October 19, 2001

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

SUBJECT: UNIVERSITY OF MISSOURI-COLUMBIA - AMENDMENT RE: EXTENSION OF LICENSE EXPIRATION DATE (TAC NO. MB0850)

Dear Mr. Butler:

The U.S. Nuclear Regulatory Commission (Commission) has issued the enclosed Amendment No. 32 to Amended Facility License No. R-103 for the University of Missouri-Columbia Research Reactor. The amendment changes the Facility License in response to your application of December 27, 2000, as supplemented on April 12 and June 6, 2001.

The amendment changes the license expiration date from November 21, 2001, to October 11, 2006. This amendment recaptures the construction time between the issuance date of Construction Permit No. CPRR-68 and issuance of the operating license.

A copy of the safety evaluation supporting Amendment No. 32 is also enclosed.

Sincerely,

/RA/

Alexander Adams, Jr., Senior Project Manager
Operational Experience and
Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosures:
1. Amendment No. 32
2. Safety Evaluation

cc w/enclosures:
Please see next page

cc:

University of Missouri
Associate Director
Research Reactor Facility
Columbia, MO 65201

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

Mr. Ron Kucera, Director
Intergovernmental Cooperation
and Special Projects
Missouri Department of Natural Resources
P.O. Box 176
Jefferson City, MO 65102

October 19, 2001

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

SUBJECT: UNIVERSITY OF MISSOURI-COLUMBIA - AMENDMENT RE: EXTENSION OF LICENSE EXPIRATION DATE (TAC NO. MB0850)

Dear Mr. Butler:

The U.S. Nuclear Regulatory Commission (Commission) has issued the enclosed Amendment No. 32 to Amended Facility License No. R-103 for the University of Missouri-Columbia Research Reactor. The amendment changes the Facility License in response to your application of December 27, 2000, as supplemented on April 12 and June 6, 2001.

The amendment changes the license expiration date from November 21, 2001, to October 11, 2006. This amendment recaptures the construction time between the issuance date of Construction Permit No. CPRR-68 and issuance of the operating license.

A copy of the safety evaluation supporting Amendment No. 32 is also enclosed.

Sincerely,

/RA/

Alexander Adams, Jr., Senior Project Manager
Operational Experience and
Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No. 50-186

Enclosures:
1. Amendment No. 32
2. Safety Evaluation

cc w/enclosures:
Please see next page

DISTRIBUTION:

PUBLIC	REXB r/f	TDragoun	MMendonca
AAdams	EImbro	OGC	EHylton
FGillespie	SHolmes	CBassett	DMatthews
WEresian	PIsaac	GHill (2) (T5-C3)	PDoyle

ACCESSION NO.: ML011170201 **TEMPLATE #: NRR-058**
***Please see previous concurrence**

OFFICE	REXB:LA	TechEd	REXB:PM	OGC	REXB:ABC
NAME	EHylton:rdr	*PKleene	*AAdams	*SUttah	EImbro
DATE	05/ 18 /2001	04/ 14 /2001	05/ 18 /2001	07/ 13 /2001	10/ 16 /2001

C = COVER **E = COVER & ENCLOSURE** **N = NO COPY**
OFFICIAL RECORD COPY

UNIVERSITY OF MISSOURI-COLUMBIA

DOCKET NO. 50-186

AMENDMENT TO AMENDED FACILITY LICENSE

Amendment No. 32
License No. R-103

1. The U.S. Nuclear Regulatory Commission (the Commission) has found that

   A. The application for an amendment to Amended Facility License No. R-103 filed by the University of Missouri-Columbia (the licensee) on December 27, 2000, as supplemented on April 12 and June 6, 2001, conforms to the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the regulations of the Commission as stated in Chapter I of Title 10 of the *Code of Federal Regulations* (10 CFR);

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance that (i) the activities authorized by this amendment can be conducted without endangering the health and safety of the public and (ii) such activities will be conducted in compliance with the regulations of the Commission;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public;

   E. This amendment is issued in accordance with the regulations of the Commission as stated in 10 CFR Part 51, and all applicable requirements have been satisfied; and

   F. Prior notice of this amendment was not required by 10 CFR 2.105 and publication of a notice for this amendment is not required by 10 CFR 2.106.

2. Accordingly, the license is amended by a change to paragraph 4. of Amended Facility License No. R-103 which is hereby amended to read as follows:

   4. This amended license is effective as of date of issuance and shall expire at midnight on October 11, 2006.

3. This license amendment is effective as of the date of its issuance.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

Eugene V. Imbro, Acting Chief
Operational Experience and
Non-Power Reactors Branch
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Date of Issuance: October 19, 2001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

SUPPORTING AMENDMENT NO. 32 TO

AMENDED FACILITY LICENSE NO. R-103

THE UNIVERSITY OF MISSOURI-COLUMBIA

DOCKET NO. 50-186

1.0 INTRODUCTION

By letter dated December 27, 2000, as supplemented on April 12 and June 6, 2001, the University of Missouri-Columbia (UMC or the licensee) submitted a request to extend the expiration date of Amended Facility License No. R-103 for the University of Missouri-Columbia Research Reactor (MURR) from November 21, 2001, to October 11, 2006.

2.0 EVALUATION

The regulation in 10 CFR 50.51 specifies that each license will be issued for a fixed period of time not to exceed 40 years from the date of issuance. Construction Permit No. CPRR-68 was issued to the licensee on November 21, 1961. Facility Operating License No. R-103 was issued on October 11, 1966, with an expiration date of November 21, 2001, 40 years after the issuance date of the construction permit. To allow the operating license to have a fixed term of time not to exceed 40 years, the licensee has requested that the expiration date of the license be changed from midnight November 21, 2001, to midnight October 11, 2006, 40 years after the issuance date of Facility Operating License R-103. This would recapture the time from November 21, 1961, the date of issuance of CPRR-68, until October 11, 1966, the issuance date of Facility Operating License No. R-103.

The reactor is a pressurized, reflected, light-water-moderated and -cooled heterogeneous design fueled with high-enriched, aluminum-clad, plate-type fuel. The reactor has a maximum steady-state power level of 10 megawatts thermal (MW(t)). The reactor core is in a pressure vessel. The reactor pressure vessel is in a cylindrically shaped pool and during operation is covered by about 23 feet (7 m) of water for radiation shielding. The reactor pool is surrounded by a biological shield. The reactor is located within a containment building.

Facility Operating License No. R-103 was issued to the University with a maximum power level of 5 MW(t). On July 9, 1974, Amendment No. 2 to the license was issued increasing the maximum operating power level to 10 MW(t). The facility normally operates on a 24-hour-a-day schedule with a shutdown once a week for refueling and maintenance. The facility has a history of more than 200,000 hours of safe operation over 34 years.

The NRC staff has evaluated the safety issues associated with issuance of the proposed license amendment. These issues involve the condition of various facility systems and the ability of these systems to continue to function adequately during the recapture period. Very few components in a non-power reactor (NPR) are subjected to high temperatures and

pressures or high neutron fluence. Although the MURR is unique among NRC-licensed NPRs in having the reactor core in a pressurized vessel, the pressure safety limit for the reactor is 85 psia (482 kPa), which is significantly less than pressures encountered in nuclear power plants.

The facility technical specifications (TSs) contain surveillance requirements for components with a safety function. The licensee has developed procedures to carry out the surveillance requirements of the TSs and has carried out these surveillances in accordance with the TSs and procedures as verified by the NRC inspection program for the facility. The TS-required surveillance procedures help to ensure that facility equipment functions as described in the hazards analysis report and that unacceptable degradation of equipment is not occurring. The NRC NPR inspection program reviews the frequencies and results of these surveillance procedures to ensure compliance with the requirements of the TSs. The NRC inspection program has not identified programatic problems in the area of facility surveillance and condition of equipment. Equipment failures that have occurred were corrected and steps were taken by the licensee to minimize reoccurrence. Items that have fixed lifetimes, such as control rods and reflectors, are replaced on an established schedule.

The licensee discussed the material condition of the containment building, core components, reactor safety system, primary and pool water systems, and radiation monitoring systems. The licensee outlined the necessary testing and calibrations that are performed on these systems, if necessary.

The reactor is designed so that components subjected to high neutron fluence can be replaced. These components are the reactor pressure vessel, island tube sample holder, control blades, beryllium reflector, and graphite reflector elements. Some reactor components are replaced on a routine basis. For example, the beryllium reflector is replaced about every 26,000 megawatt-days (about every 8 years) to prevent stress cracking. Control blades are used 2 years in the reactor, removed from service and inspected, and are returned to service if acceptable. Control blades are used for a maximum of about 6 years in the reactor. Graphite reflector elements are inspected and are replaced as needed. All of the original graphite elements have been replaced. The island tube sample holder was last replaced in 1999 to change the configuration of the holder.

The reactor pressure vessel dates to original construction. It is made of 6061-T6 aluminum alloy. The vessel consists of two concentric pipes, which are surrounded by water in the reactor pool. The pressure boundary is between the outer wall of the inner pipe and the inner wall of the outer pipe. Inside the inner pipe is an area open to the reactor pool. The island tube sample holder is located here. The outside of the outer pipe is in contact with the pool water. If a pressure vessel pipe broke, a low-pressure reactor scram would occur and the reactor primary system coolant would mix with the reactor pool coolant. This failure would not endanger the facility staff or the public. The pipes making up the MURR aluminum vessel are not subject to ductile-brittle transition. However, other damage mechanisms such as irradiation aging, corrosion, and low-cycle fatigue (caused by neutron fluence, pH, and stress to the vessel pipes) must be considered. Studies have been performed at the Oak Ridge National Laboratory as part of development work for the Advanced Neutron Source Reactor on the impact of high neutron fluence on 6061-T6 aluminum. Of concern is the stress from swelling of the aluminum caused by transmutation of aluminum into silicon by thermal neutrons and the formation of microscopic voids by fast neutrons. Information from the studies indicates that

operation of the MURR reactor for the requested recapture period will not have any deleterious material property effects caused by neutron exposure. The primary and pool coolant pH and conductivity are measured routinely and maintained within limits where the aqueous corrosion resistance of the aluminum is high. Cyclic stress on the pressure vessel pipes is caused by the pressurization and depressurization of the primary system as part of reactor startup and shutdown. If the stress is large enough and repeated enough times, material failure due to fatigue can occur. The stress caused by the startup/shutdown cycle in the MURR is less than 20 percent of the infinite lifetime stress limit, and the number of cycles needed for fatigue (even if the stress limit could be exceeded) is much greater that the numbers of cycles the reactor will experience through the end of the recapture period. Therefore pressurization and depressurization of the reactor will not result in pressure vessel pipe failure.

The physical condition of the pressure vessel pipes is observed during weekly refueling and a close visual inspection is performed during replacement of the beryllium reflector. The inspection during the last beryllium replacement in 1997 had no remarkable findings. The beryllium is scheduled for replacement next in 2005. During 2000 a visual inspection was performed of the pool liner, focusing on weld areas. No indications of corrosion or other damage were observed.

Primary coolant sampling for iodine indicates that there have not been any failures of fuel cladding, which is the primary barrier for fission products. In addition, the licensee routinely inspects 12.5 percent of fuel elements at end-of-life for anomalies. No significant deviations from original design have been seen.

The licensee controls water chemistry to minimize corrosion of components in contact with water. The conductivity and pH of the primary and pool system coolant are maintained at levels which minimize corrosion and degradation of components. Conductivity and pH are measured on a regular basis and a conductivity alarm warns the reactor operators of abnormal coolant conductivity.

The licensee has maintained the reactor safety system, radiation monitoring system, and engineered safety features. Systems have been maintained by replacing components that have failed or reached the end of their lives. Systems have also been updated and replaced to reflect advances in technology. The original nuclear instrumentation is in the process of being replaced with state-of-the-art instrumentation. Components that provide process information to the safety system such as temperature transmitters, resistance temperature detectors, relay units, and trip units have been updated. The area radiation monitoring system and stack monitor have been replaced. An additional second stack monitor was recently installed for operational flexibility. Components in the containment isolation system such as control solenoid valves have been replaced as needed. In addition, components (such as an additional containment isolation valve) have been added to the system to provide redundancy.

NRC review of MURR annual reports and the NRC NPR inspection program have shown the effluent releases from the MURR are below allowable limits and that public and staff exposure to radiation is well controlled and below allowable limits. Airborne effluents meet the concentration limits of Technical Specification 3.7 and are within the constraint on air emissions of 10 mrem per year total effective dose equivalent in 10 CFR 20.1101(d). Liquid effluent monthly concentrations meet regulatory requirements found in Appendix B, Table 3 of 10 CFR Part 20 in accordance with 10 CFR 20.2003. Occupational staff exposure to radiation

meets the requirements of 10 CFR Part 20, Subpart C and radiation dose to members of the public meets the requirements in 10 CFR Part 20, Subpart D. The staff expects that releases and exposures will continue to be within limits during the construction permit recapture period.

The licensee has maintained administrative controls such as emergency preparedness, security, operator training, and quality assurance in compliance with the regulations and the facility emergency, security, and operator requalification plans. Changes to the facility are carried out in accordance with the regulations. Changes undergo facility management and safety committee review (the Reactor Safety Subcommittee and/or the Reactor Advisory Committee). Modifications to the facility are tracked and the TSs require that additions and modifications to systems described in the TSs shall be made, tested, and maintained in accordance with the specifications to which the system was originally designed and fabricated or with specifications approved by NRC.

The staff concludes from its consideration of the design, operation, testing, and monitoring of the structures, systems, and components that an operating license for the MURR with a 40-year term is consistent with NRC safety evaluations, supporting amendments, and licensing documentation. Also, the NRC staff considers that the licensee's organization has maintained the capability to continue operations safely during the recapture period. Therefore, based on the discussion above, the NRC staff finds there is reasonable assurance that the MURR will continue to operate safely for the additional period of time authorized by this amendment.

3.0 ENVIRONMENTAL CONSIDERATION

The Commission has prepared an Environmental Assessment and Finding of No Significant Impact (EA), which was published in the *Federal Register* on October 19, 2001 (66 FR 53267).

On the basis of the EA and this safety evaluation, the Commission has determined that no environmental impact statement is required and that issuance of this amendment will have no significant adverse effect on the quality of the human environment.

4.0 CONCLUSION

The staff has concluded, on the basis of the considerations discussed above, that (1) because the amendment does not involve a significant increase in the probability or consequences of accidents previously evaluated, or create the possibility of a new or different kind of accident from any accident previously evaluated, and does not involve a significant reduction in a margin of safety, the amendment does not involve a significant hazards consideration; (2) there is reasonable assurance that the health and safety of the public will not be endangered by the proposed activities; and (3) such activities will be conducted in compliance with the Commission's regulations and the issuance of this amendment will not be inimical to the common defense and security or the health and safety of the public.

Principal Contributor: A. Adams, Jr.

Date: October 19, 2001