March 7, 2013

Ms. Betty Adrian
Reactor Administrator
Department of the Interior
U.S. Geological Survey
PO Box 25046 MS 975
Denver Federal Center
Denver, CO 80225-0046

SUBJECT: UNITED STATES GEOLOGICAL SURVEY – ADDITIONAL CLARIFICATION REQUESTED RE: RESPONSES TO NRC REQUEST FOR ADDITIONAL INFORMATION DATED SEPTEMBER 29, 2010 (TAC NO. ME1593)

Dear Ms. Adrian:

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 TRIGA Reactor (GSTR), dated January 5, 2009, (a redacted version of the safety analysis report is available on the NRC's public Web site at www.nrc.gov under Agencywide Documents Access and Management System (ADAMS) Accession No. ML092120136). As part of our review, the NRC staff submitted requests for additional information (RAIs) by letter dated September 29, 2010 (ADAMS Accession No. ML102510077).

The NRC staff has reviewed your responses, submitted by USGS letter dated February 8, 2013 (a redacted version is available in ADAMS Accession No. ML13052A179), to our request for clarification, by NRC letter dated October 2, 2012 (ADAMS Accession No. ML12270A415) and has identified additional clarification needed in the attached table. Please provide responses to the enclosed request for additional information within 45 days of 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. Your response must be submitted in accordance with 10 CFR 50.4, "Written Communications." Information included in your response that is considered security, 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."

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,

/AAdams 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

cc: See next page

cc:

Environmental Services Manager
480 S. Allison Pkwy.
Lakewood, CO 80226

State of Colorado
Radiation Management Program
HMWM-RM-B2
4300 Cherry Creek Drive South
Denver, CO 80246

Mr. Timothy DeBey
Reactor Director
U.S. Geological Survey
Box 25046 - Mail Stop 424
Denver Federal Center
Denver, CO 80225

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

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,

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Geoffrey Wertz, Project Manager
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ADAMS Accession No.: ML13059A027 *concurrence via e-mail NRR-088

OFFICE	PRLB:PM*	PRLB:LA	PRLB:BC	PRLB:PM*
NAME	GWertz	GLappert	AAdams	AAdans for GWertz
DATE	2/27/2013	2/28/2013	3/4/2013	3/7/2013

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OFFICE OF NUCLEAR REACTOR REGULATION

REQUEST FOR ADDITIONAL INFORMATION

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) staff has reviewed your responses to our requests for additional information (RAIs) by USGS letter dated February 8, 2013, and has identified several RAI responses that need additional clarification as described in the attached table. Please provide responses to the enclosed RAI within 45 days of the date of this letter. The page number references in the [ ] below reference the pages in the RAI response letter dated February 8, 2013.

RAI No.	Original RAI	Information Needed
9	Describe the limiting core configuration.	Please provide the results of the U.S. Geologic Survey TRIGA Reactor (GSTR) neutronic analyses that document the Limiting Core Configuration (LCC) and operating core including: • The stainless steel and aluminum clad fuel diameter does not appear consistent given the information provided in the GSTR SAR. Please explain the difference or revise. [pg. 3] • The aluminum FE active length does not appear consistent with standard TRIGA fuel. Please explain the difference or revise. [pg. 3] • The reactivity worths calculated from the supplied k-effectives do not appear to have been calculated correctly (see the methodology provided in ANSI/ANS-19.11-1997), and consequently differ from NRC staff calculations by as much as 4.7 percent. Please explain your methodology or revise the calculations and ensure that the corrected values are utilized in your responses. [pg. 4] • The NRC staff calculated the shutdown reactivity and could not re-produce the USGS value provided of -$1.30 using either methodology described above. Please explain the calculation or revise. [pg 4] • The NRC staff review of neutronic model acceptability is established using comparisons of measured and calculated excess reactivity and control rod worths. USGS measured excess reactivity has not been provided, no comparisons between calculations and measurements are supplied, and no conclusions are drawn regarding whether the comparisons are acceptable. Please provide. [pg. 4]

9	(Continued)	• The 9.7 kilowatt (kW) power for the FE in ring C of Figure 5 does not appear consistent with other ring C FEs. Please confirm the power level. [pg 5] • In the response dated July 31, 2012, GSTR indicated that the neutronic analysis would be performed at a power level of 1.1 megawatts with a core consisting of 110 FEs. The total core power for the current submittal does not indicate the total core power. Please provide the total core power used the analysis [pgs 5-6]
12	Describe the departure from nucleate boiling ratio (DNBR) analysis.	Provide thermal-hydraulic analysis for the LCC consistent with the following: • The dimensions of the unit cell do not appear consistent with the GSTR SAR (FE outside diameter) and the calculated flow area may be too small (24 %). Consequently, the calculated fuel temperatures and flow velocities provided would be too large. Please explain the differences or revise. [pg. 8] • The diagrams for the RELAP models appear reversed. Please explain the differences or revise. [pg. 9] • The analysis does not identify which RELAP model is being used for the DNBR; and while the peak FE power appears correct, the peaking factor is inconsistent with what is derived from Figure 3. Please explain the difference or revise. [pg. 9] • The previous RAI response provided the flow velocity; the latest response provides the mass flux; please provide the <u>mass flow rate</u> as previously requested at the licensed power using the technical specifications (TS) max allowed water temperature. [pg. 9] • The NRC staff finds that the GSTR steady state DNBR of 1.45 does not meet the guidance of NUREG-1537 (DNBR $\geq$ 2.0). Please explain why your approach is correct, or recalculate the DNBR with corrected unit cell geometry. [pg. 9] • Based on the FE length, it does not appear possible for the maximum DNBR to be located .41 meters from the bottom of the FE as stated. Please explain or revise. [pg. 9] • The GSTR pulsing analysis FE temperatures (e.g. 831 degrees celsius (C)) do not include consideration of uncertainties and for a $3.00 pulse, exceeds the GA recommended limit of 830 degrees C. If the flow area corrections are made as noted in the first bullet, the pulsing temperature values may be significantly reduced. Please provide a revised pulsing analysis, include consideration of uncertainties, or explain. [pg. 9] • The NRC staff noted that the GSTR response references centerline fuel temperatures. For stainless steel TRIGA fuel, which represents the limiting fuel in GSTR analysis, the material at the centerline is not fuel. Please explain the difference or revise the maximum fuel temperature. [pgs. 11-15]

14.2	Describe how the limited safety setting system (LSSS) and SCRAM setpoints protect the safety limit.	The “reactivity vs. time for Reg. rod withdraw simulation” table on page 15 did not indicate the control rod withdraw speed. Please provide the rod withdraw speed for GSTR control rod drives. Please explain how the uncontrolled rod withdraw analysis uses this maximum rate of withdrawal, and how the analysis supports the control rod scram times and LSSS TS. [pg. 15]
15.3	Explain the methods used to determine the maximum hypothetical accident (MHA) doses	• Should the section titled “Revised response to [RAI] 24.9” be RAI 15.3? [pg. 18] • The updated GSTR SAR Section 13.2.1.1 references a radioactive release in water, when NUREG-1537 states that the "failure of one fuel element in air is the MHA for a TRIGA reactor". Please revise the MHA analysis and all references to a release in water, or explain. [pg 20] • Please provide a reference for the source term provided in Table 13.1. [pg. 22] • Although not so stated, the NRC staff interpreted the temperature used in equation 13.1 as being the centerline temperature from the DNBR analysis. After a revised fuel temperature is obtained following correction to the DNBR model identified above, please provide a revised analysis ensurinig that the temperature used is in this analysis is a fuel only temperature, not the centerline. The NRC staff notes that the use of a volume averaged fuel temperature in the limiting pin is sufficiently conservative for equation 13.1. [pg. 21] • Table 13.5 thyroid doses are not needed. Please provide the CEDE and TEDE. [pg 26]. • Table 13.6 indicates that the MHA occupational dose exceeds the limit of Title 10 of the *Code of Federal Regulations* Part 20 prior to 5 minutes. Please provide an analysis and conclusions that demonstrate compliance with the requirements for occupational dose (5000 millirem for the stay time authorized in the emergency plan). [pg. 26-27]
23.1	Criteria for significant change in core configuration.	The criteria for a significant change in core configuration is usually a reactivity value based on a measureable reactivity difference from the current core, and provides a safety margin with respect to the shutdown margin (SDM), i.e., is a value less than the SDM. The previous RAI response did not provide a reactivity based criteria for determining what constitutes a significant change in core configuration. Please explain.

<table>
<tr>
<td>24.3</td>
<td>Basis for the SDM Value</td>
<td>The GSTR determined control rod worths were reported with uncertainties of 2.2 percent, 2.2 percent, 2.2 percent and 2.5 percent. Applying these uncertainties to the nominal shutdown reactivity (SDR) results in a variation from -$2.083 to -$1.841, with an accuracy of $0.24. GSTR is proposing a SDM of $0.30. This leaves a possible margin to criticality of only $0.06. Based on the NRC staff calculations shown below, the NRC staff does not understand why GSTR proposed an excess reactivity of $7.00, which is larger than the LCC excess reactivity, and is resulting in a small estimated SDR and a proposed SDM of $0.30. Please explain or revise. [pg. 18]
<table>
<tr><th>Reactivity</th><th>TS proposed</th><th>LCC</th><th>LCC biased</th><th>OCC</th><th>OCC Biased</th></tr>
<tr><td>Excess</td><td>$7.000</td><td>$6.324</td><td>$6.463</td><td>$4.387</td><td>$4.484</td></tr>
<tr><td>Shim1</td><td>-$2.419</td><td>-$2.419</td><td>-$2.367</td><td>-$2.163</td><td>-$2.116</td></tr>
<tr><td>Shim2</td><td>-$2.259</td><td>-$2.259</td><td>-$2.210</td><td>-$2.250</td><td>-$2.202</td></tr>
<tr><td>Reg.</td><td>-$4.317</td><td>-$4.317</td><td>-$4.224</td><td>-$3.359</td><td>-$3.287</td></tr>
<tr><td>Trans.</td><td>-$2.648</td><td>-$2.648</td><td>-$2.583</td><td>-$2.057</td><td>-$2.007</td></tr>
<tr><td>SDR</td><td>-$0.326</td><td>-$1.002</td><td>-$0.698</td><td>-$2.083</td><td>-$1.841</td></tr>
</table>
</td>
</tr>
<tr>
<td>24.9</td>
<td>No calculational reference for values provided.</td>
<td>• The text preceding Table 1 appears to indicate that the distance used in the analysis was 295 meters to the receptor (Denver Federal Center (DFC) fence line); however, a corresponding dose value is not provided in Table 1 for that distance. Also, doses to members of the public should not be reduced by occupancy factors. Statements regarding loitering are not applicable to receptor locations for the public. Please explain or revise. [pg. 30]
• The calculational results in Table 2 indicate 7.75 curies (Ci) per year of Argone 41 (Ar-41) released which corresponds to ~950 hours of full power operation. The most recent USGS Annual Report, dated January 24, 2012, indicated that 12.607 Ci of Ar-41 was released for 1191 megawatt-hour of operation. Please explain how Table 2 provides a best estimate of routine operation given the significantly larger release in 2012, or revise. [pg. 30]
• The calculational result in Table 2 for the 295 meter distance (DFC fence) appears to have been reduced by the occupancy factor of 22.8 percent. Doses to members of the public should not be affected by occupancy factors. Please explain or revise. [pg. 30]
• The COMPLY output file provided appears to be identical to the one provided in the previous submittal (dated November 16, 2012) and does not reflect analysis as is now being presented. Please explain or revise. [pg 30]</td>
</tr>
</table>