May 6, 2010

Mr. Ralph Butler, Director
Research Reactor Center
University of Missouri-Columbia
Research Park
Columbia, MO 65211

SUBJECT: UNIVERSITY OF MISSOURI AT COLUMBIA – REQUEST FOR ADDITIONAL INFORMATION RE: LICENSE RENEWAL, SAFETY ANALYSIS REPORT, COMPLEX QUESTIONS (TAC NO. MD3034)

Dear Mr. Butler:

We are continuing our review of your renewal request for Amended Facility Operating License No. R-103 for the University of Missouri - Columbia Research Reactor which you submitted on August 31, 2006, as supplemented. During our review of your renewal request, questions have arisen for which we require additional information and clarification. The enclosure is a partial request for additional information containing complex questions. We are requesting a response within 120 days of the date of this letter. There is an additional request for information containing our remaining questions being sent under separate cover. In accordance with Title 10 of the *Code of Federal Regulations* Section 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 renewal 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 Licensing Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosure: As stated

cc w/encl: See next page

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Gainesville, FL 32611

OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ADDITIONAL INFORMATION

REGARDING LICENSE RENEWAL REQUEST FOR

THE UNIVERSITY OF MISSOURI-COLUMBIA RESEARCH REACTOR

LICENSE NO. R-103; DOCKET NO. 50-186

The purpose of these questions is to assist the staff in determining that the renewal application from the University of Missouri, Missouri University Research Reactor (MURR) meets the requirements of the regulations, in particular the regulations in Title 10 of the *Code of Federal Regulations* Parts 20 and 50. The questions are based on a review of your application using the U. S. Nuclear Regulatory Commission (NRC) staff's standard review plan in NUREG-1537, "Guidelines for Preparing and Reviewing Applications for the Licensing of Non-Power Reactors," Part 2, "Standard Review Plan and Acceptance Criteria."

We have split our questions into two groups, complex questions that have a 120-day requested response time and the remaining questions with a 45-day response time. Because of this, the numbering of the questions below is not consecutive. Both groups of questions considered together result in a complete set of consecutively numbered questions.

CHAPTER 4

4.14 Section 4.5.3, Operating Limits.

d. Page 4-40 and Technical Specification (TS) 3.2 b. Discuss how the one inch limit restricts flux tilting to ensure power peaking factors.

4.15 Section 4.6, Thermal Hydraulic Design, Page 4-43. It is unclear what the thermal design limit and the operating limit are. Provide further clarification for the temperature limit of the fuel cladding. Discuss the effect of fuel oxide layer build-up on the results of the analyses.

4.16 Section 4.6.1, Natural Convective Cooling Analysis, TS 2.1 c., Safety Limits, and TS 2.2 c., Limited Safety Systems Settings. The TS and Safety Analysis Report (SAR) do not include a limitation on inlet or bulk coolant temperature. Explain the effect of coolant temperature on the analysis and justify why a limit on inlet or bulk coolant temperature should not be required.

ENCLOSURE

CHAPTER 13

13.2 Section 13.2.2.1, Accident initiating events and scenarios, Page 13-17.

a. From Fig. 13.4 (page 13-22), the DNB limiting power is about 17 megawatt (MW) thermal (t). What is the basis for the "burnout" power of 25.23 MW(t)? What is the corresponding peak fuel temperature?

b. The SAR states it was assumed that the MURR core could withstand the prompt power burst associated with the rapid step insertion of positive reactivity. Please provide the bases for this assumption. Please discuss the results of the analysis if parameter initial conditions are at TS or license limits. Please discuss the results for reactor operation in Mode II or III.

c. The SAR discusses other step insertions (i.e., up to 0.003 $\Delta k/k$). Please discuss the results of the analysis if parameter initial conditions are at TS or license limits. Please discuss the results for reactor operation in Mode II or III.

d. Please discuss the effect of build up of an oxide layer on the fuel cladding.

13.3 Section 13.2.2.1.2, Continuous Control Blade Withdrawal. Justify why the regulating blade is not part of this evaluation. Explain if reactor operation in Mode II or III changes the results of the evaluation.

13.4 Section 13.2.3, Loss of Primary Coolant.

a. Explain why initial conditions of the analysis are not TS and license limits or provide an analysis at TS and license limits.

b. Please describe any benchmarking that has been performed on the RELAP model and conclusions as to the accuracy of the model's results. Please discuss the effect on the analysis of oxide layer build up on the fuel cladding.

c. It is not clear from the SAR which version of RELAP is used for the loss of primary coolant calculations. However, RELAP5/MOD3.3 had a fundamental error in the point kinetics model that has recently been fixed. Does the version of the code used in the loss of coolant analysis have the fixes implemented? If not, confirm that the analysis model is giving results consistent with the accident, e.g. by checking results as a function of time step or with another stand-alone point kinetics model.

13.6 Section 13.2.4, Loss of Primary Coolant Flow. Explain why loss of pressurizer pressure is the most limiting initiating event for this class of event. Please discuss the effect on the analysis of fuel burnup and oxide layer build-up on the cladding.

13.9 Section 13.2.6, Experiment Malfunction.

a. The release path for the failure of fueled experiments is different than the MHA. The containment of fission products afforded by the primary system is not present for the failure of a fueled experiment in the reactor pool. Please provide dose calculations for the failure of a fueled experiment in the pool.

b. Please provide an example of a calculation of an irradiation container that meets the requirement for containing the pressure by at least a factor of two from the detonation of 25 milligrams of TNT-equivalent material.

CHAPTER 16

16.1 Section 16.1.1, Fuel and Fuel Cladding, TS 3.8, Reactor Fuel, and TS 4.5, Reactor Fuel.

a. The bases for TS 3.8 b. states that the TS assures that fuel elements found to be defective are no longer used for reactor operation. The TS contains a limit on dimensional changes of coolant channel between fuel plates of 10 mils. What is the basis for the 10 mils and what is the impact of this amount of fuel channel dimensional change on thermal-hydraulic and accident analysis?

b. TS 4.5 requires one of eight fuel elements that have reached their end-of life to be inspected. However, SAR 16.1.1 states that fuel elements are visually inspected during each refueling. Explain this difference between the SAR and proposed TSs. How can unacceptable dimensional changes be found while a fuel element is in service if fuel elements are only inspected at end-of-life?

APPENDIX B

B.1 Appendix B should provide the methodology and calculation of off-site doses at the location of the nearest residence and at the location of highest public dose. Due to the elevated nature of calculated plumes for stable Pasquill Stability Classes (E and F), the chosen location at 150 meters cannot be assured to be at the location of maximum offsite dose. The dose at the nearest residence (760 meter) is dominated by the dose from Pasquill Classes D, E, and F, but at 150 meters, the hypothetical plume has not reached ground level. Further, the methodology to weight the atmospheric dispersion conditions will not work for the non-linear calculation of dispersion if only a single receptor distance is used. Provide a revised calculation of off-site dose from Ar-41 that determines the maximum offsite dose.

APPENDIX C

C.2 Section C.2.1, RELAP5 Application. RELAP5/MOD3.3 had a fundamental error in the point kinetics model that has recently been fixed. Does the version of the code used in the thermal-hydraulic analysis have the fixes implemented? If not, confirm that the analysis model is giving results consistent with the transient, e.g. by checking results as a function of time step or with another stand-alone point kinetics model.

C.3 Section C.2.2, Modeling of the MURR. Please explain why initial conditions of the analysis are not TS and license limits. Please discuss the effect on the analysis of fuel burnup and oxide layer build up on the fuel cladding.