June 6, 2002

Dr. John A. Bernard, Director
Nuclear Reactor Laboratory
Massachusetts Institute of Technology
138 Albany Street
Cambridge, MA 02139-4296

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION (TAC NO. MA6084)

Dear Dr. Bernard:

We are continuing our review of your license renewal request for Amended Facility Operating License No. R-37 for the Massachusetts Institute of Technology Research Reactor which you submitted on July 8, 1999, as supplemented. During our review of your request, questions have arisen for which we require additional information and clarification. This letter represents a third partial request for additional information and completes questions associated with our initial review of your application. Please provide responses to the enclosed partial request for additional information and the other two partial requests you have received previously within 180 days of the date of this letter. Questions 1 to 33 were sent to you by letter dated April 16, 2001, and questions 34 to 58 were sent to you by letter dated May 30, 2001. In accordance with 10 CFR 50.30(b), your response must be executed in a signed original under oath or affirmation. Following receipt of the additional information, we will continue our evaluation of your amendment request.

If you have any questions regarding this review, please contact me at (301) 415-1127.

Sincerely,

/RA/

Alexander Adams, Jr., Senior Project Manager
Research and Test Reactors Section
Operating Reactor Improvements Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-20

Enclosure:
As stated

cc w/enclosure:
Please see next page

Massachusetts Institute of
  Technology

Docket No. 50-20

cc:

City Manager
City Hall
Cambridge, MA 02139

Department of Environmental
  Quality Engineering
100 Cambridge Street
Boston, MA 02202

Test, Research, and Training
  Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

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ADAMS ACCESSION NO.: ML021500351 **TEMPLATE #: NRR-088**

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THIRD PARTIAL REQUEST FOR ADDITIONAL INFORMATION
MASSACHUSETTS INSTITUTE OF TECHNOLOGY RESEARCH REACTOR
DOCKET NO. 50-20

59. Section 7.2.2.2, “Reactor Protection System,” Page 7-8. This section gives the values for the Limiting Safety System Setting (LSSS) and the Safety Limit (SL) as 7.4 MW and 11.2 MW respectively. The LSSS is correct by Figure 4-27 using the parameters of coolant height, 10 ft., primary flow rate, 1800 gpm, and reactor coolant outlet temperature, 60 degrees C. Using Figure 4-25 the SL with those same parameters is 9.1 MW. Please discuss this apparent inconsistency.

60. Section 10.2.4.1, “High Flux Pneumatic Tube” and 10.2.4.2, “Pneumatic Tube System (1PH1, 1PH2, 1PH3, 1PH4),” Page 10-12. Is it possible for a sample carrier to become stuck in pneumatic tube piping such that a radiation hazard exists? Are samples sent to NW13 received and used under the reactor license?

61. Section 10.3.1, “Requirements,” Page 10-25. Please discuss with whom the responsibility lies to determine if an experiment falls within the envelope of a previously approved use and therefore can be approved by Reactor Operations or the Reactor Radiation Office, or otherwise must be approved by MITRSC.

62. Section 10.3.2, “Experiment Classification and Approval Activity,” Page 10-25. Did you make any changes to your unreviewed safety questions considering recent amendments to 10 CFR 50.59?

63. Section 10.3.2.6, “In-Core Samples Assemblies,” Page 10-28. Are there weight limits for ICSAs? Please discuss the requirements imposed on the exterior dimensional tolerances of an ICSA jacket in order to minimize bypass flow.

64. Section 10.3.2.8, “Closed-Loop Digital Control,” Page 10-31. Please describe the quality assurance program that is implemented with digital control experiments to give assurance that the experiment (hardware and software) will function as designed and approved. Section (c). With whom does the responsibility lie to ensure that after installation all experimental equipment is completely isolated from the safety system and will remain that way during the experiment?

65. Section 11.1.1.4, Airborne Radiation Sources, Page 11-2. Please calculate the maximum anticipated annual dose to workers from airborne radiation sources.

66. Section 11.2.2.3, “Dilution Factor,” Page 11-24. Please provide details of your calculations that provide the basis of the dilution factor of 50,000 and dose scaling factor of 1,200. What would be the dose from the routine annual release of effluent (assuming continuous 6 MW operation) to the maximum exposed member of the public and at the nearest residence?

67. Section 11.2.2.4, “Liquid Wastes from the Reactor Building,” Page 11-24. Please discuss how you meet the requirements of 10 CFR 20.2003(a)(1) for solubility of liquid waste discharged to the sanitary sewerage.

68. Section 11.2.2.6, “Other Liquid Waste,” Page 11-27. Does waste from the laboratory sinks discussed in this section go to the waste tanks? If not, how are the requirements of 10 CFR 20.2003(a) met?

69. Section 11.2.2.7, “Tritium Discharge Limit,” Page 11-28. Please provide the basis of the 1 µCi/liter tritium concentration limit assuring that the 5 curie discharge limit in 10 CFR 20.2003(a)(4) will not be exceeded.

70. Section 12.1.1, “Structure,” Page 12-1. Please describe how the provisions of 10 CFR 35.6, “Provisions for research involving human subjects,” is met for BNCT.

71. Section 12.1.3, “Staffing,” Page 12-7. In accordance with the regulations, you require a senior reactor operator present at the facility for recovery from unplanned or unscheduled significant reductions in power. What is your definition of significant reduction in power?

72. Section 12.2.3, “Review Function,” Page 12-14, Section 12.3.2, “Approval Process,“ Page 12-16, Section 12.9.1, “Procedures,” Page 12-26, TS 7.2.2.a, TS 7.4.1.3.a and TS 7.4.2. Reference is made to 10 CFR 50.59 and unreviewed safety question in these sections of the SAR and TSs. Please review references in your SAR to 10 CFR 50.59 to ensure that the SAR is consistent with the recent revision to 10 CFR 50.59 (e.g., the term unreviewed safety question has been dropped from the regulation).

73. Section 12.3.1, “Scope of Procedures,” Page 12-15. Discuss the need for procedures for radiation protection and the use and shipment of byproduct material under the reactor license.

74. Section 12.3.3, “Procedure Change Method,” Page 12-17. How do you ensure that temporary changes to procedures are in accord with the requirements of 10 CFR 50.59?

75 Section 12.2.2, “Procedure Change Method,” Page 12-18. Reference is made to 10 CFR 50.72(b)(i)(B). Please note that 10 CFR 50.72 is not applicable to research reactors and the specific regulation you referred to does not exist.

76. Section 12.5.1, “Annual Report,” Page 12-21. Your summary of liquid waste information has you reporting total radioactivity released for specific nuclides, if the gross beta radioactivity exceeds 1×10^{-5} µCi/ml at the point of release. What is the basis of this limitation?

77. Chapter 13, General. Reference 13-14 of the SAR refers to the PARET report entitled “Investigation of the Use of the PARET Code to Evaluate Safe Reactivity Limits for the MITR II Reactor” by Jean Baptiste Dutto and Stephane Evo (Genie Atomique June 1994). The Dutto and Evo report states that the authors “cannot certify that the equations used in this code are accurate enough to give reliable results (page 83).” Please justify the use of this report and the code in determining the reactivity limits for the MITR.

78. Chapter 13, General. SAR Section 4.1 states the LSSS for coolant flow rate as

1800 gpm. The reactivity limit report referenced in question 77 was performed using the nominal coolant flow rate of 2000 gpm. Please justify the use of the higher flow rate in the transient calculations.

79. Chapter 13, General. SAR Section 4.6.3 discusses the flow through the core and states that 92.1% of the total core flow actually goes through the core. The rest of the flow bypasses the fuel elements. This section also states that the flow through the channel with the minimum flow is 86.4% of the average channel flow. Taking these factors into consideration with question 78, the minimum flow through a coolant channel could be only 71% of the flow used in the transient calculation referenced in question 77. Please justify the use of the higher flow rates in the transient calculations.

80. Chapter 13, General. Basis 3 of TS 3.1.6 refers to the affect of the low corrosion film thermal conductivity on heat transfer. This is especially the case with transients. That is alluded to in the basis for TS 5.3 even though the reference was to clad thickness affecting thermal transient behavior. The Dutto and Evo report does not appear to consider the corrosion film layer in the transient analysis. Please justify basing reactivity limits on that analysis if the corrosion layer is not part of the model.

81. Chapter 13, General. The basis for TS 3.1.6 assumes a maximum fuel clad film thickness of 2 mils. Please discuss how this film thickness was used in the accident analyses presented in the SAR and how it affected the results of those analyses and the TSs emanating from those results.

82. Section 13.1.1, Part a, “Maximum Hypothetical Accident,” Page 13-1. Please discuss the detection of boiling in the core with the linear flux channels. How much of a change in magnitude and frequency of the leakage flux, as “seen” by the linear channels, is expected from boiling in one to four channels in the center of the core? Has the high frequency noise resulting from the channel boiling actually been observed by accident or experiment? What surveillance is performed to ensure that the frequency response of the instrumentation is maintained? Please estimate the amount of time that the operator has to detect the boiling noise and respond by decreasing power before there is fuel failure. Why does the operator lower reactor power as opposed to scramming the reactor?

83. Section 13.1.2, Part a, “Insertion of Excess Reactivity,” Page 13-2. Please discuss any other mechanisms, other than the experiment failure, that were considered for a step reactivity accident?

84. Section 13.1.2, Part b, (ii), Insertion of Excess Reactivity,” Page 13-2. Please discuss how the variable speed option for the control experiment is realized. Is the limit on ramp reactivity, 5×10^{-4} $\Delta k/k/s$, based on the control experiment?

85. Section 13.1.6, “Experiment Malfunction,” Page 13-4. Please discuss the scope of accidents in this section that are considered as “not credible.” Is the experiment failure accident mentioned in Section 13.1.2.a outside the scope of this section?

86. Section 13.2, Part a, “Accident Analysis and Determination of Consequences,”

Page 13-4. TS 3.1.6 allows UAl alloy fuel. Please discuss any operational limits that are different when the UAl alloy vs. UAl_x cermet fuel is being used?

87. Section 13.2.1.3, “Atmospheric Release,” Page 13-12. What is the likelihood that the over-pressure relief system will initiate during the MHA. Please describe a scenario that leads to the initiation of the over-pressure relief system.

88. Section 13.2.1.5, “Conclusion for the Maximum Hypothetical Accident,” Page 13-16. Please verify that the internal dose to the thyroid is the committed dose equivalent for a 2-hour exposure.

89. Section 13.2.2.1, “Step Reactivity Insertion,” Page 13-18. The heat transfer and accident transient analysis results may be affected in conflicting ways depending on how the coolant channel is modeled without the fins. Please discuss how the determination was made that not considering the fins was a conservative assumption. In addition the increase in the assumed oxide thickness will decrease the hydraulic diameter of the grooves. Please evaluate how this will affect the friction losses and the attendant decreased velocities in the grooves and subsequent oxide and crud deposition in the grooves. This may require thermal evaluations with the grooves filled with oxide unless data is available to demonstrate otherwise. Please discuss how two-phase flow affects the heat transfer of the fins and the assumption that not considering them is conservative. Please discuss the maximum fuel clad temperature if the step insertion is 1.5 beta $\Delta k/k$ with natural circulation.

90. Section 13.2.2.2, “Ramp Reactivity Insertion,” Page 13-21. From the stated SL for 2000 gpm primary coolant flow table 4-25 shows that the Coolant T_{out} is 55 ºC. Please discuss the rational for using these initial conditions rather than the less conservative assumption of LSSSs (1800 gpm and 60 ºC). Please provide the results of an analysis done using a reactivity ramp of 5×10^{-4} $\Delta k/k/s$ with a coolant flow and coolant T_{out} of 1800 gpm and 60 ºC respectively. Please discuss the sensitivity of result of the analysis to the initial power. In other words is there an initial power other than 6.0 MW (up to the LSSS of 7.4 MW) that will result in a higher peak power? Describe an accident that would cause a reactivity ramp of 5×10^{-4} $\Delta k/k/s$.

91. Section 13.2.3.2, “Break in Light-Water Core Tank,” Page 13-23. Please discuss this analysis further. What is the time limit for the action to increase the water volume suggested? What impact does the reduced total heat capacity have on the ability of natural convection to remove the decay heat? What are the consequences if the water volume is not increased?

92. Section 13.2.4, “Loss of Primary Coolant Flow,” Page 13-25. Are there check valves in the discharge lines of MA-1 and MA-1A to prevent back flow through the idle pump if one pump is lost by equipment malfunction? If not what is the analysis for such an accident?

Part a. The primary coolant low flow scram setpoint is indicated as 1800 gpm in Table 7. Please justify using 2000 gpm as the initial condition. Please discuss the meaning of the statement “…6.1 MW is the maximum steady-state power compatible with an LSSS of 7.4 MW."

Part b. The primary outlet temperature scram setpoint is indicated as 60 ºC in Table 7. Please justify using 55 ºC as the initial condition. Please discuss the coolant T_{out} and reactor power relative to the SLs for natural circulation during a loss of flow accident.

93. Section 13.2.5.1, "Mishandling of Fuel," Page 13-26. Please discuss the use of the UAl alloy fuel and how its use will affect the conclusions of this section.

94. Section 13.2.6, "Experiment Malfunction," Page 13-28. List the accidents for which experiment malfunction is considered as a possible initiating mechanism.

95. Section 13.2.9.1, "Operation with Shim Blades in a Non-Uniform Bank Position," Page 13-37. When operating with one shim blade inoperative and fully withdrawn what is the maximum radial peaking factor? This situation is not discussed in the SAR.

96. Section 13.2.9.3, "Spill of Heavy Water," Page 13-39. Please discuss the reason that 55 ºC is used for calculating evaporation of D_2O rather than 60 ºC (coolant temperature used for the analysis of a MHA).

97. Section 13.3, "Summary and Conclusions," Page 13-40. Please clarify the difference for whole body dose in this section (381 mrem at 21 m) and in Table 13-4 and section 13.2.1.5 (247 mrem at 21 m).

98. Chapter 15, "Financial Qualifications." Please provide any updates to the section as necessary. Please submit a copy of the latest financial statements of the Institute.

99. Section 16.3.1.4, Part a, "In-Core Components, Fuel," Page 16-8. Please discuss planned surveillance to verify that the corrosion does not exceed the assumed thickness of 2 mil at the proposed fission density limit. Section 16.3.1.4, Part b, "In-Core Components, Cladding," Page 16-8. Please discuss the fission density limit, corrosion thickness at the fission density limit, fission product release fraction, and swelling and blistering when using UAl alloy fuel.

100. Section 16.3.1.7, "Exterior Surfaces," Page 16-10. Please discuss the formation of HCO_3 when using CO_2 in the presence of moisture relative to corrosion of the outer surface of the D_2O tank. Are inspections of the exterior tank surfaces planned as regular surveillance?

The following questions concern the Technical Specifications (TSs):

101. TS 1.3.32.4. Please justify using the limit of 1.0% δk/k (1.27$) for the uncontrolled or unanticipated change in reactivity rather than the one dollar limit in ANSI/ANS-15.1-1990 section 6.7.2(1)c(iv).

102. TS 2.1.1. See question 29 for SAR Section 4.6.6.2 concerning the determination of the value of R. Please amend the specification and basis as necessary.

103. TS 2.2. See questions 31, 32, and 33 for SAR Section 4.6.7. Please amend the specification and basis as necessary.

104. TS 3.1.2. See question 18 for SAR Section 4.2.2.1. Please discuss this specification relative to the situation presented in TS 3.1.4.5. Please amend the specification and basis as necessary. Please discuss the possibility, as stated in the basis, of interactions of rods or mechanisms that could cause more than one rod to be stuck in the out position.

105. TS 3.1.3. See question 89 for SAR Section 13.2.2.1 concerning the maximum clad temperature for a 1.5 beta reactivity step with natural circulation and low power. Please amend the specification and basis as necessary.

106. TS 3.1.4.4.a. See question 29 for SAR Section 4.6.6.2 and question 102 for TS 2.1.1 concerning the determination of the value of R. Please amend the specification and basis as necessary.

107. TS 3.1.4.4.b. See question 31 for SAR Section 4.6.7 and question 103 for TS 2.2 concerning the evaluation of SAR Equation (4-40) and TS Equation (2.2-1). Please amend the specification and basis as necessary.

108. TS 3.1.4.4. Part c of the TS requires an evaluation to be performed. The record of the evaluation is completed and approved by two Senior Reactor Operators (SROs). Do the SROs perform the evaluations? If so, how is it assured that they have the necessary engineering background to perform the evaluations?

109. TS 3.1.4, basis 4.a. Please discuss the calculated safety limit of 9 MW relative to the analysis presented in the SAR Section 13.2.2.2, page 13-21.

110. TS 3.1.6.3. Please provide a basis for fission density limit for the UAl alloy fuel.

111. TS 3.1.6, basis 3. Please provide analysis and discussion in the SAR concerning the affect that the "significant heat transfer resistance" of the 2 mil corrosion layer has on the accident analysis results. What value of thermal conductivity is used for the corrosion layer for the analysis?

112. TS 3.2.2.4. In the basis for this specification it is stated that the limit for a non-secured experiment should apply because it is "…not intended that the controller inserts the full amount of available reactivity…." Yet TS 1.3.18 defines a movable experiment as "…one where it is intended that all or part of the experiment may be moved" and the non-secured experiment as "…one where it is intended that the experiment should not move while the reactor is operating…." Please reevaluate the specification and basis considering these two definitions.

113. TS 3.2.3.3. TS 3.2.3 Specification 3 states that the SCRAM set points shall be more conservative than the corresponding LSSS. However in Table 3.2.3-1, lines 2, 3, and 10 the set points are listed with less than or equal symbols. Please clarify.

114. TS 3.2.4.1.a. Please justify not listing the specific startup interlocks as part of the specification.

115. TS 3.2.7. Please discuss "indication" as used in this specification. How does the operator verify indication prior to startup?

116. TS 3.3.1.2. How is the "capability" of the natural convection and anti-siphon valves to open verified prior to going critical?

117. TS 3.1.3 and SAR Section 13.2.2.1. The analyses done as bases for TS 3.1.3 were reactivity step insertions while in the forced convection high power and natural convection low power conditions. The specification introduces the possibility of the application of the limit based on the forced convection high power condition when actually in a forced convection low power condition. Was any analyses done to support this?

118. TS 3.3.2. You have a standing order in place to operators based on an evaluation of your current TS in this area. Please review this proposed TS based on the analysis you have performed on your current TS and make any changes needed to this TS.

119. TS 3.3.6. If the conductivity specification supports the stated objectives of the TS please justify the absence of a time limit specification on the out-of-specification chemistry condition.

120. TS 3.5.1 and 3.5.2. Please provide a basis of the 250 kW limit in these specifications.

121. TS 3.7.1.3. Please discuss the frequency of surveys and analyses when they are used as a substitute for continuous monitoring.

122. TS 3.7.4. Please list all special nuclear, byproduct and source material that you propose to possess under your reactor license and discuss the need for the material. If the possession limits are the same as your current license, stating that fact will be sufficient.

123. TS 4. TS 1.3.11 on frequency allow surveillance tests to be waived under certain conditions. Are there any TS in section 4 that should not be waived? For example, how does TS 1.3.11 impact on TS 4.1.5.c?

124. TS 4.1.5 b. Please discuss the accuracy of the burnup calculations. What is the margin allowed to assure that specification 3 of TS 3.1.6. is not violated?

125. TS 4.2.1. Discuss the history of accuracy of calculations of reactivity worths as compared to measurements and why this is deemed to be acceptable.

126. TS 1.3.37, TS 3.2, and TS 4.2. There are differences in the definition of SCRAM Time in these specifications. Please clarify.

127. TS 4.2.4. Discuss the basis for the 24 hour shut down limit. During the past year, about how often was the reactor shut down for periods greater than 24 hours and thus requiring performance of this surveillance?

128. TS 4.3.5. This TS refers to sampling requirements in TSs 3.3.2 and 3.3.3. Please describe the sampling requirements in these TSs.

129. TS 5.3. Please discuss the lack of a specification for the dimensions and number of fins as a fuel plate design criterion.

130. TS 5.3 basis. The basis states that clad thickness affects the delay time for heat removal in the event of a fast transient. Please discuss how the effectiveness of the fins varies with the transient time. Please discuss how the heat transfer delay time change due to the growth of the corrosion layer affects the accident analyses presented in the SAR. Discuss how the presence of the fins (i.e. sharp internal and external corners and variations in the local chemical, flow, heat transfer, and nuclear conditions) affect the corrosion layer growth and spallation. Revise the SAR and TS basis as necessary.

131. TS 6.1.1. Should the reactivity worth limits for single experiments be absolute value and for total worth be the sum of the absolute values?

132. TS 6.1.4.c. Is the 10 percent limit per capsule or for all capsules under irradiation? If the limit is per capsule, how do you ensure compliance with 10 CFR Part 20 if more than 10 capsules are vented?

133. TS 7.6.2.a. Please discuss the meaning of "…no immediate safety significance…" as used in this specification.

134. TS 7.8.1(c). In accordance with 10 CFR 50.36(c)(2) records of reviews of violations of LCOs should be retained for the life of the facility license. Please amend this TS accordingly.

135. TS General. Please update your TS as needed to reflected license amendments issued to MIT since the renewal TS were submitted to NRC.