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

November 22, 2019

Ms. Amber Johnson, Director
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University of Maryland
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SUBJECT: UNIVERSITY OF MARYLAND – SECOND REQUEST FOR ADDITIONAL INFORMATION RE: LICENSE AMENDMENT REQUEST FOR THE USE OF 16 ADDITIONAL FUEL ELEMENTS IN THE MARYLAND UNIVERSITY TRAINING REACTOR (EPID NO. L-2018-LLA-0037)

Dear Ms. Johnson:

By letter dated January 29, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18032A096), as supplemented by letter dated March 26, 2018 (ADAMS Accession No. ML18092A086), and June 6, 2019 (ADAMS Accession No. ML19165A021), the University of Maryland submitted a request for an amendment to Renewed Facility Operating License No. R-70 for the Maryland University Training Reactor. The requested amendment would authorize the use of 16 additional fuel elements in the reactor core.

The U.S. Nuclear Regulatory Commission (NRC) staff's review of the license amendment request (LAR) identified the need for additional information, as described in the enclosed request for additional information (RAI). Within 60 days from the date of this letter, provide either a response to the RAI, or a written request for additional time to respond which includes the proposed response date and a brief explanation of the reason. Following receipt of the 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, per 10 CFR 50.30(b), "Oath or affirmation," be executed in a signed original under oath or affirmation. Information included in the response that is considered sensitive or proprietary and sought to be withheld from public disclosure, must be marked in accordance with 10 CFR 2.390, "Public inspections, exemptions, requests for withholding." Any information related to security should be submitted in accordance with 10 CFR 73.21, "Protection of Safeguards Information: Performance Requirements."

If you have any questions regarding the NRC staff's review of the LAR, or if you intend to request additional time to respond, please contact me at 301-415-3398 or by electronic mail at Cindy.Montgomery@nrc.gov.

Sincerely,

R/A

Cindy K. Montgomery, Project Manager
Non-Power Production and Utilization Facility
Licensing Branch
Division of Advanced Reactors and Non-Power
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Office of Nuclear Reactor Regulation

Docket No. 50-166
License No. R-70

Enclosure:
As stated

cc: See next page

cc:

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Test, Research and Training
Reactor Newsletter
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ADAMS Accession No. ML19312C376 ***concurrence via e-mail**

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OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ADDITIONAL INFORMATION

REGARDING AMENDMENT TO

RENEWED FACILITY OPERATING LICENSE NO. R-70

THE UNIVERSITY OF MARYLAND

MARYLAND UNIVERSITY TRAINING REACTOR

DOCKET NO. 50-166

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed University of Maryland's (UMD) license amendment request (LAR) and its request for additional information (RAI) responses dated June 6, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19165A021), for compliance with the appropriate regulations in Title 10 of the *Code of Federal Regulations* (10 CFR) using the following guidance and standard(s):

- 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)

- American National Standards Institute/American Nuclear Society, (ANSI/ANS)15.1-2007, "The Development of Technical Specifications for Research Reactors"

Based on its review, the NRC staff requires the following additional information to continue its review of the LAR.

RAI-1 The regulations in 10 CFR 50.34, "Contents of applications; technical information," paragraph (b)(2) require that the safety analysis report (SAR) include the evaluations required to show that safety functions of the structures, systems, and components (SSCs) listed in 10 CFR 50.34(b)(2)(i) will be accomplished.

The guidance in NUREG-1537, Part 1, Section 4.6, "Thermal-Hydraulic Design," states that licensees should present the information and analyses necessary to show that sufficient cooling capacity exists to prevent fuel overheating and loss of integrity for all anticipated reactor operating conditions. The licensee should address the coolant flow conditions for which the reactor is designed and licensed; a detailed description of the methods used in the thermal-hydraulic analysis should be provided.

The guidance in NUREG-1537, Part 2, Section 4.5.2, "Reactor Core Physics Parameters," states that: "The calculational assumptions and methods should be justified and traceable to their development and validation, and the results should be compared with calculations of other similar facilities and previous experimental measurements."

Additional information is needed for the NRC staff to ensure that sufficient cooling exists for the proposed core geometry to prevent the fuel from overheating. The NRC staff needs more information to understand the heat removal conditions (such as fuel surface saturation temperature, onset of nucleate boiling, departure from nucleate boiling, and/or flow instability) that provide for adequate fuel channel cooling.

In response to RAI No. 2, UMD stated that a new thermal-hydraulic analysis is unnecessary. UMD further stated that average power per element will be reduced from 2.00 kilowatts (kW) to 1.95 kW.

1. Provide the methodology used to determine average power per element for both the current and proposed core configurations.

2. Justify why the core neutronics analysis for the proposed core was performed at 250 kW even though the Reactor Power Level scram maximum setpoint is 120 percent of full power (300 kW).

3. Justify by using specific parameters (i.e., peaking factor, departure from nucleate boiling ratio, core power level, average fuel element power etc.) why the current thermal-hydraulic analysis bounds the proposed core configuration.

4. Explain and justify the influence, if any, to the neutronic and the thermal hydraulic analysis for the proposed core configuration based on UMD's recent identification of several slightly misaligned fuel bundles in the existing core. In addition, explain how UMD would verify that the proposed addition of 16 fuel elements (i.e., four fuel bundles) are fully aligned and seated properly in the grid plate.

RAI-2 The regulations in 10 CFR 50.34(b)(2) require that the SAR include the evaluations required to show that safety functions of the SSCs listed in 10 CFR 50.34(b)(2)(i) will be accomplished.

The guidance in NUREG-1537, Part 2, Section 4.5.2, states that "The calculational assumptions and methods should be justified and traceable to their development and validation, and the results should be compared with calculations of other similar facilities and previous experimental measurements. The ranges of validity and accuracy should be stated and justified."

In response to RAI No. 4, UMD performed a different method (i.e., rod drop) for measuring rod reactivity worth and concluded that these measurements better agree with the simulated values of rod worth.

Additional information is needed for the NRC staff to understand which method(s) UMD will use to measure rod reactivity worth to ensure the reactor can be shutdown with sufficient margin from any operating condition.

1. Explain which method(s) UMD plans to use to measure rod reactivity worth for initial startup of the reactor in the Startup Plan – Additional Reactor Fuel included in the LAR and during its required surveillance in technical specification (TS) 4.2.1.

2. Explain when UMD will perform the control rod reactivity worth measurements considering the fuel loading process. For example, does UMD plan to conduct

multiple control rod reactivity worth measurements as fuel is loaded into the core or perform a single measurement after all 16 elements are loaded into the core.

3. Provide a current graph and quantitative data of measured control rod reactivity worth from 2010 to 2019 (Figure 14 – Historic MUTR Control Rod Data).

RAI-3 The regulations in 10 CFR 50.34(b)(2) require that the SAR include the evaluations required to show that safety functions of the SSCs listed in 10 CFR 50.34(b)(2)(i) will be accomplished.

The guidance in NUREG-1537, Part 1, Section 13.1.2, "Insertion of Excess Reactivity," states, in part, that an insertion-of-excess-reactivity event is a ramp insertion of reactivity by drive motion of the most reactive control rod or shim rod, or ganged rods, if possible. (This event could occur during reactor startup procedures or when the reactor is at power.)

The current Maryland University Training Reactor (MUTR) TS 3.1, "Reactor Core Parameters," Specification 1, states that: "The EXCESS REACTIVITY relative to the REFERENCE CORE CONDITION, with or without experiments in place, shall not be greater than $1.12."

The LAR proposes a limiting condition for operation (LCO) for excess reactivity of not greater than $3.50.

In response to RAI No. 5, UMD stated that the rod withdrawal analysis of December 18, 2006, does not provide a bounding condition for the proposed excess reactivity LCO of $3.50. The NRC staff needs more information to ensure that peak fuel temperature remains below temperature safety limit of 1,000 degrees Celsius in TS 2.1, "Safety Limit," and that thermal-hydraulic conditions in the fuel channel remain subcooled.

1. Provide a ramp reactivity analyses, taking into consideration the proposed excess reactivity limit of $3.50, starting at both high and low power conditions for the proposed core configuration. Provide the values of maximum fuel centerline temperature and maximum power achieved for all scenarios evaluated.

2. Explain the methodology, inputs, and assumptions used in the control rod withdrawal analysis.

RAI-4 The regulations in 10 CFR 50.34(b)(2) require that the SAR include the evaluations required to show that safety functions of the SSCs listed in 10 CFR 50.34(b)(2)(i) will be accomplished.

The guidance in NUREG-1537, Part 1, Section 4.5.3, "Operating Limits," states that the licensee should present information on the amount of negative reactivity that must be available by control rod action to ensure that the reactor can be shut down safely from any operating condition and maintained in a safe shutdown state. The analyses should assume that (1) the most reactive control rod is fully withdrawn (one stuck rod), (2) non-scrammable control rods are at their most reactive position, and (3) normal electrical power is unavailable to the reactor. The licensee should discuss how shutdown margin will be verified. The analyses should include all relevant uncertainties and error limits.

Additional information is needed for the NRC staff to ensure the reactor can be shutdown with adequate margin as stated in TS 3.1 from any operating condition for the proposed core configuration.

The LAR states the following:

> Using the control rod values from Table 3, the Shutdown Margin is calculated from the total rod worth minus the most reactive rod minus the excess reactivity. An upper limit of $0.50 on the Shutdown Margin is defined in technical specification 3.1.2. Allowing for an excess reactivity of $3.50, guarantees that the shutdown margin shall always be maintained.

MUTR TS 3.1, Specification 2, states the following:

> The SHUTDOWN MARGIN shall not be less than $0.50 with:
>
> (a) The reactor in the REFERENCE CORE CONDITION; and
> (b) Total worth of all experiments in their most reactive state; and
> (c) Most reactive CONTROL ROD fully withdrawn.

1. Provide a shutdown margin determination that includes relevant uncertainties for the proposed core configuration applying the requirements of TS 3.1 Specification 2.

2. Explain the methodology used to obtain the data supporting the shutdown margin determination for the proposed core. Additionally, state any inputs or assumptions used in the shutdown margin determination.

RAI-5 The regulations in 10 CFR 50.34(b)(2) require that the SAR include the evaluations required to show that safety functions of the SSCs listed in 10 CFR 50.34(b)(2)(i) will be accomplished

The guidance in NUREG-1537, Part 1, Section 13.1.2, states, in part, that an insertion-of-excess-reactivity event can be used to show why LCO on reactivity are justified.

In the LAR, UMD applies the Fuchs-Nordheim technique to analyze a $4.00 insertion of reactivity in the proposed core configuration. The NRC staff needs more information to understand the input values to the analysis to ensure the peak fuel temperature remains below temperature safety limit of 1,000 degrees Celsius in TS 2.1.

Explain and justify each value used in the Fuchs-Nordheim technique that is used to analyze a $4.00 insertion of reactivity in the proposed core configuration.

RAI-6 The regulations in 10 CFR 50.36, “Technical specifications,” paragraph (c)(3) require TSs to contain surveillance requirements relating to test, calibration, or inspection to assure that the necessary quality of systems and components is maintained, that facility operation will be within safety limits, and that the LCO will be met.

NUREG-1537, Part 1, Appendix 14.1, Section 4.1(6) “Fuel Parameters,” states that: “For non-pulsing TRIGA reactors, the fuel should be inspected and measured on at

least a 5-year cycle. Approximately 20 percent of the fuel could be inspected and measured annually."

The NRC staff needs more information to ensure the integrity of the fuel cladding is maintained to minimize the possibility of an inadvertent release of radioactive fission products.

In response to RAI No. 5, UMD proposes a change to MUTR TS 4.1, "Reactor Core Parameters," Specification 4, to modify the fuel bundles that are inspected annually as follows:

4.1 Reactor Core Parameters

> *4. A visual inspection of 2 fuel bundles from rows B and C shall be performed annually at intervals not to exceed 15 months. The bundles inspected shall change each year so that in a 5 year period the entire group will be inspected. If any are found to be damaged, an inspection of the entire MUTR core shall be performed.*

UMD proposes that only 2 out of 28 fuel bundles which represents only 7 percent of the core be visually inspected on an annual basis.

Provide a basis for visually inspecting 2 fuel bundles on an annual basis considering that UMD is proposing to increase the total number of fuel elements from 93 to 109 with slightly irradiated fuel that has been in storage for a considerably long time.

RAI-7 The regulations in 10 CFR 50.34(b)(2) require that the SAR include the evaluations required to show that safety functions of the SSCs listed in 10 CFR 50.34(b)(2)(i) will be accomplished.

The guidance in NUREG-1537, Part 1, Section 13.1.2, states that an insertion-of-excess-reactivity event can be used to show limiting conditions for operation on reactivity are justified.

Additional information is needed for the NRC staff to ensure the reactor can be shutdown with adequate margin as required by TS 3.1 from any operating condition for the proposed core configuration.

TS 4.1, Specifications 1 and 2, state the following:

1. The EXCESS REACTIVITY shall be determined annually, at intervals not to exceed 15 months, and after each time the core fuel configuration is changed, these changes include any removal or replacement of CONTROL RODS.

2. The SHUTDOWN MARGIN shall be determined annually, at intervals not to exceed 15 months, and after each time the core fuel configuration is changed, these changes include any removal or replacement of CONTROL RODS.

UMD proposes to change TS 3.1, Specification 1, to the following:

> *The EXCESS REACTIVITY relative to the REFERENCE CORE CONDITION, with or without experiments in place shall not be greater than $3.50.*

1. Explain how UMD ensures that the excess reactivity of $3.50 proposed in TS 3.1, Specification 1, is not exceeded when experiments are placed in the core.

2. Explain how UMD ensures that the shutdown margin requirement of $0.50 is not exceeded when experiments are placed in the core.