



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

March 12, 2018

Dr. Lin-wen Hu, Director  
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Mr. Alberto Queirolo, Director  
of Reactor Operations  
Massachusetts Institute of Technology  
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SUBJECT: MASSACHUSETTS INSTITUTE OF TECHNOLOGY – RESPONSE TO  
REQUEST FOR REVIEW OF LOW-ENRICHED URANIUM CONVERSION  
PRELIMINARY SAFETY ANALYSIS REPORT FOR THE MASSACHUSETTS  
INSTITUTE OF TECHNOLOGY RESEARCH REACTOR  
(EPID: L-2017-LLA-0445)

Dear Dr. Hu and Mr. Queirolo:

By letter dated December 6, 2017 (Agencywide Documents Access and Management System Accession No. ML17345A518), Massachusetts Institute of Technology (MIT) staff submitted a preliminary safety analysis report (PSAR) for the conversion of the MIT reactor (MITR-II) from highly enriched uranium (HEU) to low-enriched uranium (LEU) fuel to the U.S. Nuclear Regulatory Commission (NRC) staff for review and comment. This letter provides the results of the NRC staff's initial review, which was performed to determine if there is sufficient technical information in scope and depth to allow the NRC staff to begin its detailed review. As noted in the letter from the MIT staff, the LEU fuel has not been approved for use, and MIT is not prepared to convert from HEU to LEU fuel at this time. As such, no licensing action is being requested by MIT at this time.

The NRC staff has determined that the submitted PSAR does not contain sufficient information to conduct its detailed review. The enclosed document identifies the information needed by the NRC staff to conduct its review. NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," Parts 1 and 2, Chapter 18, "Highly Enriched to Low-Enriched Conversions," will be utilized in the conduct of the review. As such, if MIT staff determines a need to deviate from the guidance, the need to deviate and its relevant nexus to safety must be clearly articulated in order for the NRC staff to conduct its review.

In response to the NRC staff initial review, MIT may augment or withdraw and resubmit revised documents for the NRC staff to conduct its safety evaluation of converting the MITR-II from HEU to LEU fuel.

If you have any questions please contact me at 301-415-3936 or by electronic mail at [Patrick.Boyle@nrc.gov](mailto:Patrick.Boyle@nrc.gov).

Sincerely,

**/RA/**

Patrick G. Boyle, Project Manager  
Research and Test Reactors Licensing Branch  
Division of Licensing Projects  
Office of Nuclear Reactor Regulation

Docket No. 50-20  
License No. R-37

Enclosure:  
As stated

cc: w/enclosure: See next page

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(EPID: L-2017-LLA-0445) DATE: MARCH 12, 2018

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NRR-106

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OFFICE OF NUCLEAR REACTOR REGULATION  
ACCEPTANCE REVIEW OF THE  
LOW-ENRICHED URANIUM CONVERSION  
PRELIMINARY SAFETY ANALYSIS REPORT  
FOR THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY REACTOR  
LICENSE NO. R-37; DOCKET NO. 50-20

By letter dated December 6, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17345A518), the Massachusetts Institute of Technology (MIT, the licensee) submitted a preliminary safety analysis report (PSAR) for the conversion of the MIT reactor (MITR-II) from highly enriched uranium (HEU) to low-enriched uranium (LEU) reactor fuel.

The U.S. Nuclear Regulatory Commission (NRC) staff performed a sufficiency review of the submitted information and compared it to the guidance provided in NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," Parts 1 and 2, Chapter 18, "Highly Enriched to Low-Enriched Conversions." The purpose of the review was to determine if sufficient information was provided for the NRC staff to begin its safety evaluation (SE) of the proposed fuel conversion. The NRC staff recognizes that MIT is not prepared to convert the MITR-II at this time, so the purpose of preparing an SE would be to document the review of the existing information to support a conversion effort to be requested in the future.

Based on its review of the submitted information, the NRC staff has determined that supplemental information is needed to proceed with the preparation of an SE. These information needs were discussed with MIT staff during a telephone conversation on January 19, 2018. In order for the NRC staff to review the LEU conversion PSAR, the information deficiencies identified must be addressed, as described below.

- 1) MIT's submitted PSAR contained revision lines; however, it did not present a discussion of the changes made to the PSAR. Unlike the facility operating license and associated technical specifications, the NRC does not maintain a reviewed and controlled copy of the current safety analysis report (SAR). As a result it is not possible for the NRC staff to compare the submitted version of the PSAR to MIT's current SAR, since the current version of the SAR has not been provided to the NRC staff. Therefore, the technical basis for each change to the PSAR should be provided.
- 2) In the cover letter dated December 6, 2017 (ADAMS Accession Number ML17345A516) MIT stated that "[t]he emphasis in any conversion SAR is to explain the differences between the LEU and HEU cores and to show the acceptability of the new design ..." NUREG-1537, Part 1, Chapter 18 states that the differences of the capacities between the proposed LEU core and the current operational HEU core should be described. Contrary to the statement in the cover letter and inconsistent with the guidance document, the revised PSAR does not describe the differences between the HEU and LEU fueled cores.

Enclosure

Therefore, a comparison of the parameters for the current operating HEU core to the proposed LEU core should be provided. Included with this should be a validation of the accuracy of the calculated results for the LEU core, comparing the HEU core analysis results to the measured parameters of the operating HEU core (e.g., control rod reactivity worth curves).

- 3) The NRC staff is utilizing NUREG-1537, Parts 1 and 2 for its review of the submitted material. NUREG-1537, Part 2, is a document that provides guidance for the NRC staff to conduct its review and support regulatory findings. To facilitate the use of NUREG-1537 in its review, the NRC staff recommends that licensees follow the format and content guide provided in NUREG-1537, Part 1. The NRC staff will then compare the licensee's analysis to the acceptance criteria in Part 2 of NUREG-1537.

For example, MIT could use the following guidance in NUREG-1537, Part 1, Chapter 18, Appendix 18.1, Section 4.2.1, "Fuel Elements," which states:

The LEU fuel elements should be compared to the HEU fuel elements. Any changes resulting from the lower enrichment and possible higher uranium concentration in the LEU elements should be included. The licensee should discuss in detail the mechanical design of the fuel element, volume ratios of fuel to moderator and fuel to coolant, uranium burnup, fission product barrier (cladding) and retention capabilities, and thermal capabilities and characteristics of fueled components. Dimensions such as water gap thickness and fuel element spacing also should be given. If applicable, control and dummy elements should be described.

The NRC staff would then evaluate the information provided against the corresponding section in NUREG-1537, Part 2, Chapter 18, Appendix 18.1, Section 4.2.1, "Fuel Elements," which states:

The areas of review for the fuel elements should include a detailed comparison of the HEU and LEU elements. All changes in enrichment should be discussed, including the effect on reactor operating characteristics and safety. The reviewer should compare the fuel plate and fuel element design bases, mechanical designs, construction materials, fuel elements, including cladding, dimensions, metallurgical features, volume ratios of fuel to moderator and fuel to coolant, thermal capabilities, and capabilities of the fuel meat to sustain uranium burnup and to retain fission products. Both standard and special fuel element design, such as control-rod elements, should be reviewed, as applicable.

By following these guidance excerpts, the safety analysis of the LEU fuel elements should include the discussion of the operating characteristics of the LEU as compared to the HEU core capabilities to be evaluated by the NRC staff.

Therefore, to facilitate the use of NUREG-1537, the NRC staff recommends that MIT prepare a revised safety analysis following the format and content specified in Chapter 18 of NUREG-1537, Part 1 with a discussion of how the analysis was performed including information such as initial conditions, assumptions, analysis methods, and correlations utilized in the analysis. Also, the revised safety analysis should identify how the results of the analysis meet the acceptance criteria in Part 2 of NUREG-1537. For any parameter or condition that does not apply to MIT's facility, the reason for excluding the information from

the safety analysis for the fuel conversion should be clearly articulated.