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J. A. BERNARD, JR.
Director of Reactor Operations

March 31, 1994

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attn: Document Control Desk

Subject: Request for Adjustment of Facility Operating License No. R-37 for the Massachusetts Institute of Technology Research Reactor (MITR); Docket No. 50-20.

Gentlemen:

Facility Operating License No. R-37, which is for the Massachusetts Institute of Technology Research Reactor (MITR), is scheduled to expire at midnight 7 May 1996. The Massachusetts Institute of Technology hereby requests that this license be adjusted to expire at midnight April 24, 2001 for the purpose of recovering time during which the reactor was either under construction, shutdown for modification, engaged in low-power testing that was a prerequisite for operation at the authorized power level, or engaged in core modification found to be necessary as a result of the low-power testing. Information supporting this request is contained in the Safety Review No. 0-94-2, a copy of which is enclosed. This request has been reviewed and approved by the MIT Reactor Safeguards Committee. Correspondence concerning this request should be directed to Dr. Bernard.

Sincerely,

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Director of Reactor Operations
MIT Research Reactor

Otto K. Harling
Director
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A020

Safety Review #-0-94-2

Adjustment of Facility Operating License No. R-37

1. Description of Change

Facility Operating License No. R-37 expires at midnight 7 May 1996. It is proposed that this license be adjusted so that it expires at midnight 24 April 2001 in order to recover time during which the reactor was under construction, shutdown for modification, engaged in low-power testing that was a prerequisite for operation at the authorized power level, or engaged in core modification found to be necessary as a result of the low-power testing. Table One provides a chronology of the operating license. The time intervals for which an adjustment is requested are listed below. In each instance, the basis of the request is that MIT was, despite the issuance of the operating license for the interval in question, unable to make use of that license at the authorized power level either because of some aspect of the regulatory process or because the startup testing identified a need to modify the reactor core.

(a) On May 7, 1956, the United States Atomic Energy Commission (AEC) issued Construction Permit No. CPRR-5 to the Massachusetts Institute of Technology (MIT). Construction then began on the original reactor, the MITR-I. On June 9, 1958, the AEC issued Facility Operating License No. R-37, which authorized operation at power levels up to 1 MW. The license was effective on its date of issuance and it was to expire at midnight May 7, 1996. Initial criticality was achieved on July 21, 1958. Supporting documentation for the above dates is contained in the letter dated 9 June 1958 from Mr. H. L. Price, Director, Division of Licensing and Regulation (AEC) to Mr. James McCormack, Vice-President (MIT). A copy of this letter is attached as Appendix A to this safety review.

Given the above, an adjustment of Facility Operating License No. R-37 is justified because its expiration date was based retroactively from the authorized start of construction. A more appropriate approach would have been to base the expiration date on either the actual date of issuance of the license itself (9 June 1958) or on the date of initial criticality (21 July 1958). If the former is used then the facility operating license should be extended by two years and thirty-three days. If the latter is used, then the adjustment should be for two years and seventy-five days. The latter date has been used here.

(b) The MITR-I was operated infrequently at low power from the date of initial criticality on 21 July 1958 to 1 June 1959. The purpose of this low-power operation was to conduct startup testing pursuant to the operating license requirements. It was found during the course of this testing that the uranium loading (106 grams) of the MITR-I fuel elements was insufficient to permit routine operation at the authorized power level. Specifically, the core did not contain enough excess reactivity to offset xenon poisoning and also provide compensation for burnup. Accordingly, the fuel was redesigned and remanufactured with a uranium loading of 160 grams. This extended the interval of low-power operation to June 1959. An adjustment of Operating License No R-37 to recover this time is justified because the satisfactory completion of the startup testing and the associated modification of the reactor's fuel were prerequisites to routine operation at the authorized power level. Recovery of this interval would add three hundred and fifteen days to the operating license. Supporting documentation for the dates of

low-power operation in 1958/1959 is contained in the MITR console log books. A summary of that information is given in Appendix B to this safety review.

(c) On 9 April 1973, Construction Permit No. CPRR-118 was issued to MIT by the AEC. This permit authorized modification of the MITR. At 1618 24 May 1974, the original MITR-I was shut down for the last time and further operation was precluded until the construction specified in Permit No. CPRR-118 was complete. The MITR-I was heavy-water cooled and moderated. It had been decided to modify this reactor so that it would be light-water cooled and moderated with a heavy-water reflector. The new design, known as the MITR-II, offered higher flux levels for the same power as well as significantly reduced tritium production. On 23 July 1975, the U.S. Nuclear Regulatory Commission (NRC) issued Amendment No. 10 to Facility Operating License No. R-37. This amendment authorized operation of the modified reactor at power levels up to 5 MW. The amendment was effective on its date of issuance and it did not alter the expiration date (7 May 1996) of the license as originally issued. Initial criticality was achieved on 14 August 1975. Supporting documentation for the above dates is contained in the letter dated 23 July 1975 from Mr. George Lear, Chief, Operating Reactors Branch #3, Division of Reactor Licensing (USNRC) to Mr. Lincoln Clark, Jr. Director, MIT Research Reactor (MIT). A copy of this letter is attached in Appendix C to this safety review.

Given the above, an adjustment of Facility Operating License No. R-37 is justified because its expiration date was not altered to allow for the time that the reactor was shut down for the modification. This shutdown lasted from 24 May 1974 to 14 August 1975 and the facility operating license should therefore be adjusted by one year and eighty-two days.

(d) The modified reactor, the MITR-II, was operated infrequently at low power from the initial criticality on 14 August 1975 to 15 April 1976 when routine operation at appreciable power (2.5 MW) became possible. The purpose of this low-power operation was to conduct startup testing, much of which is documented in the report, "MITR-II Startup Report." This report was prepared for the USNRC pursuant to license requirements. During the course of this testing, axial and radial power mappings were performed. These showed a need to reconfigure the reactor core so as to satisfy the safety and operating limits during power operation. This was done from 7 February 1976 to 8 March 1976 and routine operation at 2.5 MW was achieved in mid-April 1976. Operation at the authorized power level of 5 MW was contingent upon further core changes and was not achieved until late November 1976. An adjustment of Facility Operating License No. R-37 to recover time spent on this endeavor is justified because the satisfactory completion of such testing was a prerequisite to routine operation at the authorized power level. Recovery of time expended for this low-power operation of the MITR-II would add two hundred and forty-five days to the operating license. Supporting documentation for the dates of the low-power operation in 1975-1976 is contained in the MITR console log books. A summary of that information is given in Appendix D to this safety review.

Table One

Chronology of Facility Operating License No. R-37

Date	Event	Power Level Actual	Power Level Authorized
7 May 56	Construction Permit CPRR-5 issued.	None	None
9 June 58	Facility Operating License No. R-37 issued retroactive to 7 May 1956.	None	1 MW
21 July 58	Initial criticality of MITR-I.	< 10 W	1 MW
July 58-June 59	Startup testing.	Various	1 MW
1 June 59	Routine operation at 1 MW initiated.	1 MW	1 MW
20 June 61	Amendment No. 4 issued. This authorized operation at 2 MW.	1 MW	2 MW
20 Nov. 61	Operating power increased to 2 MW.	2 MW	2 MW
12 Oct. 65	Amendment No. 7 issued. This authorized operation at 5 MW.	2 MW	5 MW
1 Nov. 65	Operating power increased to 5 MW	5 MW	5 MW
9 Apr. 73	Construction Permit CPRR-118 issued for modification of the MITR to a light-water cooled and moderated facility.	5 MW	5 MW
24 May 74	MITR-I shut down.	None	None
23 July 75	Amendment No. 10 issued. This authorized operation of the modified reactor at 5 MW.	None	5 MW
14 Aug. 75	Initial criticality of the modified reactor (MITR-II).	<10 W	5 MW
Aug.-Dec. 75	Startup testing.	Various	5 MW
4-5 Dec. 75	Initial operation at 1 MW and performance of thermal power calibration.	1 MW	5 MW
Feb.-Mar. 76	Core reconfigured.	None	5 MW
15 Apr. 76	Routine operation at 2.5 MW initiated.	2.5 MW	5 MW
Nov. 76	Core redesigned.	None	5 MW
Dec. 76	Routine operation at 5 MW initiated.	5 MW	5 MW

2. Safety Evaluation

The basis of this request for the adjustment of Facility Operating License No. R-37 is that MIT will not have received the full benefit of that license if it is allowed to expire at midnight 7 May 1996. This failure to achieve full benefit was not and is not within MIT's control. Rather it is the result of certain practices that are inherent in the licensing process. These include (1) the retroactive dating of an operating license to the date of issuance of the associated construction permit, (2) the counting of time expended on startup testing against the operating license even though the satisfactory completion of that startup testing is a prerequisite to routine operation at the authorized power level, (3) the counting of time expended on fuel and/or core modifications against the operating license even though those modifications were identified during the startup testing as essential to the achievement of operation at the authorized power level, and (4) the counting of time spent on facility modification against the operating license even though the facility could not be legally operating during that interval (i.e., a construction permit had been issued to authorize the modification and this superseded the operating license until such time as the latter was amended). The issuance of an operating license constitutes a significant investment both on the part of the licensee and on the part of society with the latter acting through the cognizant regulatory agency. It makes little sense to waste a portion of that investment.

It should be recognized that this request is for a license adjustment and not a renewal. Accordingly, the criteria on which this request should be evaluated are not those of a license renewal. In particular, findings established at the time of issuance of the original license and/or its amendments remain valid. The principal question should therefore be whether or not the licensee (MIT) is capable of continuing to operate the facility in a manner such that public health and safety are not endangered. MIT is clearly capable of so doing. The best evidence for this conclusion is the facility's operating record. This is documented in reports provided annually to the U.S. Nuclear Regulatory Commission or to its predecessor agencies. These give the history of the facility, document the types of educational and research activities conducted with the reactor, list changes in facility design and procedures, and provide summaries of operational activities including effluent releases. These reports show the MITR to have an excellent safety record while at the same time maintaining high standards of accomplishment.

Central to MIT's capability to continue operation of the MIT Research Reactor in a safe manner is the protocol that has been established to ensure that all proposed changes to the facility are properly reviewed. Such changes might include the updating of a procedure to incorporate new regulatory requirements, the installation of a new item of equipment, or the initiation of a new experiment. Whenever a change is to be made, a written safety review is prepared. This document consists of a description of the proposed change, a safety evaluation, and a determination of whether or not an unreviewed safety question, as defined in 10 CFR 50.59, exists. If the change involves equipment or material, a quality assurance program, which among other things documents the quality of materials used and installation methods, will also be established. All safety reviews require the approval of two licensed senior reactor operators, the Director of Reactor Operations and, when appropriate, the Reactor Radiation Protection Officer. In addition, safety reviews that affect certain components or documents, such as the fuel or emergency plan to cite two examples, require approval by the MIT Reactor Safeguards Committee (MITRSC). The MITRSC is a group of eminent engineers and scientists, some affiliated with MIT and some with other organizations, who provide a broad range of expertise in all aspects of reactor design, operation, and management. This Committee provides an independent check on facility operation. The MITRSC meets in its entirety at least annually and acts through approved Subcommittees on a more frequent basis. Finally, if a safety review

does involve an unreviewed safety question, it is submitted to the U.S. Nuclear Regulatory Commission for prior approval.

The safety review process ensures that all proposed changes in the facility's design and operation conform to the cognizant regulations. In order to ensure that all appropriate changes are identified, MIT has established a system of reviews and/or audits. Some of these are license requirements. For example, such is the case with the aforementioned annual reports that are submitted every August to the USNRC. Others are the result of NRC requirements. These include an annual review of the emergency plan which is done together with an annual exercise of that plan. Other review requirements are self-imposed. These include an annual review of the training program, quarterly administrative audits, and an annual quality assurance audit. These audits and others are performed by the Reactor Operations Staff. In addition, there is a requirement for an independent audit that is conducted by a qualified individual not affiliated with the Operations Group. This audit is performed for the MITRSC. If any of these audits identifies a deficiency, it is corrected and the result documented. If a suggestion is made for improved operation, it is considered and, if adopted, a safety review is prepared.

In summary, the combination of the safety review process and the audit requirements establishes a check and balance system that ensures that the facility is operated safely and that any incipient problems are readily identified and corrected. A further check is, of course, the periodic inspections that are conducted by the USNRC. The reports filed in conjunction with these inspections show MIT to have an excellent safety record.

As further evidence that MIT is capable of continuing to operate the MIT Research Reactor in a safe manner, a brief summary is given here of some of the more important components of reactor operation.

a) Administrative Condition: The administrative condition is excellent in that required facility documents are kept current both in terms of their description of the reactor and its systems, and in terms of their compliance with current regulations. Examples include:

   (i) Safety Analysis Report (SAR): This report describes the reactor's design, its systems, and its instrumentation. Also, it provide a basis for the Technical Specifications that are part of the operating license. Whenever a reactor component that is described in the SAR is changed, an 'SAR Revision' is prepared by the reactor staff and, after review and approval by the MIT Reactor Safeguards Committee, submitted to the cognizant regulatory agency. Originally, this was the Atomic Energy Commission. Currently, it is the U.S. Nuclear Regulatory Commission. The result is that the MIT Research Reactor's Safety Analysis Report reflects the current status of the facility.

   (ii) Emergency Plan and Procedures: There is an internal MITR requirement for an annual review of these documents. Revisions are made, under the aforementioned safety review process, whenever a change is deemed appropriate. For example, both the plan and its implementing procedures were completely rewritten in 1982 in accordance with NRC regulations that were newly-issued at that time. Also, major portions of both the plan and procedures were revised in 1993 as a result of changes in 10 CFR 20.

(iii) Security Plan and Procedures: These are reviewed on a regular schedule and revised in a manner similar to the emergency plan whenever it is so required.

(iv) Quality Assurance Program: This program is submitted every five years to the U.S. Nuclear Regulatory Commission for review and reissuance of approval.

(v) Abnormal Operating/Standard Operating/Administrative Procedures: These documents and their associated checklists are updated on a more or less continuous basis with modifications and/or additions being made whenever appropriate. The MITR Staff typically prepares 20-25 safety reviews on these documents in a given year.

b) Material Condition: The material condition of all systems important to safety is excellent. This includes the containment building, the core tank and housing, the primary and heavy-water systems, the nuclear and process safety systems, and the effluent monitoring equipment. Examples include:

(i) Containment Building: The MITR has a full containment capable of withstanding at least 2 psig of overpressure. All penetrations and dampers are inspected quarterly and a building pressure test is performed annually.

(ii) Core Component Inspection: All in-core components are inspected quarterly for evidence of degradation. In addition, inspections are on occasion made of normally inaccessible areas such as the exterior of the heavy-water tank. These have shown no corrosion. MIT has taken considerable care to ensure the integrity of the core components and the other major systems (primary, heavy water or D_2O, and shield). The following should be noted:

(1) The core housing, light-water tank, heavy-water tank, and all in-core components such as the natural circulation and anti-siphon valves were newly installed during the reactor modification in 1974. Thus, even though Facility Operating License No. R-37 dates to 1956, the core components themselves were new in 1974/1975.

(2) Particular attention is given to water chemistry control of the primary, D_2O, and shield systems. Each is equipped with an ion exchange column for demineralization and with conductivity monitors that read out in the reactor control room. These monitors provide an alarm to the console operator in the event that there is an abnormal increase in conductivity. Thus, any problem is detected in its incipient stages. In addition, the primary coolant is analyzed prior to startup for pH, chloride, and conductivity.

(3) Surfaces that are not submersed in coolant and which are in areas that are difficult to inspect are kept under a cover gas, either CO_2 or helium. The objective is to preclude the possible formation of nitric acid or other corrosives. Surfaces treated in this manner include the outer surface of the D_2O tank, the reentrant thimbles, and certain of the experiment ports. (Note: Nitric acid can form when air, which

consists of nitrogen and oxygen and which contains moisture, is exposed to gamma rays.)

One other item worth noting about the MITR's material condition is that a review has been conducted of the potential for radiation damage to the aluminum core components. Aluminum does not undergo a ductile-brittle transition as do ferritic steels. However, damage can occur because of irradiation aging (in which aluminum transmutes to silicon), corrosion, and low-cycle fatigue. These three damage mechanisms are respectively a function of the neutron fluence, pH, and stress to which the core tank is subject. Operation of the MIT Research Reactor has been such that none of these parameters is of concern. Also, they would not become of concern during the proposed license adjustment. The latter two may be discounted entirely because the pH has been kept slightly acidic so as to minimize corrosion, and the stress on the tank is about 60 MPa which is a factor of three below the level of concern. The effect of fluence on aluminum may also be discounted. There are three reasons for this conclusion. First, the MITR core housing, core tank, and reflector tank were newly installed in 1973/1974. Aluminum tanks such as these are routinely judged adequate for at least a forty year lifetime. Yet, those now in service at the MIT Research Reactor are only twenty years old. Second, both the fluence and the fast to thermal flux ratio for the MITR's aluminum vessels are bounded by those of vessels at other facilities such as the High Flux Beam Reactor at the Brookhaven National Laboratory. Third, the effect of fluence on aluminum has been studied by Weeks et al. ("Effects of High Thermal and High Fast Fluences on the Mechanical Properties of Type 6061 Aluminum on the HFBR," ASTM STP 1046, 1990). The sum of the accumulated and projected fluence on the MITR-II core tank through the proposed license adjustment is at least a factor of two below the level of concern.

(iii) Control Blades: These are made of boron-impregnated stainless steel. They are inspected every six months and are replaced periodically, usually every 100,000 MWH. This ensures that any mechanical problems would be detected early and that the reactivity worth of these blades remains effective despite boron depletion.

(iv) Tests and Calibrations: More than 100 tests and calibrations are conducted each year according to an established schedule. These ensure that all equipment is in proper operating condition and that any incipient failures are identified and repaired.

c) Operator Training: The MITR has rigorous training programs both for the initial licensing of newly-hired personnel and for the maintenance of qualification of licensed personnel. It is worth noting that the facility's track record with regard to new candidates is one of the best among any U.S. reactor (research or power). Also, in 1992, it was required by NRC that any operator or senior operator whose license was to expire in 1993 or 1994 be reexamined by NRC. Seven MITR licensed operators were in this category and all passed the NRC exams.

d) Effluent Releases: Effluent releases are monitored by quadruply redundant gas and particulate monitors. These monitors are interlocked to the containment building ventilation so that in the event of detection of an abnormal effluent level, the building will be sealed before the material in question is released. In addition to these on-line monitors, effluents are sampled on a regular basis by personnel under

the administrative control of the MIT Environmental Medical Service. Records show that effluent releases are well below allowable levels. (Note: This information is provided annually to the U.S. Nuclear Regulatory Commission in the annual reports that are submitted each August.)

e) Financial Condition: The Massachusetts Institute of Technology has the financial resources to support the continued safe operation of the facility. Also, pursuant to NRC requirements, MIT has placed those funds needed for the facility's eventual decommissioning in an escrow account.

The above information demonstrates that the Massachusetts Institute of Technology is capable of continuing to operate the MIT Research Reactor in a safe manner. The items cited are not comprehensive. Rather the intent is to provide examples of MIT's commitment to maintain and operate the facility such that "There is reasonable assurance (i) that the activities authorized by the operating license can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the rules and regulations of the USNRC."

3. Unreviewed Safety Question Determination

An unreviewed safety question is judged to exist if (1) the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety previously evaluated in the safety analysis report may be increased; or (2) a possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report may be created; or (3) the margin of safety as defined in the basis for any technical specification is reduced (10 CFR 50.59). The proposed adjustment of the MITR's facility operating license does not meet any of these three criteria because nothing is being changed except the expiration date of the license. Moreover, that adjustment would merely recover the full duration of the license as originally approved for reactor operation.

Appendix A

Letter dated 9 June 1958 from H. L. Price, Director, Division of Licensing and Regulation (AEC) to Mr. James McCormack, Vice-President (MIT).