclear criticality safety programs.

DISCUSSION

The following sections contain a description of the possession limits, authorized activities, place of use, organization, technical qualifications, training, radiation safety, calibration, effluent control, criticality safety, environmental protection, emergency planning, material control and security, financial assurance, and compliance history.

Possession Limits

The maximum quantity of SNM that may be possessed and used is identified by isotope, enrichment, chemical and physical form, and mass in grams. Table 1 of this SER lists the maximum quantities of SNM that may be possessed by the MIT under the license, SNM-986. In their September 28, 2005, response, the MIT provided an amendment to specify the quantity of uranium enriched [ ] U-235 isotope in the form of unclad metal or UO_2. In addition, in their March 20, 2006, response, the MIT amended Section 1.7 of the renewal application and provided a tabulation of the current storage and use of licensed material at their authorized places of use. The information from these submittals has been incorporated into Table 1 of this SER.

Table 1. Possession Limits

Material	Form	Quantity
A. Uranium enriched to in the U-235 isotope	A. UO_2 pellets, clad in steel, aluminum, or zircaloy	A.
B. Uranium enriched to in the U-235 isotope	B. Metal or UO_2, slugs, foils, pellets and other shapes, clad	B.
C. Uranium enriched to in the U-235 isotope	C. Metal or UO_2, solid slugs, foils, pellets and other shapes, unclad	C.
D. Uranium enriched to in the U-235 isotope	D. Metal, UO_2 & other compounds and alloys, solid slugs, foils, fission chambers, pellets, and other shapes clad and unclad, as laboratory solids and solutions	D.

E. Plutonium	E. Pu-Be neutron source and Pu-Al neutron filter	E.
F. Plutonium	F. Solid alpha source	F.
G. Plutonium	G. Solid, foils, pellets	G.
H. Natural uranium	H. Solid and solution	H.
I. Depleted uranium	I. Any	I.
J. Any byproduct material unseparated contained in any of the above	J. Unseparated	J.
K. U-233	K. Solid	K.
L. Plutonium	L. Any	L.

The NRC staff note that in the license renewal, the MIT designates Materials A, B, C, G and K and a portion of Materials E, H, and I as possessed for storage only.

<u>Authorized Activities and Place of Use</u>

The MIT uses SNM for research and training at various campus locations. The SNM and source material shall only be used at the following locations: the MIT Campus and MIT reactor, Cambridge MA; the Bates Linear Accelerator, Middleton MA; and, the Lincoln Laboratory, Lexington MA.

Activities for which the licensed material is used are described in Section 1.7 of the license renewal application, as revised March 20, 2006. These activities include the following:

1. Alpha sources: Electrodeposited plutonium alpha sources [Material F] are used on the MIT campus and at the Bates Linear Accelerator in the routine calibration of alpha detection devices used in health physics monitoring and radiation safety.

2. Use in fission chambers: [ ] U-235 [Material D] is used for detection and measurement of neutrons generated in the MIT Reactor or Plasma Science and Fusion Center (PSFC) (an on-campus building). There are currently 12 fission chambers at the PSFC containing [ ].

3. Use of neutrons generated by SNM: Plutonium-beryllium encapsulated neutron sources [Material E] are used for calibration of neutron monitoring devices and for research purposes at the MIT reactor facility. Calibrations of neutron monitoring devices are also performed at the PSFC and the Bates Linear Acclerator. All calibrations are performed under the supervision of the radiation protection programs.

4. Filtering of neutron beams: Several types of neutron spectrometers are used for teaching and research on the MIT reactor. Tailoring of the neutron energy spectrum in the beams for neutron spectrometers is sometimes desirable, and one method for accomplishing this is by means of selective absorption of neutrons at the 0.3 eV resonance of Pu-239 by means of filters, three of which are possessed under this license [Material E].

5. Laboratory solids and solutions: Enriched, natural, and depleted uranium and plutonium are used in various forms, both solid and liquid [Materials D, H, I and L]. Depleted or enriched uranium and plutonium are used as "spikes" for calibrating analyses of geological specimens. Migration of uranium and plutonium in soil with regards to decontamination of contaminated sites has been studied. Identification and characterization of unknowns in soils requires the use of uranium and plutonium standards. Research and teaching uses involving small quantities [ ] of SNM [ ] are reviewed by the Radiation Protection Program health physics staff and reviewed and authorized by the MIT Radiation Protection Committee.

<u>Possession of Licensed Materials for Storage Only</u>

In addition to the activities described in Section 1.7 of the license renewal, the MIT has designated several of the licensed materials for storage only (specified in the renewal, as revised March 20, 2006). These materials, and the quantity designated as storage only, are identified in Table 2 of this SER.

Table 2. Materials Designated for Storage Only

Material	Quantity Designated as Storage Only
A. Uranium enriched to in the U-235 isotope	A.
B. Uranium enriched to in the U-235 isotope	B.
C. Uranium enriched to in the U-235 isotope	C.
E. Plutonium	E.
G. Plutonium	G.

H. Natural uranium	H.
I. Depleted uranium	I.
K. U-233	K.

<u>Organization</u>

Figure I.2-1 of the application illustrates the lines of responsibility and authority for possession and use of radioactive material under SNM-986. Key positions include the Director of Environmental Health and Safety (EHS), the Campus Radiation Protection Officer (RPO), the MIT Reactor Radiation Protection Officer (MITR-RPO), the Criticality Officer in the Nuclear Reactor Laboratory (NRL), and the Accountability Officer in the NRL. These are separate functions held by separate individuals. The following describes these functions and responsibilities.

The Campus RPO, who functions under the supervision of the EHS, is responsible for providing advisory and technical services necessary for the implementation of the MIT's Radiation Protection Programs for both ionizing and non-ionizing radiation, including those sources held under this license and including the reactor. The Campus RPO is also responsible for all byproduct material not held under the R-37 license. The MITR-RPO, is also under the supervision of the Director of EHS, and is responsible for the radiation protection program at the reactor site. The MITR-RPO does not report to the Director of Reactor Operations, indicating that the responsibility for radiation protection is separate from the responsibility for utilization of radioactive materials. The primary responsibility for safety is assigned to the Department, Laboratory, or Center's heads and their supervisory personnel or principal investigator. As indicated in Figure I.2-1 of the renewal, the responsibility for radiation protection is entirely separate from that of the utilization of licensed materials.

The Criticality Officer in the NRL is responsible for providing advisory and technical services with regard to the use, storage, and shipping of SNM where criticality considerations are involved. The Accountability Officer in the NRL provides an accounting for all source material and SNM. The Campus RPO is accountable for all radioactive material except that held under the R-37 license.

Two committees have the responsibility for the safety review of the SNM. The Reactor Safeguards Committee (RSC) is responsible for the nuclear safety of the MIT Research Reactor. This Committee has the responsibility for safety reviews of all utilization of materials under the SNM license when the material is used on the reactor or its use or storage within the reactor restricted area presents safety considerations with regard to the reactor. The Radiation Protection Committee (RPC) is responsible for the establishment and continuing review of the radiation protection program at the Institute and its off-campus sites. The RPC is also responsible for the Institute's compliance with radiation protection regulations required by state, federal, and local agencies.

Technical Qualifications

Based on staff review of the commitments in Section 2.5 of the renewal application titled "Personnel Education and Experience Requirements," the NRC staff agrees that the MIT has identified the necessary technical staff, with the proper qualifications, to administer an effective and safe radiological safety program.

Personnel Training

Licensed personnel at the reactor shall be trained and retrained in accordance with the MIT Reactor Procedure Manual, Qualification and Requalification Program. The manual outlines procedures for qualification and re-qualification of operators and supervisors. The qualification procedures require personnel to perform practical factors and take written exams. The MIT Procedure Manual also contains instructions for the qualification of personnel who may require a different level of access to material. Refresher training is provided to the Health Physics staff every two years and the records for this training are kept for at least five years. The licensee's personnel training program is sufficient to maintain the knowledge and skills necessary to operate and maintain the facility in a safe manner.

Radiation Safety

As Low as Reasonably Achievable (ALARA) Program

The MIT has committed to developing written operating procedures, policies, and instructions to ensure that occupational radiation exposures are maintained ALARA. The MIT ALARA Program includes a formal annual review of the radiation protection program for adherence to the ALARA concept, as well as, quarterly reviews of occupational radiation exposures by the RPC to determine that the doses are ALARA. The licensee's ALARA program is considered adequate.

Control of Personnel Exposure

The MIT has committed to performing personnel monitoring in compliance with 10 CFR 20.1502. The MIT uses personal dosimeters, supplied by an outside vendor, that holds current National Voluntary Laboratory Accreditation Program accreditation. Dosimeters are changed out quarterly. To reduce the likelihood of internal exposure, eating and drinking are prohibited in areas where unencapsulated radioactive material is used, and smoking is prohibited in all buildings. The licensee's program to ensure that personnel radiation exposures are minimized is considered adequate.

Control of Contamination

Persons using radioactive material are responsible for routine surveys to detect excessive contamination or radiation. The area where radioactive materials are stored and handled has been designated as a "controlled area." Persons that have access to controlled areas must be registered with the RPO. All personnel, packages, and equipment leaving the reactor building must be monitored for residual activity and/or contamination. The RPO determines when it is necessary to wear protective clothing in order to prevent contamination. The licensee's program for controlling contamination is sufficient to ensure safe operations.

Calibration of Instruments

Portable survey instruments are calibrated according to criteria outlined in internal procedures. Records of these calibrations are maintained for at least three years. Survey instruments for contamination are equipped with check-sources for operational checks prior to each use. The licensee's program and procedures for calibration is sufficient to ensure reliable operation of survey instruments.

Effluent Control

All solid SNM wastes are retained and all liquid SNM wastes are converted to solids. Both solid and liquid wastes are transferred to an authorized recipient for disposal. Solid and liquid source material wastes are disposed of as SNM waste, except for those small quantities of liquid wastes which are discharged to the sanitary sewer in accordance with 10 CFR 20.2003.

Air effluent from the licensed material located in the reactor area is controlled under Facility Operating License R-37. Air effluent from non-reactor activities to unrestricted areas is limited such that the 24-hour average airborne concentration of radioactive material entering the ventilation duct of each laboratory does not exceed the limits of Appendix B, Table II, of 10 CFR Part 20. In accordance with the operating procedures described in Section 3.2.2, of the license renewal, proposals from experimenters include provisions for effluent controls and the provisions are reviewed by the RPC or the RSC. The NRC staff has determined that this commitment to the control of gaseous effluents, and the provision for review in accordance with the operating procedure, is adequate to maintain effluents within regulatory limits.

Security and Material Control Accounting

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] Section 4.2.8 of the renewal application titled "Security" commits to maintain and implement all provisions of the NRC-approved PSP, including changes made pursuant to 10 CFR 50.54(p) and 70.32(e). The MIT has a PSP under Operating License R-37. In Section 2.2 of the License Application titled "Organizational Responsibilities and Authority," the MIT also states

that the Accountability Officer in the NRL is responsible for providing an accounting (at least annually) of all SNM held under materials license SNM-986.

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To ensure that the physical protection requirements continue to be implemented, the staff recommends the following license condition:

As it pertains to License SNM-986 [

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the licensee shall fully implement and maintain in effect all provisions of the Physical Security Plan, entitled "Physical Security Plan for the MIT Research Reactor Facility," approved by the Commission under License No. R-37; and as it may be further revised in accordance with the provisions of 10 CFR 50.54(p) and 10 CFR 70.32(e).

<u>Nuclear Criticality Safety (NCS)</u>

Under SNM License No. 986, the MIT is authorized to use SNM at the following three campuses: (1) the MIT Campus and MIT Research Reactor, Cambridge, MA; (2) Bates Linear Accelerator, Middleton, MA; and (3) Lincoln Laboratory, Lexington, MA. For all three campuses, with the exception of the restricted area for the MIT Research Reactor, the quantities of SNM are limited to less than the minimum required to form a critical mass independent of the degree of water moderation and/or water reflection. With this limitation on the distribution of SNM, the requested safety controls outside the reactor restricted area need only provide assurance that the limits of 10 CFR 70.24(a) are not exceeded. To ensure NCS inside the reactor restricted area, the licensee uses administrative procedures and engineered controls.

The RSC is responsible for safety reviews, including nuclear criticality safety, of all SNM used in the reactor restricted area. The RSC also reviews and approves all new or significantly modified operating plans and policies and all new experiments involving significant changes in

procedure. The Criticality Officer (CO) is responsible for the nuclear criticality safety of all use and storage of SNM within the restricted area boundary at the reactor site. The CO provides advisory and technical reviews regarding the use, storage, and shipping of SNM where criticality considerations are involved. In addition to a degree in engineering or the physical sciences from an accredited college or university, the CO must have at least 3 years of nuclear safety experience including 1 year of experience in outside-of-reactor nuclear criticality safety. At least one member of the RSC will be qualified to review NCS evaluations by meeting the minimum requirements of the CO. The responsibility for ensuring that the quantity of SNM does not exceed the limits specified in 10 CFR 70.24(a), in any building outside the reactor restricted area resides with the Accountability Officer. The staff has reviewed the NCS organizational structure and finds that it is acceptable because NCS evaluations are performed by a qualified reviewer and the independent review of NCS evaluations by the RSC ensures quality assurance.

The MIT's audit program includes an annual independent audit of operating records, an annual physical inventory of all SNM, and a quarterly administrative audit. The criticality safety independent audit is performed by a designated Senior Reactor Operator or an equivalent Director of Reactor Operations designee. During the annual physical inventory of all SNM required by the license, the licensee performs an inspection to assure that labeling, posting, and criticality requirements are met. The quarterly administrative audit is performed by the Director of Reactor Operations and/or Reactor Superintendent and includes the nuclear criticality safety of SNM in use and in storage at the reactor site. The staff reviewed the MIT audit program as it relates to nuclear criticality safety and concludes that the program is adequate because elements of the NCS program are reviewed on a timely basis, thereby identifying potential problems before they occur.

The MIT's approach to criticality safety is based on the double contingency policy, which states that storage and experiments shall incorporate sufficient margins of safety so that two unlikely, independent, and concurrent changes in conditions are required before a criticality accident is possible. The maximum quantity of SNM that may be possessed and used is identified by isotope, enrichment, chemical and physical forms, and mass in the license (Materials 'A' through 'L') and was reviewed by the NRC staff to determine whether there was an NCS concern.. [

] The quantity of SNM in any building outside the reactor restricted area (Materials 'E' through 'L') is less than the minimum required to form a critical mass independent of the degree of water moderation and/or water reflection. Based on the type, form, and/or quantity of material, the NRC staff concluded that Materials 'D' through 'L' does not present NCS concerns. [ ]

The authorized activities inside the reactor restricted area [

] include: thermal-to-fast-flux converters, thermal physics experiments and storage of SNM. The fast flux facilities described in previous license applications have been dismantled and the material is stored and

awaiting disposition with the Department of Energy. However, the staff reviewed the technical requirements contained in the license application for a thermal-to-fast flux converter. NCS is provided for a thermal-to-fast flux converter that uses the reactor as the thermal neutron source by: (1) maintaining a specified configuration such that the k_{eff} will remain less than 0.7 under all conditions (including flooding) and (2) implementing controls to preclude flooding (i.e., there is no sprinkler system). Also, any flux converter will be used in fixed positions in the reactor with 12-inch spacing to provide isolation in the event of flooding. The staff reviewed the safety analysis for the thermal-to-fast flux converters and concluded that adequate protection is provided to ensure that the double contingency principle will be fulfilled and that these operations may be performed safely. However, if the MIT should wish to pursue consideration of a new fast flux facility [ ], additional review and information will be required.

The licensee has specified NCS limits, contained in Table I.4-1 of the license application, which are less than the minimum quantity of U-235 required for a criticality event with the assumption of optimum moderation and full reflection, for the storage of low-enriched uranium and UO_2 fuel rods [ ]. The staff reviewed the safety analysis for the storage of this material and concluded that these MIT established limits are acceptable because the storage configuration should remain subcritical under both normal and credible abnormal conditions.

[ ] SNM possessed under the license, source and byproduct materials can be stored in separate trays or shipping containers, in storage vaults up to a limit of 350 grams U-235 per tray or container, provided that 12-inch spacing is maintained. The mass limit of 350 grams and the restriction of water entering the vault provides acceptable NCS controls. [ ] remain subcritical (k_{eff} less than 0.85) under normal and abnormal conditions. The staff reviewed the safety analysis for the storage of additional SNM, source and byproduct materials and unirradiated reactor fuel and concluded by restricting water from entering the storage vault and limiting the mass, that storage of these materials can be performed safely.

Based on the review as described above, the NRC staff concludes that there is reasonable assurance that the MIT's NCS program is adequate to assure the safety of the requested SNM handling and storage activities and that the regulatory requirements are met.

<u>Environmental Protection</u>

The staff has determined that the renewal of MIT's license will not adversely affect the public health and safety or the environment. In accordance with 10 CFR 51.22(c)(14)(v), which authorizes a categorical exclusion for the renewal of material licenses, pursuant to 10 CFR Part 70 for the use of radioactive materials for research and development and for educational purposes, neither an Environmental Impact Statement nor an Environmental Assessment is warranted for this action.

Emergency Planning

This license does not authorize the licensee to possess the types and quantities of materials specified in 10 CFR 70.22(l)(1), therefore, the licensee is not required to have an emergency plan. However, the MIT has an emergency plan for the research reactor that includes SNM-986. In addition, the MIT limits the amount of SNM that is possessed outside of the reactor area to sub-critical amounts. For material contained outside of the reactor area, the licensee does have an emergency procedure in place that outlines the steps to be taken in the event of accidents involving radioactive contamination or exposure of personnel. The licensee has established adequate emergency management procedures to protect workers, the public, and the environment.

Decommissioning

10 CFR 70.25(d) prescribes the required amounts of financial assurance for decommissioning by quantity of material. Of the maximum quantities of SNM that may be possessed by the MIT under the license, unsealed forms [ ] are equivalent to 1 x 10^3 microcuries of U-235. This quantity corresponds to the category in 10 CFR 70.25(d) of greater than 10^4 but less than or equal to 10^5 times the applicable quantities of Appendix B to Part 30, with the prescribed amount of financial assurance for decommissioning of $1.125 million.

The licensee submitted a Certification of Financial Assurance (dated November 30, 2005) and an Amended Escrow Agreement (dated November 30, 2005). The NRC staff reviewed these documents. The amended escrow agreement provides $1.125 million for decommissioning facilities under SNM-986. The staff notes that the escrow agreement includes $20 million for decommissioning the research reactor licensed to the MIT, but the reactor cost estimate was not reviewed as part of this action. The amended escrow agreement and certification statement conform to the NRC regulations and regulatory guidance and are acceptable.

Compliance History

The licensee's inspection and enforcement records since the last renewal was reviewed and discussed with Region I. Region I did not express concerns from an inspection and enforcement perspective and, therefore, has no objection to the issuance of the renewal.

CONCLUSION

Upon completion of the safety review of the licensee's application and discussion with the Region I inspector regarding the licensee's compliance history, the staff has concluded that the licensee has the necessary technical staff to administer an effective radiological safety program. Conformance by the licensee to their proposed conditions, as well as those developed by the staff, does ensure that the licensed activities will not constitute an undue risk to the health and safety of the public or the environment.

Based on the discussion above, it is recommended that the license be renewed for a 10-year period in accordance with the application and subject to the recommended conditions.

Region I concurs with this recommendation.

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