September 29, 2010

Dr. Tamara Dickinson
Reactor Administrator
Department of the Interior
U.S. Geological Survey
12201 Sunrise Valley Dr., MS 911
Reston, VA 20192

SUBJECT: UNITED STATES GEOLOGICAL SURVEY —REQUEST FOR ADDITIONAL INFORMATION REGARDING THE LICENSE RENEWAL REVIEW FOR THE USGS TRIGA REACTOR (TAC NO. ME1593)

Dear Dr. Dickinson:

The U.S. Nuclear Regulatory Commission (NRC) is continuing its review of your application for the renewal of Facility Operating License No. R-113 for the U.S. Geological Survey (USGS) TRIGA reactor, dated January 5, 2009.

We require additional information and clarification on questions that have arisen during our review. Please provide responses to the enclosed request for additional information within 60 days after the date of this letter. In accordance with Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.30(b), you must execute your response in a signed original document under oath or affirmation.

If you have any questions about this review or if you need additional time to respond to this request; please contact me by telephone at 301-415-0893 or by electronic mail at geoffrey.wertz@nrc.gov.

Sincerely,

**/LTran for RA/**

Geoffrey Wertz, Project Manager
Research and Test Reactors Licensing Branch
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-274

Enclosure: As stated

cc w/encl: See next page

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

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**OFFICE OF NUCLEAR REACTOR REGULATION**

**REQUEST FOR ADDITIONAL INFORMATION**

**REGARDING THE RENEWAL OF THE FACILITY OPERATING LICENSE**

**FOR THE UNITED STATES GEOLOGICAL SURVEY TRIGA REACTOR**

**LICENSE NO. R-113; DOCKET NO. 50-274**

The U.S. Nuclear Regulatory Commission (NRC) is continuing its review of your application for the renewal of Facility Operating License No. R-113 for the U.S. Geological Survey (USGS) TRIGA reactor (GSTR), dated January 5, 2009. Our review conformed to the "Interim Staff Guidance (ISG) on the Streamlined Review Process for License Renewal for Research Reactors" (Agencywide Document Access and Management System Accession No. ML092240244). During this review, we have identified areas needing additional information.

Please address and provide responses to the following requests for additional information:

## Significant Facility Changes

1. The ISG requires the NRC staff to review significant changes to the facility, including those done in accordance with the provisions of Title 10 of the *Code of Federal Regulations* Section (10 CFR) Section 50.59. In 1988, changes to the GSTR were made which involved the installation of a new reactor tank liner. The details of this change are not provided in the GSTR Safety Analysis Report (SAR). As such, please provide a description of the new tank liner, the applicable design and construction criteria, and any associated additional instrumentation or equipment added as a result of the new tank liner. In addition, please describe any analyses of accidents and malfunctions associated with the new tank liner.

## GSTR SAR Chapter 4 – TRIGA Reactor

2. NUREG–1537, Part 1 Section 4.2.1, "Reactor Fuel," requests a description of the reactor fuel that includes material properties. The GSTR SAR Table 4.1 describes the GSTR fuel inventory as having 8.5 weight percent (wt%) and 12 wt% SS clad fuel and 8 wt% Aluminum clad fuel. However, GSTR SAR Subsection 4.2.1.7 only describes the volumetric-specific heat for 8.5 wt% and 20 wt% fuel. Please provide the volumetric heat capacity for 8 wt% and 12 wt% fuel.
3. NUREG–1537, Part 1 Section 4.2.3, "Neutron Moderator and Reflector," requests a comprehensive description of the moderator and reflectors. The GSTR SAR only describes the graphite reflector ring surrounding the core and does not discuss axial

reflector regions or the moderating effect of the coolant or fuel. Please provide information describing the contribution to reflection and moderation provided by the fuel, coolant and structural members such as the grid plates.

4. NUREG–1537, Part 1 Section 4.2.4, “Neutron Startup Source,” requests information pertaining to the neutron strength and spectrum: source type and materials, burnup and decay lifetime, and regeneration characteristics. The GSTR SAR does not provide such information. Please provide information relating to the nuclear characteristics of the source.

5. NUREG–1537, Part 1 Section 4.2.5, “Core Support Structure,” requests a description of the core support structure.

   5.1 The GSTR SAR provides Figure 4.3 describing the upper core plate but not the lower core plate. Please provide a figure depicting the lower core plate with the dimensions and locations of all penetrations for coolant flow.

   5.2 The GSTR SAR describes a change to the reflector-core platform in the 1988 design change pertaining to the replacement liner which characterizes the new mounting provided for the reactor core as a tripod with a system of leveling screws. GSTR SAR, Figure 1.1 does not show a tripod structure. Please provide a figure depicting this structure, identify the location of the tripod legs in relation to the ribs, and describe the design considerations that were used to consider all loads and hydraulic forces.

6. NUREG–1537, Part 1 Section 4.3, “Reactor Tank or Pool,” requests a description of the reactor tank and associated components. The description should include design considerations ensuring that no hydrodynamic, hydrostatic, mechanical, chemical, and radiation forces or stresses could cause a failure and should also discuss the locations of penetrations and attachment methods for other components and pipes. The GSTR SAR provides only physical dimensions. Please describe the design of the reactor tank including any penetrations.

7. NUREG–1537, Part 1 Section 4.4, “Biological Shield,” requests a description of the biological shield design basis, design methods, and the conformance of dose consequences to regulatory requirements. The GSTR SAR does not discuss these issues. Please provide information that addresses these subjects.

8. NUREG–1537, Part 1 Section 4.5, “Nuclear Design,” requests a detailed description of analytical methods used in the nuclear design, including computer codes used to characterize technical parameters pertaining to the GSTR. The GSTR SAR has not provided such information. Please provide descriptions of the analytical methods employed in Sections 4.5.1 through 4.5.6 of the application to calculate power distributions, reactivity coefficients, control rod worths, and Departure from Nucleate Boiling Ration (DNBR).

9. NUREG–1537, Part 1 Section 4.5.1, “Normal Operating Conditions,” requests a description of the limiting core configuration “that would yield the highest power density using the fuel specified for the reactor.” The GSTR SAR provides a description of a typical core, but not the limiting core configuration applicable to GSTR. Please provide a description of the limiting core configuration for the GSTR. If the GSTR retains the dual LSSS of 100 kilowatts (kW) and 1.1 megawatts (MW), then limiting core configurations

need to be specified for each LSSS. Please also provide tabulations of control rod worths and core excess reactivities for all core configurations.

10. NUREG–1537, Part 1 Section 4.5.2, "Reactor Core Physics Parameters," requests a description of the neutronic methods and a full set of parameters that are appropriate for use in the GSTR safety analysis. The GSTR SAR does not provide sufficient information. Please provide fuel and moderator temperature, void, and power coefficients; and power distribution estimates.

11. NUREG–1537, Part 1 Section 4.5.3, "Operating Limits," requests information regarding the operating limits applicable to the limiting core configuration of the GSTR. The GSTR SAR provides only an upper limit on excess reactivity and a value for the shutdown margin.

    11.1 Please describe any limits on excess reactivity components, such as those due to temperature variations; poisons (e.g., xenon and samarium); and experimental worths including pulse limitations.

    11.2 Please provide limits on control rod worths and describe the manner for determining a shutdown margin, including a discussion of uncertainties.

    11.3 Please describe the limits on core excess reactivity for the GSTR.

12. NUREG–1537, Part 1 Section 4.6, "Thermal-Hydraulic Design," requests a description of thermal-hydraulic conditions in the GSTR to demonstrate that sufficient cooling capacity exists for steady-state and pulsed operating conditions. Please describe the DNBR analysis pertaining to the GSTR addressing both the steady-state and pulsed operations.

13. In order to complete the environmental assessment, please provide environmental monitoring data from 1986 to April 2010 (or the latest period of data collection) for the following:

    13.1 The leakage of reactor coolant from the reactor tank, which could have begun before the 1987 shutdown and the 1988 reactor tank replacement.

    13.2 Water leakage from a 3,000 gallon underground tank, first identified to be leaking in June 2006 at a maximum of 13.8 gallons per day.

    Any pertinent data are of interest, including but not limited to ground water tritium and soil gamma spectrometry results for samples taken at or near the leak locations. Provide the data not already reported to the NRC (e.g., not submitted in annual reports), or indicate in which report submitted to the NRC the data can be found.

    13.3 Following the June 2006 leaking tank repairs, potential corrective actions were identified in NRC inspection report 030-03728/06-01. Please provide information on what corrective actions were implemented and the basis for those actions. If a second monitoring well was constructed, please provide the data for tritium, gamma spectrometry, and any other analytical results obtained for samples collected from the well.

## GSTR SAR Chapter 13 – Accident Analysis

14. NUREG–1537, Part 1 of Chapter 13, “Accident Analyses” requests that the facility limiting conditions for operation be selected to preclude unacceptable radiological consequences.

    14.1 In GSTR SAR Section 13.1, the GSTR SAR states that fuel temperature limits of 1,100 °C for stainless steel clad fuel and 535 °C for aluminum clad fuel were set to preclude the loss of clad integrity. GSTR SAR Technical Specification (TS) Section 14.2.1 lists safety limits for stainless steel clad fuel and aluminum fuel of 1,000 °C and 535 °C, respectively. The NRC has accepted (NUREG–1537 Appendix 14.1) that no fuel damage or cladding failure is expected if the fuel temperature for aluminum clad fuel is maintained at a temperature of less than 500 °C and the stainless steel clad fuel temperature is not to exceed 1,150 °C when the cladding temperature is less than 500 °C and is not to exceed 950 °C if the cladding temperature is greater than 500 °C. Please provide justification for the use of fuel temperature safety limits that are different from the stated limits in NUREG–1537.

    14.2 Within Chapter 13, the assumed power level or trip setpoint for accident analysis is set at 1.0 MW (Maximum Hypothetical Accident, Loss of Coolant Accident) and 1.06 MW (uncontrolled rod withdrawal). However, the Limiting Safety System Setting (LSSS) and SCRAM setpoints are set at 1.1 MW. Please describe how these setpoints ensure that the safety basis is maintained.

15. NUREG–1537, Part 1 Section 13.2, ”Accident Analysis and Determination of Consequences”Items (5) and (6) requests sufficient details for the staff to perform a confirmatory analysis. The staff reviewed the GSTRs methods for computing the dose within and beyond the confines of the reactor facility in case of a fission product release. The NRC staff’s review found that the GSTR SAR’s method is consistent with the guidance in the standard review plan. However, the NRC staff was unable to perform a confirmatory assessment of the resultant doses due to insufficient information and the lack of detailed assumptions related to site meteorology.

    15.1 GSTR SAR Subsection 13.2.1.2 states that the highest power density of 22 kW was used to determine the fuel element inventory. In GSTR SAR Subsection 4.5.1.2, the GSTR core was assumed to have 100 fuel rods. In Subsection 13.2.2.2.1, the total peaking factor (PF) is 3.85. In Subsection 13.2.2.2.2, the GSTR SAR states that the GSTR routinely operates with all but two or three grid positions occupied by the fuel element. The core has 125 fuel grid positions. Therefore, there could be as many as 122 fuel rods. Therefore, the highest density rod appears to range between 31.6 and 38.5 kW (e.g., an average rod density of 8.20 to 10 kW [1,000/100 to122 rods] multiplied by a PF of 3.85). Please describe the method and assumptions used to determine the highest power density of 22 kW, and the fission product inventory in Table 13.1. Also, please explain why the fission product release is limited to halogens and noble gases and does not include semi-volatile fission products such as cesium.

    15.2 GSTR SAR Subsection 13.2.1.2 states that the HOTSPOT computer code and “uniform dispersion with 10 CFR Part 20 Appendix B conversion factors” were

used to calculate doses to the public. The HOTSPOT computer code is a single isotope-based dose calculation model using Federal Guidance Report (FGR) No. 11 or FGR No. 13 dose conversion factors and requires site-specific meteorology in terms of stability and wind speed. Therefore, please provide the process and assumptions used in applying the HOTSPOT computer code to determine the public doses presented in Table 13.6.

15.3 GSTR SAR Table 13.5 provides the occupational committed dose equivalent (CDE) for the thyroid and total effective dose equivalent (TEDE) for a 2- and a 5-minute exposure in the reactor bay. The NRC staff was unable to reproduce the TEDE doses using the derived air concentration (DAC)-hour method. Please explain the methods used to determine the thyroid doses in sufficient detail to permit confirmatory calculations.

16. NUREG–1537, Part 1 Section 13.1.2, "Insertion of Excess Reactivity" requests analysis of excess reactivity events.

16.1 GSTR SAR Table 13.7 provides maximum reactivity insertion and related quantities for 12 wt% fuel. The table cites a peak fuel temperature of 1100 °C but then cites reactivity at 1000 °C. Please explain this table and describe how the calculated values were obtained is sufficient detail to allow confirmatory analysis.

16.2 GSTR SAR Table 13.7 provides maximum reactivity insertion and related quantities for 12 wt% fuel but not for the 8 wt% or 8.5 wt% fuel in the GSTR inventory. Please provide this information for the 8 and 8.5 wt% fuel.

16.3 GSTR SAR Subsection 13.2.2.2.1 states that "the maximum peak temperature measured for 12/20 fuel element was 345 °C from a $2.31 pulse. The theory presented predicts this pulse would have a peak fuel temperature of 514 °C. Please provide additional text explaining how the measured value was determined and show the assumptions and parameters used in calculating the 514 °C temperature.

GSTR SAR Subsection 13.2.2.2.2 provides information regarding analysis of the rod withdrawal accident. The analysis assumes an initial power of 100 watts and describes moving all 4 rods together until the reactor power reaches the trip setpoint. NUREG-1537, Section 4.5.3, "Operating Limits" requests that only the maximum worth rod is withdrawn in the most reactive region Please provide an analysis showing the limiting initiating power, the position of the non-moving rods during the analysis, and their response to the accident.

17. NUREG–1537, Part 1 Section 13.1.3, ""Loss of Coolant" requests analysis of loss of coolant events

17.1 GSTR SAR Subsection 13.2.3.2.2.4 provides information on the linear attenuation coefficient and scattered angel, expressions for the energy of scattered photons, and scattering cross sections. However, using the supplied methods and data the NRC staff was unable to reproduce the dose values cited in Table 3-10. Please review the calculations in this subsection and provide information showing the calculation of doses in Table 13-10 using the parameters provided.

17.2 GSTR SAR Subsection 13.2.3.2.2.4 states that the reactor bay ceiling is about 16 feet above the top of the reactor and the distance from the scattered point (ceiling above the center of the reactor tank) to the dose point (individual at 16 feet from the center of the reactor tank) is 757 centimeters (24.8 feet). Using these dimensions, the scattered angle is calculated at 40.1 degrees. However, this configuration results in the reactor bay ceiling to be 19 feet above the top of the reactor. This same subsection later provides a scattered angle of 50.9 degrees for the same dose point, which relates a distance of 19.2 feet from the center of the reactor tank. Please clarify the assumptions used and reevaluate the dose.

18. GSTR SAR Subsection 13.2.5.2 uses a gap release fraction of $1.22 \times 10^{-4}$ which is higher than the gap release fraction used in GSTR SAR Subsection 13.2.1.2 for the MHA ($1.66 \times 10^{-5}$). Please provide an analysis using a consistent gap release fraction.

## GSTR SAR Chapter 14 - Technical Specifications

19. ANSI/ANS-15.1-2007, Section 1.3, recommends industry accepted definitions for terms commonly used in Research and Test Reactor (RTR) Technical Specifications (TSs). Some of the GSTR TS definitions differ. Please explain:

    19.1 The terms “Reactor Operator,” “Senior Reactor Operator,” “Unscheduled Shutdown,” and “Reactivity Worth of an Experiment” are used but not defined.

    19.2 “Regulating Rod” does not match the definition in ANSI-15.1-2007 in which it is called “Regulating Control Rod.”

    19.3 “Reactor Operation” is used whereas ANSI-15.1-2007 uses “Reactor Operating.”

    19.4 “Reactor Secured” does not implement the definition in ANSI-15.1-2007.

20. NUREG–1537, Part 1, Appendix 14.1, Section 2.1, “Safety Limits,” states that the NRC finds 530 °C an acceptable fuel and cladding temperature limit not to be exceeded under any conditions of operation." GSTR TS 14.2.1 states that "The temperature in an aluminum-clad TRIGA fuel element shall not exceed 995 °F (535 °C) under any mode of operation." Please provide a justification for using 995 °F (535 °C) as a safety limit.

21. GSTR TS Section 14.2.2, “Limiting Safety System Setting,” states that the limiting safety system setting shall be a steady state thermal power of 1.1 MW when there are at least 100 fuel elements in the core (including fuel-followed control rods) and a steady state thermal power of 0.1 MW if there are less than 100 fuel elements in the core and any of the core fuel elements are aluminum-clad. Please explain or clarify the following observations:

    21.1 Please explain whether the statement should read “or any of the core fuel elements are aluminum-clad.”

    21.2 The LSSS discusses “steady state” power whereas the subject of the LSSS is the limiting power to be used for automatic protective circuits. Please explain.

21.3 License Amendment 4 (January 1988) eliminated the allowance to exceed licensed power for purposes of testing SCRAM circuits. The safety analysis presented in the GSTR SAR provides no basis for an LSSS above 1.0 MW.

22. ANSI/ANS-15.1-2007, Section 3, "Limiting Conditions for Operation "identifies Limiting Conditions for Operations (LCO). The following items were noted in comparison to the GSTR TS LCOs:

22.1 ANSI-15.1-2007, Section 3.3 "Coolant Systems" recommends LCOs for requirements for leak or loss-of-coolant detection; and fission product activity detection. Specification 3 of LCO 14.3.3 does not employ the correct units (μmho/cm).

22.2 ANSI/ANS-15.1-2007, Section 3.8, "Experiments," establishes recommendations for reactivity limits and failures/malfunctions pertaining to experiments. GSTR TS LCO 14.3.8.1 does not employ the terminology "absolute value," as cited in the guidance. Please explain.

23. ANSI/ANS-15.1-2007, Section 4, "Surveillance Requirements," identifies Surveillance Requirements (SRs) for LCOs. The following GSTR SR items were identified. Please explain:

23.1 SR 14.4.1 Reactor Core Parameters, Specification 2, does not include any criteria for determining what represents a "significant change" in core configuration.

23.2 There does not appear to be a SR for ensuring the proper installation of the mechanical stop for the transient control rod per LCO 14.3.1.2.

23.3 There does not appear to be a SR for assuring that aluminum-clad fuel is loaded only in the F and G rings of the core per LCO 14.3.1.3.

23.4 There does not appear to be a SR for assuring that steady state power limit of 0.1 MW is not exceeded per LCO 14.3.1.3.

24. ANSI/ANS-15.1-2007, Section 1.2.2, "Format," recommends that the Basis "provides the background or reason for the choice of specification(s), or references a particular portion of the SAR." The Bases listed below lacked sufficient information. Please provide additional information:

24.1 In the Basis for Section 14.2.1, GSTR SAR subsection 4.5.3.1 could not be found.

24.2 In the Basis for Section 14.2.2, GSTR SAR subsections 4.5.3.1 and 4.5.3.3, could not be found. The Basis also references 1.1 MW which differs from the licensed power level of 1.0 MW used throughout the GSTR SAR.

24.3 The Basis for Section 14.3.1.1.1 provides no reference or analysis to support the selection of $.55 as the shutdown margin.

24.4 The Basis for Section 14.3.1.1.2 contains information regarding shutdown margin, nominal rod worth, total rod worth, etc., but there is no reference provided to support the values cited.

24.5 The Basis for Section 14.3.1.2 provides a reference to GSTR SAR Section 13.2.2.2.1, “Maximum Reactivity Insertion” that is supposed to provide a discussion and basis for the statements regarding temperature response to reactivity insertion. However no basis for the statement could be found in that section of the GSTR SAR.

24.6 The Basis for Section 14.3.1.2 provides a reference to GSTR SAR Section 13.2.2.2.1, “Maximum Reactivity Insertion.” However, no basis is provided to substantiate the temperature limits of 325 $^{o}$C in aluminum-clad fuel and 800 $^{o}$C in stainless-steel clad fuel.

24.7 In the Basis for Section 14.3.3, GSTR SAR subsection 4.5.3.1.1 could not be found. In addition, values are provided for the minimum height established for water above the top of the core (Specification 1) but no such discussion existed in either GSTR SAR Sections 4.4 or 11.1.1.1. There is no basis provided for the pH range selected in Specification 4; this range is outside of the NUREG-1537 recommended range.

24.8 In the Basis for Section 14.3.5 it is stated that the worst case TEDE is well below the 10 CFR Part 20 limit for individual members of the public for 2 scenarios – the ventilation system is operating and the system is not operating; a reference to GSTR SAR Section 13.2.1 is provided. However, in the GSTR SAR section the only scenario evaluated is for the ventilation system in operation.

24.9 The Basis for Section 14.3.7.2 provides that the $4.8 \times 10^{-6}$ uCi/ml release limit for $^{41}$Ar out the stack would result in an annual TEDE $\leq$ 5 mrem, which is 50% of the applicable limit (10 mrem). However, the referenced GSTR SAR section 11.1.1.1.1 did not provide any calculations that substantiate the basis.

24.10 In the Basis for Section 14.3.8.1, GSTR SAR references 7.2.3.1 and 13.2.2 are provided as the basis for establishing the reactivity worth of any single movable experiment e.g., less than $1.00. However there is no such discussion provided in either of the GSTR SAR sections. Additionally, the acceptability for the $3.00 and $5.00 limit on a single secure experiment and the total worth of all experiments, respectfully, is not provided.

24.11 In the Bases for Sections 14.4.1, 14.4.2, 14.4.3, 14.4.5, 14.4.7, and 14.4.8, there are no references provided to support the specifications and requirements stated.

24.12 In the Basis for Section 14.5.2, GSTR SAR subsection 4.5.3.3 could not be found.

24.13 In the Basis for Section 14.5.3.2, a reference is provided in GSTR SAR Section 4.2.2 to support the following statement, “The nuclear behavior of the air- or aluminum-follower, which may be incorporated into the transient rod, is similar to a void.” However, no such information was identified in GSTR SAR Section 4.2.2.

25. ANSI/ANS-15.1-2007,Section 6, “Administrative Controls,” provides information regarding content and format. Please provide additional information:

25.1 ANSI/ANS-15.1-2007, Section 6.1.3(1)(b) states that "A second designated person present at facility complex able to carry out prescribed instructions."

GSTR Administrative Control (AC) TS 14.6.1.3 1 (b) states, "A second facility staff person present or on call," which is a variance from the guidance.

25.2 ANSI/ANS-15.1-2007, Section 6.2.3, “Review Function” and Section 6.2.4, “Audit Function,” provide guidance on the review and audit of specific areas. GSTR TS 14.6.2.3 “Review and Audit Function” does not state the review and audit functions. Please explain the deviation from the ANSI guidance.

25.3 ANSI/ANS-15.1-2007, Section 6.4, “Procedures,” describes the content.” However, GSTR Section 14.6.4 does not include the topic “use, receipt and transfer of by-product material, if appropriate.”

25.4 ANSI/ANS-15.1-2007, Section 6.5 “Experiments Review and Approval” describes the requirements that should be included for the review and approval of experiments. The GSTR Section 14 does not include a section for the review and approval of experiments in its “Administrative Controls.”

25.5 ANSI/ANS-15.1-2007, Section 6.6 “Required Actions” describes requirements pertaining to actions to be taken and circumstances when they apply. GSTR AC 14.6.5.1 specifies actions pertaining to safety system setting limit (should be LSSS) violations. However, the value cited was 1.0 MW, not 1.1 MW, or 100 kW depending on the core configuration as detailed in Section 14.2.2. Please explain.

25.6 ANSI/ANS-15.1-2007, Section 6.8.2, “Records to be retained for at least one certification cycle,” requests that retraining and requalification of records for operators be maintained at all times the individual is employed or until the certification is renewed. Per 10 CFR Section 55.55(a) this period is 6 years. GSTR Administrative Controls Section 14.6.7.2 identifies the retention period as one training cycle but does not define this period in years.