December 17, 2015

Mr. Ralph Butler, Executive Director
University of Missouri-Columbia
Research Reactor Center
1513 Research Park Drive
Columbia, MO 65211

SUBJECT: UNIVERSITY OF MISSOURI AT COLUMBIA – CLARIFICATIONS NEEDED TO NUCLEAR REGULATORY COMMISSION STAFF REQUEST FOR ADDITIONAL INFORMATION REGARDING THE RENEWAL OF FACILITY OPERATING LICENSE NO. R-103 FOR THE UNIVERSITY OF MISSOURI AT COLUMBIA RESEARCH REACTOR (TAC NO. ME1580)

Dear Mr. Butler:

The U.S. Nuclear Regulatory Commission (NRC) is continuing its review of your application for the renewal of Facility Operating License No. R-103, dated August 31, 2006 (redacted versions of the application and supplement are available on the NRC's public web site at www.nrc.gov under Agencywide Documents Access and Management System (ADAMS) Accession Nos.: ML062540114 - cover letter; ML092110573 - Safety Analysis Report (SAR), Chapters 1-9; ML092110597 - SAR, Chapters 10-18), for the University of Missouri at Columbia Research Reactor. The NRC staff reviewed your responses, by letter dated October 1, 2015 (ADAMS Accession No. ML15275A314), to our request for additional information (RAI), by letter dated April 17, 2015 (ADAMS Accession No. ML15098A648), and identified several RAI responses which needed additional information or clarification. These RAIs were discussed with your staff by a conference call conducted on November 20, 2015. Those RAI responses which need additional information or clarification are provided in the enclosure.

In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) 50.30(b), "Oath or affirmation," you must execute your response in a signed original document under oath or affirmation. Your response must be submitted in accordance with 10 CFR 50.4, "Written communications." Information included in your response that is considered sensitive or proprietary, that you seek to have withheld from the public, 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." Following receipt of the additional information, we will continue our evaluation of your renewal request.

If you need additional time to complete this request, or have any questions regarding this review, please contact me at (301) 415-0893, or by electronic mail at Geoffrey.Wertz@nrc.gov.

Sincerely,

/RA/

Geoffrey A. Wertz, 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: See next page

cc:

Les Foyto, Associate Director
Reactor and Facilities Operations
University of Missouri – Columbia
Research Reactor Center
1513 Research Park Drive
Columbia, MO 65211

Homeland Security Coordinator
Missouri Office of Homeland Security
P.O. Box 749
Jefferson City, MO 65102

Planner, Department of Health and Senior Services
Section for Environmental Public Health
P.O. Box 570
Jefferson City, MO 65102

Deputy Director for Policy
Department of Natural Resources
1101 Riverside Drive
Fourth Floor East
Jefferson City, MO 65101

A-95 Coordinator
Division of Planning
Office of Administration
P.O. Box 809, State Capitol Building
Jefferson City, MO 65101

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

If you need additional time to complete this request, or have any questions regarding this review, please contact me at (301) 415-0893, or by electronic mail at Geoffrey.Wertz@nrc.gov.

Sincerely,

/RA/

Geoffrey A. Wertz, 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: See next page

DISTRIBUTION:

PUBLIC	PRLB R/F	RidsNrrDprPrta Resource
RidsNrrDprPrtb Resource	GWertz, NRR	JEads, NRR
RidsNrrDpr Resource	AMendiola, NRR	AAdams, NRR
NParker, NRR		

ADAMS Accession No: ML15337A175; *concurrence via email **NRR-106**

OFFICE	DPR/PRLB/PM*	DPR/PRLB/LA*	DPR/PRLB/BC	DPR/PRLB/PM
NAME	GWertz	NParker	AAdams	(AAdams for) GWertz
DATE	12/02/2015	12/03/2015	12/17/2015	12/17/2015

OFFICIAL RECORD COPY

OFFICE OF NUCLEAR REACTOR REGULATION

CLARIFICATIONS NEEDED FOR THE

REQUEST FOR ADDITIONAL INFORMATION

FOR THE RENEWED LICENSE FOR

THE UNIVERSITY OF MISSOURI-COLUMBIA RESEARCH REACTOR

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

The U.S. Nuclear Regulatory Commission (NRC) is continuing its review of your application for the renewal of Facility Operating License No. R-103, dated August 31, 2006 (redacted versions of the application and supplement are available on the NRC's public web site at www.nrc.gov under Agencywide Documents Access and Management System (ADAMS) Accession Nos.: ML062540114 - cover letter; ML092110573 - Safety Analysis Report (SAR), Chapters 1-9; ML092110597 - SAR, Chapters 10-18), for the University of Missouri at Columbia Research Reactor. The NRC staff reviewed your responses, by letter dated October 1, 2015 (ADAMS Accession No. ML15275A314), to our request for additional information (RAI), by letter dated April 17, 2015 (ADAMS Accession No. ML15098A648), and identified several RAI responses which needed additional information or clarification. These RAIs were discussed with your staff by a conference call conducted on November 20, 2015. Those RAI responses which need additional information or clarification are provided below.

Note: The numbering in the column labeled "RAI No." corresponds to the RAIs issued by NRC letter dated April 17, 2015. The brackets [page] at the end of each item indicate the page number on the RAI response provided by MURR letter dated October 1, 2015.

RAI No.	Information/Clarification Needed
1. a.	i. No information was provided for the rod time for full insertion (scram). Provide a consistent and conservative definition of the full control rod insertion and ensure that this definition is used for all accident analyses [page 5]. ii. Table 2 indicates that the shim blade worth is .01364 (positive) and the 80 percent inserted worth is -0.1127 (negative). Ensure that a consistent use of the sign (positive/negative) for control blade worth is used in all responses [page 6]. iii. The response indicates that using fresh (new) control blades is conservative. For some situations this does not seem correct, (e.g., depleted blades would be more conservative for shutdown margin). Clarify and revise the response as necessary [page 6]. iv. Table 3 does not provide the individual blade worths as requested (for blades 1, 2, 3, 4, shim and regulating). Provide individual blade worths and revise calculations of core sub-criticality [page 7].

Enclosure

1. b.	The information provided in the response only addressed Loss of Coolant Accident and Loss of Flow Accident. Provide blade worths and scram times for all accidents analyzed, or ensure that a consistent set of such values are used in the accident analyses [page 7].
3. c.	Only blade D measurements were provided. Provide a numerical list of the control blade worths (calculated and measured) for blades 1, 2, 3, 4, shim, and regulating for the operational core(s), and specify the conditions that apply (power, flow, xenon, temperature, etc.) [page 20].
4.	The response referenced SAR 4-41 and 4-42, which related to a core configuration described as typical. However, the methods used in that analysis are not consistent with the analytical methods defined in the current RAI responses. Explain [page 26].
6. a.	i. The insertion of excess reactivity analysis does not specify what blade worths were used. Provide the blade worths [page 31]. ii. Table 1 does not specify which values pertain to the top or bottom of fuel and how this data was generated. Provide clarification [page 32].
7. a.	i. The basis for the peaking factor of 2.423 was not explained. Explain [page37]. ii. The response describes the use of 5,474-gram fuel, but the inventory appears to use 6.2 kg. Clarify the basis for the inventory provided [page 37].
7. d.	RAI responses appear to reference Attachment numbers that are not correct (Attachment 8 may actually be Attachment 10, Attachment 9 may actually be Attachment 11, etc.). This appears to occur in multiple locations in the response document. Review and revise as necessary.
7. g.	i. The basis for establishing the source term is not clear. Provide the basis, and, if possible, the source term output (e.g., ORIGEN, etc.) [page 40]. ii. The information provided on the average radioiodine concentrations refers to their decayed values, but the values seem to be constant (not decayed). Explain and provide assumptions for decay, if applicable [page 45]. iii. The values for Krypton (Kr)-89, Kr-90, Xenon (Xe)-135m, Xe-137, and Xe-138 concentrations appear to be low in comparison to confirmatory calculations done by the NRC staff [pages 45 and 53]. Explain and revise as necessary. iv. It appears that the derived air concentration (DAC) values were used from different sources (10 CFR Part 20 Appendix B, and 10 CFR 835). Provide dose calculations using a consistent methodology [page 48]. v. It appears that the thyroid dose calculation is provided instead of the committed effective dose equivalent (CEDE). Provide the CEDE [page 48]. vi. The basis for the dilution source reduction factor of 292 is not clear. Provide the basis for this value [page 51]. vii. The basis for the use of the effluent concentration limit of 2.0×10^{-8} is not provided. Explain [page 51].
9. a.	The response does not describe the alarms that would indicate a fuel malfunction event. Provide a description of all such alarms and fully respond to the information requested in the RAI [page 59].

9. b.	i. The basis for establishing the source term is not clear. Provide a basis, preferably the source term output (e.g., ORIGEN, etc.) [page 59]. ii. The source term values appear incorrect for 30 minutes of decay based on confirmatory calculations by NRC staff. Explain and revise as necessary [page 62]. iii. On page 63 of the response the activity in the pool water is stated to be instantaneously released but on page 64 this activity is stated to be decayed. Explain if the radioisotopes are decayed, and if they are, the basis and assumptions used [page 64]. iv. It appears that the thyroid dose calculation is provided instead of the CEDE. Provide CEDE [page 67]. v. The basis for the use of the effluent concentration limit of 2.0×10^{-8} is not provided [page 70].
10. a	The response does not describe the alarms that would indicate an experiment malfunction event. Provide a description of all such alarms and fully respond to the information requested in the RAI [page73].
10. b	i. Neither the SAR, nor the response, explain how venting of a fueled experiment is accomplished. Describe this path and the equipment involved in that path for monitoring and/or mitigating radioisotopes released in this manner [page 74]. ii. The response does not describe the limiting locations of a failed fueled experiment for occupational or public receptors. Explain in the revised response and ensure that the response addresses both vented and unvented fueled experiments [page 74].
10. c	i. The response indicates that releases from fueled experiments are tallied with the normal release information reported annually. It does not clarify what level of reporting would occur if a failed fueled experiment would occur and when that reporting would take place. Clarify [page 74]. ii. The basis for establishing the source term is not clear. Provide a basis, preferably the source term output (e.g., ORIGEN, etc.) [page 76]. iii. The response indicates that this accident involves an instantaneous release. It is not clear why there is a discussion of decaying the isotopes. Explain [page 77]. iv. The values of Kr-89, Kr-90, Xe-137, and Xe-138 concentrations appear to be low in comparison to confirmatory calculations performed by the NRC staff. Explain and revise as necessary [pages 78]. v. It appears that the DAC values were used from different sources (10 CFR Part 20 Appendix B, and 10 CFR 835). Provide dose calculations using a consistent methodology [page 80]. vi. It appears that the thyroid dose calculation is provided instead of the CEDE. Provide the CEDE [page 80].