



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

March 18, 2021

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

SUBJECT: MASSACHUSETTS INSTITUTE OF TECHNOLOGY – REQUEST FOR
ADDITIONAL INFORMATION RE: LICENSE AMENDMENT REQUEST TO
REPLACE EMERGENCY POWER SYSTEM BATTERIES
(EPID: L-2021-NFA-0000)

Dear Mr. Foster:

By letter dated March 2, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21070A185), Massachusetts Institute of Technology applied for a license amendment to Facility Operating License No. R-37 for the Massachusetts Institute of Technology Reactor. The requested licensing action would allow replacement of the existing emergency power system vented lead-acid batteries with new valve regulated lead-acid batteries, associated charger, and monitoring system. The license amendment would also revise technical specification 4.6, "Emergency Electrical Power Systems."

The U.S. Nuclear Regulatory Commission (NRC) staff identified additional information needed to continue its review of the license amendment request (LAR), as described in the enclosed request for additional information (RAI). As discussed by telephone on March 16, 2021, provide a response to the RAI or a written request for additional time to respond, including the proposed response date and a brief explanation of the reason, by April 2, 2021. Following receipt of the complete response to the RAI, the NRC staff will continue its review of the LAR.

The response to the RAI must be submitted in accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.4, "Written communications," and pursuant to 10 CFR 50.30(b), "Oath or affirmation," be executed in a signed original document under oath or affirmation. Information included in the response that you consider sensitive or proprietary, and seek to have withheld from public disclosure, must be marked in accordance with 10 CFR 2.390, "Public inspections, exemptions, requests for withholding." Any information related to safeguards should be submitted in accordance with 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements."

Based on the response date provided above, the NRC staff expects to complete its review and make a final determination on the LAR by April 28, 2021. This date could change due to several factors including a need for further requests for additional information, unanticipated changes to the scope of the review, unsolicited supplements to the LAR, and others.

If the forecasted date changes, the NRC staff will notify you in writing of the new date and an explanation of the reason for the change. In the case that the NRC staff requires additional information beyond that provided in the response to this RAI, the NRC staff will request that information by separate correspondence.

If you have any questions regarding the NRC staff's review or if you intend to request additional time to respond, please contact me at (301) 415-3936, or by electronic mail at Patrick.Boyle@nrc.gov.

Sincerely,

/RA/

Patrick G. Boyle, Project Manager
Non-Power Production and Utilization Facility
Licensing 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

Ms. Samantha Phillips, Director
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

Mr. Marshall B. Wade
Interim Reactor Superintendent
Massachusetts Institute of Technology
Nuclear Reactor Laboratory
Research Reactor
138 Albany Street, MS NW12-116B
Cambridge, MA 02139

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(EPID: L-2021-NFA-0000) DATED: MARCH 18, 2021

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ADAMS Accession No. ML21076A023

NRR-088

OFFICE	NRR/DANU/UNPL/PM	NRR/DANU/UNPL/LA	NRR/DANU/UNPL/BC
NAME	PBoyle	NParker	DHardesty
DATE	3/17/2021	3/18/2021	3/18/2021

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OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ADDITIONAL INFORMATION

REGARDING AMENDMENT TO REPLACE EMERGENCY POWER SYSTEM BATTERIES

RENEWED FACILITY OPERATING LICENSE NO. R-37

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY REACTOR

DOCKET NO. 50-020

The U.S. Nuclear Regulatory Commission (NRC) staff is continuing its review of the Massachusetts Institute of Technology (MIT, the licensee) license amendment request (LAR), provided by letter dated March 2, 2021 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML21070A185), to modify renewed Facility Operating License No. R-37 supporting technical specifications (TSs) to permit replacement of the existing emergency power system vented lead-acid (VLA) batteries with new valve-regulated lead-acid (VRLA) batteries, associated charger, and monitoring system. These requests for additional information (RAIs) have been developed based on the following requirements and guidance applicable to the LAR.

- NUREG-1537 Part 1, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Format and Content," issued February 1996 (ADAMS Accession No. ML042430055)
- NUREG-1537 Part 2, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors, Standard Review Plan and Acceptance Criteria," issued February 1996 (ADAMS Accession No. ML042430048)
- Institute of Electrical and Electronics Engineers (IEEE) Standard (Std.) 1188, "IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications"
- IEEE Std. 1187, "IEEE Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications"
- IEEE Std. 485, "IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications"
- American National Standard Institute/American Nuclear Society-15.1-2007, "The Development of Technical Specifications for Research Reactors"

As a result of the licensee's request to amend its TSs, the NRC staff performed a review of the proposed TSs using the guidance in NUREG-1537, Part 2 and identified the following RAIs.

In NUREG-1537, Part 2, Chapter 8, "Electrical Power Systems," Section 8.2, "Emergency Electrical Power Systems," the acceptance criteria related to the information on emergency electrical power systems at non-power reactors include the following:

Enclosure

- The functional characteristics of the emergency power system should be commensurate with the design bases, which are derived from analyses presented in other chapters of the safety analysis report (SAR). In general, the minimum requirement of an emergency electrical power system should ensure and maintain safe facility shutdown and to prevent uncontrolled release of radioactive material.
- The source of electrical power (generator, batteries, etc.) should be capable of supplying power for the duration required by the SAR analysis.
- The system should be designed for either automatic or manual startup and switchover.
- The emergency electrical power system should not interfere with or prevent safe facility shutdown.
- Malfunctions of the emergency electrical power system during reactor operation with normal electrical power should not interfere with normal reactor operation or prevent safe facility shutdown.
- Any non-safety-related uses of an emergency electrical power system should not interfere with performance of its safety-related functions.
- TSs should be based on the accident analyses, should include surveillance and testing, and should provide reasonable assurance of emergency electrical power system operability. The discussions in the SAR should identify the minimum design requirements, the minimum equipment required, and the power and duration of operation required.

In the enclosure to letter dated March 2, 2021, TS 4.6, "Objective," states: "To ensure that the emergency electrical power supply is maintained and tested in accordance with accepted standards."

RAIs

1. The LAR states: "They [the batteries] are designed for a performance life of 20 years (7 years full warranty, with 20 years prorated warranty)."
 - a. What is the expected service life of the batteries at MIT?
 - b. What is technical basis for the service life and criteria for replacement of the batteries? IEEE Std. 1188, Section 8, discusses battery replacement criteria.
 - c. Provide reliability information on the absorbent glass mat batteries (e.g., test data, including the test conditions and quality assurance) to justify the expected life of the batteries (i.e., a warranty is not a guarantee of performance, it is a financial agreement).
2. The acceptance criteria outlined in NUREG-1537, Part 2 states that the source of electrical power (i.e., batteries) should be capable of supplying power for the duration required by the SAR analysis. The licensee provides a discussion in the LAR regarding sizing of the batteries, and states that the manufacturer estimates that the proposed battery system exceeds the capacity of the existing battery by 133.88 percent, by incorporating aging and design growth factors.

- a. Indicate the sizing methodology used by the manufacturer and clarify whether the methodology outlined in IEEE Std. 485, was used.
 - b. Page 6 of the LAR Safety Review #2020-32, provides a table on the total battery current output and states that the equipment on emergency power is not limited to the items listed in TS Table 3.6-1. Provide all the expected loads on the battery and differentiate between continuous or momentary loads. One option is to provide a duty cycle diagram (if non-continuous loads are involved), depicting the sequence of loads the battery system is expected to supply for the specified time periods, as shown in IEEE Std. 485, Figure 2. If the batteries will only be subject to continuous loads, provide a statement as such.
3. The licensee refers to the C&D Technologies msEndur II “Installation and Operating Manual” in the LAR but does not provide specifics on installation. IEEE Std. 1187, addresses installation design criteria and procedures.
- a. What is the basis for the installation design and actual installation of these batteries (e.g., IEEE Std. 1187)?
 - b. If not conforming to IEEE Std. 1187, discuss how ventilation for temperature and hydrogen control have been addressed (e.g., adequate air flow for proper cooling (for both aging and capacity) and adequate ventilation to prevent the accumulation of hydrogen above combustible limits (i.e., 4 percent concentration). Information on ventilation is discussed in IEEE Std. 1187 Section 5.4. In addition, discuss the types of battery protection being applied (i.e., fuses, circuit breakers, etc.). IEEE Std. 1187, Section 5.8 outlines battery protection. Lastly, discuss any instrumentation, controls, and alarms that will be available for the battery system to ensure the battery remains capable during its service life. IEEE Std. 1187, Section 5.5, includes information on instrumentations, controls, and alarms.
4. VRLA batteries are more sensitive to temperature variations than the VLA batteries. VRLA batteries are more sensitive to the conditions that lead to thermal runaway, which could potentially shorten battery life. Additional information on thermal runaway is discussed in Annex B of IEEE Std. 1187 and Annex C of IEEE Std. 1188. The possibility of thermal runaway may be minimized by use of appropriate ventilation between and around the cells and by limiting the charger output current and voltage by using temperature-compensated chargers. The likelihood of thermal runaway can be minimized through periodic inspections and the use of temperature-compensated charging (or other charge-current-limiting methods). Address how thermal runaway is minimized; for example, is there routine temperature monitoring and monitoring of float current with the intent to minimize this concern?
5. The licensee references IEEE Std. 1188 in the LAR and states that the discharge test will continue to be performed consistent with IEEE Std. 1188, Section 6.3.
- a. If the licensee is conforming in full with IEEE Std. 1188 for maintenance, testing, and replacement, state as such.
 - b. If the licensee is not fully conforming to IEEE Std. 1188, discuss why the monthly and quarterly, maintenance activities per IEEE Std. 1188, Section 5.2, are not addressed to ensure capability and consideration for determining battery replacement. Specifically, certain monthly (e.g., overall float voltage, charger

output & current, ambient temperature), quarterly (e.g., cell/unit internal ohmic values, voltage of each cell/unit), and yearly (e.g., AC ripple current and/or voltage applied) are not addressed in the LAR. IEEE Std. 1188 recommends measuring voltage of each cell/unit quarterly and the LAR indicates the licensee will be measuring it semi-annually. In addition, if test results are not within the acceptance limits, what corrective actions are taken? For example, IEEE Std. 1188, Section 5.3 addresses immediate and routine corrective actions.

6. The LAR describes proposed revisions to TS 4.6. The proposed TS surveillance requirement states that a will be performed and revise the TS and/or SAR accordingly or explain why the discharge test is performed once every two years. It is not clear if the discharge test is a performance test, service test, or modified performance test. The modified performance test envelops both a performance test (i.e., for capacity) and service test (i.e., for capability). Clarify whether 1) a performance test and service test or 2) a modified performance test, TS is appropriate to ensure the quality of the emergency power system batteries, associated charger, and monitoring system.
7. Provide a revised SAR markup for Chapter 8, including, but not limited to, addressing the service life and battery rating as well describing the charging and monitoring system related to the batteries in Section 8.2.2 (or other appropriate section) of the SAR.