

February 20, 2008

Mr. P. Michael Whaley  
Kansas State University  
Nuclear Reactor Facilities Manager  
112 Ward Hall  
Manhattan, KS 66506-2500

SUBJECT: KANSAS STATE UNIVERSITY TRIGA MARK II NUCLEAR REACTOR  
ENVIRONMENTAL ASSESSMENT REGARDING RENEWAL AND POWER  
UPRATE OF FACILITY LICENSE NO. R-88 (TAC NO. MC9031)

Dear Mr. Whaley:

Enclosed is a copy of the Environmental Assessment and Finding of No Significant Impact regarding the application submitted by Kansas State University (KSU) dated September 12, 2002, as supplemented on November 11, and November 13, 2002; December 21, 2004; July 6, and September 27, 2005; March 20, March 30, June 28, and September 28, 2006; May 17, June 4, September 12, and October 11, 2007; and February 6, 2008, for a renewed Facility License No. R-88 for the Kansas State University TRIGA Mark II nuclear reactor (KSU TRIGA). The proposed action would renew Facility License No. R-88 for twenty years from the date of issuance of the renewed license, increase the licensed maximum steady-state power level to 1.25 megawatts thermal power, and increase the licensed maximum pulse reactivity insertion to \$3.00. If you have any questions regarding this review, please contact William B. Kennedy at 301-415-2784, or me at 301-415-1631.

Also enclosed is the Notice of Issuance of the Environmental Assessment that is being forwarded to the Office of the Federal Register for publication.

Sincerely,

**/RA/**

Daniel E. Hughes, Project Manager  
Research and Test Reactors Branch A  
Division of Policy and Rulemaking  
Office of Nuclear Reactor Regulation

Docket No. 50-188  
Enclosures: As stated  
cc w/enclosures: Please see next page

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Kansas State University

Docket No. 50-188

cc:

Office of the Governor  
State of Kansas  
Topeka, KS 66612

Mayor of Manhattan  
P.O. Box 748  
Manhattan, KS 66502

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

UNITED STATES NUCLEAR REGULATORY COMMISSIONKANSAS STATE UNIVERSITYDOCKET NO. 50-188KANSAS STATE UNIVERSITY TRIGA MARK II NUCLEAR REACTORENVIRONMENTAL ASSESSMENT AND FINDING OFNO SIGNIFICANT IMPACT

The U.S. Nuclear Regulatory Commission (NRC) is considering issuance of a renewed Facility License No. R-88, to be held by Kansas State University (the licensee), which would authorize continued operation of the Kansas State University TRIGA Mark II nuclear reactor (KSU TRIGA), located in Manhattan, Riley County, Kansas. Therefore, pursuant to 10 CFR 51.21, the NRC is issuing this Environmental Assessment and Finding of No Significant Impact.

ENVIRONMENTAL ASSESSMENTIdentification of the Proposed Action:

The proposed action would renew Facility License No. R-88 for a period of twenty years from the date of issuance of the renewed license, and would increase the licensed maximum steady-state power level to 1.25 megawatts thermal power (MW(t)) and the maximum pulse reactivity insertion to \$3.00 (approximately 1340 MW(t) maximum pulse power). The proposed action is in accordance with the licensee's application dated September 12, 2002, as supplemented on November 11, and November 13, 2002; December 21, 2004; July 6, and September 27, 2005; March 20, March 30, June 28, and September 28, 2006; May 17, June 4, September 12, and October 11, 2007; and February 6, 2008. In accordance with 10 CFR 2.109, the license remains in effect until the NRC takes final action on the renewal application.

Need for the Proposed Action:

The proposed action is needed to allow the continued operation of the KSU TRIGA to routinely provide teaching, research, and services to numerous institutions for a period of twenty years. Additionally, the proposed action is needed to enhance the ability of the KSU TRIGA to provide teaching, research, and services.

Environmental Impacts of the Proposed Action:

The NRC has completed its safety evaluation of the proposed action and concludes there is reasonable assurance that the KSU TRIGA will continue to operate safely for the additional period of time and at the increased power level specified in the renewed license. The details of the staff's safety evaluation will be provided in the renewed Facility License No. R-88.

The KSU TRIGA is located in the north wing of Ward Hall in the northwest sector of the University campus near the center of the city of Manhattan, Kansas. Manhattan and KSU lie in Riley County in the Flint Hills uplands. The reactor is located approximately 1.9 miles (3 km) northwest of the Kansas River and 5.6 miles (9 km) south of the Tuttle Creek Reservoir. The reactor is housed in the reactor bay, a reinforced concrete and structural steel building which serves as a confinement. The KSU TRIGA site comprises the entire building and the fenced areas immediately surrounding the building. There are no nearby industrial, transportation, or military facilities that could pose a threat to the KSU TRIGA.

The KSU TRIGA is a pool-type, light water moderated and cooled research reactor currently licensed to operate at a steady-state power level of 250 kilowatts thermal power (kW(t)). The reactor is licensed to operate in a pulse mode, with a maximum pulse thermal power of 250 MW(t). The core is located at the bottom of an aluminum tank with a diameter of 6.5 feet (2.0 m) and a depth of 20.5 feet (6.25 m). The reactor is fueled with TRIGA Mark III fuel elements and may utilize instrumented TRIGA Mark II fuel elements during the renewal period. Reactivity control is provided by 3 standard control rods and 1 transient/pulsing control rod. A

detailed description of the reactor can be found in the KSU TRIGA Safety Analysis Report (SAR). The major modifications to the Facility License were a power uprate to 250 kW(t) and the addition of pulsing capability in June 1968, and authorization to utilize stainless-steel-clad fuel in August 1970.

The licensee has requested a change to the facility design as part of the renewal request. Specifically, the licensee has requested authorization to install an additional control rod to support operation at the increased power level. The licensee has requested changes in the facility operating conditions as part of the renewal request. Specifically, the licensee has requested an increase in the licensed maximum steady-state power level and an increase in the maximum reactivity insertion. The proposed action will not significantly increase the probability of accidents. The proposed action may increase the consequences of accidents. Specifically, the increase in maximum steady-state power level may increase the fission product source term and occupational and public accident dose for the maximum hypothetical accident. The worst-case fission product source term will not result in occupational doses or doses to members of the general public in excess of the limits specified by 10 CFR Part 20. No changes are being made in the types of effluents that may be released off site. There should be no significant increase in routine occupational or public radiation exposure. Therefore, the proposed action should not significantly change the environmental impact of facility operation.

#### I. Radiological Impact

Gaseous effluents are discharged via a vent located in the ceiling of the reactor bay 11 m above grade at a volumetric flow rate of 884 ft<sup>3</sup>/min (0.417 m<sup>3</sup>/s). The reactor bay contains a continuous air monitor that measures particulate and gaseous airborne radioactivity. Another monitoring system samples air directly above the reactor pool for particulate, noble gas, and iodine activity. The only significant nuclide found in the gaseous effluent stream is Argon-41. Chapter 11, Appendix A of the KSU Safety Analysis Report (SAR) calculates the

maximum Argon-41 effluent concentration based on activation of natural Argon dissolved in the reactor pool water. The analysis shows that continuous operation at 1.25 MW(t) will lead to an average Argon-41 effluent concentration at the restricted area boundary of  $7.3 \times 10^{-9}$   $\mu\text{Ci/ml}$ , or 73% of the limit given in 10 CFR 20, Appendix B, Table 2. (Continuous operation at the current power level would lead to an average Argon-41 effluent concentration at the restricted area boundary of approximately  $1.4 \times 10^{-9}$   $\mu\text{Ci/ml}$ , or 14% of the limit given in 10 CFR 20, appendix B, Table 2.) This analysis is overly conservative as the licensee expects reactor operation to total approximately 5 megawatt-days (MWD) per year, or 1.1% of the 456 MWD per year required for continuous full-power operation. Additionally, the concentration of Argon-41 in the reactor bay will not reach equilibrium during a typical 4 to 8 hour operating period. The KSU TRIGA Technical Specifications (TS) limit the release of Argon-41 to 30 Ci per year, corresponding to a maximum offsite dose of 9.7 mrem/yr (97  $\mu\text{Sv/yr}$ ). Based on realistic analysis and the KSU TRIGA TS, the licensee will continue to satisfy the limit set by 10 CFR 20, Appendix B, Table 2, for Argon-41 emissions, and continue to maintain doses to the general public from gaseous emission ALARA (As Low As is Reasonably Achievable) as required by 10 CFR 20.1101(d).

Liquid effluents are discharged to the sanitary sewer. Discharge to the sanitary sewer occurs via the reactor bay sump which is sampled prior to discharge. The volume, activity, and inventory of the effluent stream is recorded to ensure compliance with applicable regulations. The majority of the liquid effluent stream is condensate from the reactor bay air handling unit. This condensate contains tritium generated through neutron absorption in the reactor pool water. As a result of increasing the maximum licensed power level, it can be expected that the tritium content of the reactor pool will increase linearly with the power level. Based on liquid effluent data from the past 10 years, tritium releases to the sanitary sewer should not exceed  $0.00125$   $\mu\text{Ci/ml}$ , or 12.5% of the limit given in 10 CFR 20, Appendix B, Table 3, for operation at

1.25 MW(t). (During the last 10 years, the highest tritium release concentration was 0.00025  $\mu\text{Ci/ml.}$ ) Other nuclides found in the liquid effluent stream include Cesium-137 and Cobalt-60. The concentrations of these nuclides are not expected to change as a result of increasing the reactor power level, and historically have always been within the applicable regulatory limits.

Solid low-level radioactive waste consists of items and materials used in the operation of the facility such as ion-exchange resins, filters, laboratory supplies, and cleaning materials. Approximately 1.5  $\text{ft}^3$  (0.042  $\text{m}^3$ ) of ion-exchange resin is replaced every 2-3 years. The spent resin is aggregated until a significant quantity can be collected for disposal. The increase in maximum power level is not expected to cause an increase in the volume of any solid radioactive waste generated at the KSU TRIGA, however, the specific activity of the spent ion-exchange resin is expected to increase. Based on historical data, the activity of any nuclide is not expected to exceed 400 mCi for a shipment. (During the last 13 years, one shipment of solid radioactive waste contained 80 mCi of Strontium-90.) The KSU TRIGA does not anticipate the need to ship any high-level radioactive waste during the 20-year period of license renewal.

Personnel exposures reported to the NRC were within the limits set by 10 CFR 20.1201, and ALARA. The increase in maximum reactor power level is expected to cause a minimal increase in personnel exposure, with no individual receiving a dose greater than 10% of the limits set by 10 CFR 20.1201. This expectation is based on the implementation of radiation protection and ALARA programs which have their bases in area radiological conditions, and not reactor power. Historically, doses to members of the general public who use the reactor (non-operations-personnel who are students and professors engaged in academic activities) were typically less than 15 mrem/yr (0.15mSv/yr) and within the limits set by 10 CFR 20.1301 and ALARA. Due to their limited exposure to radiation fields associated with the reactor itself, the

increase in maximum reactor power level is expected to cause a minimal increase in doses to these members of the general public, with no dose exceeding 50% of the limits set by 10 CFR 20.1301.

The licensee conducts voluntary radiation surveys of the restricted area boundary to record the radiological effect of KSU TRIGA operation on the surrounding unrestricted area. The radiation survey program comprises monitoring stations immediately surrounding the reactor bay exterior walls. The surveys are performed semi-annually, and from 1999 to 2004 indicated a dose rate of 0.044 mrem/hr (0.44  $\mu$ Sv/hr) during operation at 250 kW(t). The increase in maximum power level is expected to result in a dose rate of 0.22 mrem/hr (2.2  $\mu$ Sv/hr). The licensee expects typical annual reactor operation to total 5 MWD resulting in a dose of 21 mrem/yr (0.21 mSv/yr) at the exterior wall of the reactor bay. Historically, annual reactor operations totaled 1 MWD/yr, giving a dose of approximately 4 mrem/yr (40  $\mu$ Sv/yr.) This is below the limit set by 10 CFR 20.1301 of 100 mrem/yr (1 mSv/yr). The exterior wall of the reactor bay lies within a controlled access area enclosed by a chain-linked fence, reducing the likely annual dose of a maximally-exposed individual member of the general public.

## II. Non-Radiological Impact

The KSU TRIGA core is cooled by a demineralized, light water primary system consisting of a 5000 gal (19,000 L) tank, a heat removal system, and a processing system. Cooling of the fuel occurs by natural convection, and the bulk coolant temperature is controlled with a forced flow heat removal system. The heat removal system transfers heat to the secondary system via a plate-type heat exchanger. The secondary system uses city water to transport heat to a cooling tower positioned next to the facility.

Release of thermal effluents from the KSU TRIGA will not have a significant effect on the environment. The small amount of waste heat generated, approximately 1.25 MW at operation at full power, is transferred to the atmosphere by means of the cooling tower. This is

similar to the air conditioning unit for a large office building. Extensive heat drift will not occur at this heat dissipation rate. Generation of water vapor by the cooling tower is insufficient to cause significant fog buildup in the area.

Evaporative and blowdown losses in the secondary system, approximately 68 gal (260 L) per hour of operation during environmental conditions of high heat and low humidity are replenished with city water. The secondary system water usage is expected to scale linearly with the increase in power level, raising the peak hourly usage to 340 gal (1300 L). This rate of water usage is insignificant when compared to the total water usage for the Kansas State University Campus and the City of Manhattan. As a result, the proposed action will not have a significant impact on the local water supply.

The KSU TRIGA uses a chemical treatment plan consistent with the cooling tower vendor's recommendation to prevent scale buildup and corrosion in the secondary system. The treatment chemicals have low volatility to increase retention by the system and limit the total quantity needed to maintain efficient dissipation of heat generated in the reactor pool. Consequently, the proposed action will not have a significant chemical impact on the environment during the renewal period.

#### Environmental Effects of Accidents:

Accident scenarios are discussed in Chapter 13 of the KSU TRIGA SAR. The maximum hypothetical accident (MHA) is the instantaneous release of the noble gasses and halogens contained in the gap between the fuel and the cladding of one fuel element to the reactor building and then to the uncontrolled environment. The requested modifications in facility design do not have the potential to significantly increase the probability or consequences of the MHA. The release calculations conservatively assume continuous operation for 40 years at 1.25 MW(t), and 20 minutes of decay prior to release. The worst-case occupational dose resulting from this accident would be approximately 2.4 Rem (24 mSv) TEDE in the absence of

any mitigating actions. (Currently, the worst-case occupational dose resulting from this accident would be approximately 0.5 Rem (5 mSv) TEDE in the absence of any mitigating actions.) This value is below 10 CFR Part 20 limits for occupational exposure. Occupational dose would be significantly less given licensee procedures for timely egress from and controlled access to the confinement building following an accident involving significantly elevated radiation levels.

Worst-case doses to members of the general public would be approximately 3.6 mrem (0.036 mSv) TEDE at a receptor location 30 meters from the ventilation exhaust. (Currently, worst-case doses to members of the general public would be approximately 0.7 mrem (7  $\mu$ Sv) TEDE.) This value is below 10 CFR Part 20 limits for doses to members of the general public.

National Environmental Policy Act (NEPA) Considerations:

I. Endangered Species Act (ESA)

The Bald Eagle, Interior Least Tern, Piping Plover, and Topeka Shiner are listed as threatened or endangered in Riley County, Kansas. The site occupied by the KSU TRIGA does not contain any critical habitat for Federally or State-protected Fauna or Flora, nor do the KSU TRIGA effluents impact any critical habitats of any such Fauna or Flora. Requested modifications to the facility design do not have the potential to impact any critical habitat for Federally or State-protected Fauna or Flora.

II. Coastal Zone Management Act (CZMA)

The site occupied by the KSU TRIGA is not located within any managed coastal zones, nor do the KSU TRIGA effluents impact any managed coastal zones.

III. National Historical Preservation Act (NHPA)

The National Register Information System lists two historical sites located on the Kansas State University Manhattan Campus. The proposed action will not impact these historical sites.

Environmental Impacts of the Alternatives to the Proposed Action:

As an alternative to license renewal, the staff considered denial of the proposed action. If the Commission denied the application for license renewal, facility operations would end and decommissioning would be required with no significant impact on the environment. The environmental impacts of license renewal and this alternative action are similar. In addition, the benefits of teaching, research, and services provided by facility operation would be lost.

Alternative Use of Resources:

The proposed action does not involve the use of any different resources or significant quantities of resources beyond those previously considered in the issuance of Amendment No. 3 to Facility License No. R-88 dated June 26, 1968, which authorized a power uprate to 250 kW(t) and pulsing capability, or Amendment No. 4 dated August 31, 1970, which authorized use of stainless-steel-clad fuel. Although increasing the maximum power level will increase fuel burnup, the associated use of resources is commensurate with the added benefits of facility operation.

Agencies and Persons Consulted:

In accordance with the Agency's stated policy, on November 9, 2006, the staff consulted with the State Liaison Officer, regarding the environmental impact of the proposed action. The State official had no comments regarding the proposed action.

Finding of No Significant Impact:

On the basis of the environmental assessment, the NRC concludes that the proposed action will not have a significant effect on the quality of the human environment. Accordingly, the NRC has determined not to prepare an environmental impact statement for the proposed action.

For further details with respect to the proposed action, see the licensee's letter dated September 12, 2002 (ML022620007, ML022620011, ML022620643, ML022630012, ML022630054, ML022630077), as supplemented on November 11, 2002 (ML023190241); November 13, 2002 (ML023190219); December 21, 2004 (ML052580517); July 6, 2005 (ML051960517, ML051960520, ML051960521, ML051960522, ML052580519, ML052590053); September 27, 2005 (ML052760292); March 20, 2006 (ML061640472); March 30, 2006 (ML061010264); June 28, 2006 (ML070660601); September 28, 2006 (ML063070520); May 17, 2007 (ML071430200); June 4, 2007 (ML071630328); September 12, 2007 (ML072680471); October 11, 2007 (ML072970624) and February 6, 2008 (ML080500366). Documents may be examined, and/or copied for a fee, at the NRC's Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland. Publicly available records will be accessible electronically from the Agencywide Documents Access and Management System (ADAMS) Public Electronic Reading Room on the NRC Web site, <http://www.nrc.gov/reading-rm/adams.html>. Persons who do not have access to ADAMS or who encounter problems in accessing the documents located in ADAMS should contact the NRC PDR Reference staff at 1-800-397-4209, or 301-415-4737, or send an e-mail to [pdrc@nrc.gov](mailto:pdrc@nrc.gov).

Dated at Rockville, Maryland, this 20<sup>th</sup> day of February, 2008.

FOR THE NUCLEAR REGULATORY COMMISSION

**/RA/**

Daniel S. Collins, Chief  
Research and Test Reactors Branch A  
Division of Policy and Rulemaking  
Office of Nuclear Reactor Regulation

UNITED STATES NUCLEAR REGULATORY COMMISSION  
KANSAS STATE UNIVERSITY TRIGA MARK II NUCLEAR REACTOR

DOCKET NO. 50-188

NOTICE OF ISSUANCE OF ENVIRONMENTAL ASSESSMENT

AND FINDING OF NO SIGNIFICANT IMPACT

The U.S. Nuclear Regulatory Commission (NRC) is considering issuance of a renewed Facility License No. R-88, to be held by Kansas State University (the licensee), which would authorize continued operation of the Kansas State University TRIGA Mark II nuclear reactor (KSU TRIGA), located in Manhattan, Riley County, Kansas. Therefore, pursuant to 10 CFR 51.21, the NRC is issuing this Environmental Assessment and Finding of No Significant Impact.

Description of Proposed Action

The proposed action would renew Facility License No. R-88 for a period of twenty years from the date of issuance of the renewed license, and would increase the licensed maximum steady-state power level to 1.25 megawatts thermal power (MW(t)) and the maximum pulse reactivity insertion. The proposed action is in accordance with the licensee's application dated September 12, 2002, as supplemented on November 11, and November 13, 2002; December 21, 2004; July 6, and September 27, 2005; March 20, March 30, June 28, and September 28, 2006; May 17, June 4, September 12, and October 11, 2007; and February 6, 2008. In accordance with 10 CFR 2.109, the license remains in effect until the NRC takes final action on the renewal application.

The KSU TRIGA is located in the north wing of Ward Hall in the northwest sector of the University campus near the center of the city of Manhattan, Kansas. The reactor is housed in the reactor bay, a reinforced concrete and structural steel building which serves as a confinement. The KSU TRIGA site comprises the entire building and the fenced areas

immediately surrounding the building. There are no nearby industrial, transportation, or military facilities that could pose a threat to the KSU TRIGA.

The KSU TRIGA is a pool-type, light water moderated and cooled research reactor currently licensed to operate at a steady-state power level of 250 kilowatts thermal power (kW(t)). The reactor is licensed to operate in a pulse mode, with a maximum pulse thermal power of 250 MW(t). A detailed description of the reactor can be found in the KSU TRIGA Safety Analysis Report (SAR).

As part of the proposed action the licensee has requested an increase in the licensed maximum steady-state power level, an increase in the maximum reactivity insertion and authorization to install an additional control rod to support operation at the increased power level. The proposed action will not significantly increase the probability of accidents. The proposed action may increase the consequences of accidents, but will not result in doses in excess of the limits specified by 10 CFR Part 20. No changes are being made in the types of effluents that may be released off site. There should be no significant increase in routine occupational or public radiation exposure. Therefore, the proposed action should not significantly change the environmental impact of facility operation.

#### Summary of the Environmental Assessment

The NRC staff reviewed the licensee's application which included an Environmental Report. To document its review, the NRC staff has prepared an environmental assessment (EA) which discusses the KSU TRIGA site and facility; radiological impacts of gaseous, liquid, and solid effluents; environmental and personnel radiation monitoring; radiation dose estimates for the maximum hypothetical accident (MHA); impacts of the "no action" alternative to the proposed action; alternative use of resources; considerations related to the National Environmental Policy Act (NEPA); and presents the radiological and non-radiological environmental impacts of the proposed action.

### Finding of No Significant Impact

On the basis of the environmental assessment, the NRC concludes that the proposed action will not have a significant effect on the quality of the human environment. Accordingly, the NRC has determined not to prepare an environmental impact statement for the proposed action.

For further details with respect to the proposed action, see the licensee's letter dated September 12, 2002 (ML022620007, ML022620011, ML022620643, ML022630012, ML022630054, ML022630077), as supplemented on November 11, 2002 (ML023190241); November 13, 2002 (ML023190219); December 21, 2004 (ML052580517); July 6, 2005 (ML051960517, ML051960520, ML051960521, ML051960522, ML052580519, ML052590053); September 27, 2005 (ML052760292); March 20, 2006 (ML061640472); March 30, 2006 (ML061010264); June 28, 2006 (ML070660601); September 28, 2006 (ML063070520); May 17, 2007 (ML071430200); June 4, 2007 (ML071630328); September 12, 2007 (ML072680471); October 11, 2007 (ML072970624) and February 6, 2008 (ML080500366). Documents may be examined, and/or copied for a fee, at the NRC's Public Document Room (PDR), located at One White Flint North, 11555 Rockville Pike (first floor), Rockville, Maryland. Publicly available records will be accessible electronically from the Agencywide Documents Access and Management System (ADAMS) Public Electronic Reading Room on the NRC Web site, <http://www.nrc.gov/reading-rm/adams.html>. The EA can be found in ADAMS under Accession Number ML063190172. Persons who do not have access to ADAMS or who encounter

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Dated at Rockville, Maryland, this 20<sup>th</sup> day of February, 2008.

FOR THE NUCLEAR REGULATORY COMMISSION

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