July 15, 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 THE U.S. NUCLEAR REGULATORY COMMISSION 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 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 May 17, 2013 (a redacted version is available in ADAMS Accession No. ML13162A662), to our request for clarification sent by NRC letter dated March 7, 2013 (ADAMS Accession No. ML13059A027), and has identified, in the attached table, additional clarification that is needed. Please provide your responses to the enclosed table 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,

/Alexander Adams, Jr. 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:
RAI

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,

/Alexander Adams, Jr. 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:
RAI

cc: See next page

DISTRIBUTION:

PUBLIC	DPR/PRLB r/f	RidsNrrDpr Resource	RidsNrrDprPrta Resource
GWertz, NRR	GLappert, NRR	PTorres, NRR	RidsNrrDprPrtb Resource
PBlechman, NRR			

ADAMS Accession No.: ML13190A052 *concurrence via e-mail NRR-088

OFFICE	NRR/DPR/PRLB/PM*	NRR/DPR/PRLB/LAIT	NRR/DPR/PRLB/LA	NRR/DPR/PRLB/BC	NRR/DPR/PRLB/PM*
NAME	GWertz	PBlechman	GLappert	AAdams	GWertz (AAdams for)
DATE	7/10/13	7/10/13	7/10/13	7/15/13	7/15/13

OFFICIAL RECORD COPY

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 the United States Geological Survey (USGS) staff's responses to our requests for additional information (RAIs) for the Geological Survey TRIGA Reactor (GSTR) provided by USGS letter dated May 17, 2013 (a redacted version is available in Agencywide Documents Access and Management System (ADAMS) Accession No. ML13162A662). The NRC staff has identified several RAI responses that need additional clarification as described in the attached table. Please provide your responses to the enclosed table within 45 days of the date of this letter. The page number in the brackets [ ] below references the GSTR information provided by the USGS letter dated May 17, 2013.

RAI No.	Original RAI	Information Needed
9	Describe the limiting core configuration (LCC).	• Provide the peak fuel temperature for aluminum clad fuel element in the operating core (OC) (Figure 1) and LCC (Figure 2). [page 1] • Describe any restrictions on the locations of any aluminum clad fuel elements based on the peak fuel temperature in either the OC or LCC. [page 1] • The NRC staff has independently calculated the shutdown reactivity of the OC configuration using the information provided in the response to RAI No. 9 (excess reactivity $4.84; shim1, shim2, and the transient control rod worth's, respectively, as -$2.16, -$2.25, -$2.06). The NRC staff calculations result in a shutdown reactivity of -$1.63. Explain the USGS calculated result of -$1.75. [page 4] • Provide numerical data for information from Figure 7. [page 7]

Enclosure

<table>
<tr>
<td>12</td>
<td>Describe the departure from nucleate boiling ratio (DNBR) analysis.</td>
<td>

The NRC staff calculated a flow area per rod of 4.776 square centimeters (cm^2) for the hot fuel element and 5.981 cm^2 for the average fuel element based on the core plate figure provided in your RAI response dated November 24, 2010 (ADAMS Accession No. ML103340090). These values differ significantly from the USGS RAI response values of 5.855 cm^2, and 8.382 cm^2, respectively. The NRC staff calculation results are provided in Table 1. Provide details of your calculations. [page 8]
The NRC staff confirmatory analysis of the LCC at the limited safety setting system steady state power of 1.1 megawatts (MW) using the TRACE computer code indicates significant flow oscillations occur when the core inlet temperature exceeds 42 degrees Celsius (C). Discuss the results of the GSTR RELAP analysis including any observed flow instabilities, and its affect on fuel temperature over the range of the core inlet temperature up to 60 degrees C. [page 9]
NRC staff performed their confirmatory analysis of the LCC using a closed loop (CL) model which produced coolant flow velocities that were consistent with independent analysis and measurements from similar research reactors and power levels and, consistent with the NRC analytical solutions for single phase natural circulation flow (see Figure 1). The NRC staff has also investigated the use of other modeling techniques (fill & break and large tanks) and determined that the coolant flow velocities were too high as compared to the CL benchmarks. The NRC staff's concern is that models using coolant flow velocities higher than actual may result in a non-conservative estimate of the DNBR. NRC staff review found that the GSTR flow velocities were approximately 30 percent higher than NRC staff results and the results of models for other facilities (see Figure 1). Please justify the use of the GSTR model given the apparent variance shown in Figure 1. [page 9]
Provide the maximum fuel temperature of the aluminum clad fuel element for the pulsing analysis. [page 9]
The temperatures in Table 3 do not match the temperatures provided in Figure 7. Explain the differences. [page 10]
The results of the “Characterization of the response of GSTR to a reactivity pulse and an uncontrolled rod withdrawal transient event” did not provide peaking factors or explain their use. Provide the peaking factors, and explain their use in the analyses (i.e., were they included in the model or applied to the results obtained from a model representing the average core or channel). [page 10]
For the uncontrolled rod withdraw analysis, explain if the withdrawn control rod continues until fully withdrawn, or if it inserts upon receiving the scram signal. [page 11]
GSTR provided a temperature of 1020 degrees Kelvin (K) and then converted it to 727 degrees C. The NRC staff converted 1020 degrees K to 747 degrees C. Explain the difference. [page 11]

</td>
</tr>
</table>

15.3	Explain the methods used to determine the maximum hypothetical accident (MHA) doses	• The GSTR response to RAI No. 15.3 provided a volume-averaged fuel temperature of 423.2 degrees C. The NRC staff confirmatory analysis calculated a significantly lower average fuel temperature. In order for NRC staff to fully understand the GSTR fuel temperature, provide an explanation of the fuel element nodal structure and a description of the nodal fuel temperature calculations for the volume-averaged and peak fuel temperatures. [page 13] • The NRC staff has completed confirmatory analysis of the MHA results using HOTSPOT 2.07.2, and was unable to reproduce the GSTR dose results for the atmospheric release scenario at the Emergency Assembly Area and the Building 21 East Entrance using the assumptions stated in the response to RAI No. 15.3 (see shaded area in Table 2 for NRC staff confirmatory calculations). Provide details of the total effective dose equivalent (TEDE) dose calculations at these locations. [page 22]
24.3	Basis for Shutdown Margin Definition	• The GSTR analysis provided in response to RAI No. 9 appears to establish the GSTR Core Excess Reactivity for Technical Specification (TS) 14.3.1.1.2 as $6.18. Using the GSTR control rod worth's as provided in the GSTR response to RAI No. 9, the NRC staff confirms that the shutdown reactivity of the GSTR using the stuck control rod criteria would be -$1.20 which satisfies the existing TS shutdown margin specification of -$0.55 (TS 14.3.1.1.1). The proposed GSTR TS 14.3.1.1.1, Shutdown Margin, of $0.30 appears to unnecessarily reduce the shutdown margin TS requirement. Advise if GSTR still seeks to establish TS 14.3.1.1.1, Shutdown Margin, of $0.30, and the basis for this reduction given the analyzed core excess reactivity of $6.18. [page 24]

Table 1

	USGS	Confirm.		Source	diamter	radius	
B-Ring Distance from Center (cm)	4.053	7.9772	cm	ML103340090	6.2813	3.1406	in
C-Ring Distance from Center (cm)	7.981	3.6513	cm	ML103340090	2.8750	1.4375	in
Inner Radius of Flow Channel (cm)	2.026	1.9050	cm	SAR 10.2.1	1.5	0.75	in
Outer Radius of Flow Channel (cm)	6.017	5.8142	cm	(7.9772-3.6513)/2 + 3.6513			
Fuel Element Cross Section (cm2)	10.949	11.0241	cm^2	SAR Table 4.10	1.475	0.7375	in
Wetted Perimeter of a Single Fuel Element (cm)	11.73						
B-Ring Total Flow Area (cm2)	35.132	28.6567	cm^2	area using outer radius-area of inner radius-6*area of FE			
Flow Area/Rod (cm2)	5.855	4.7761	cm^2	calc			
Effective Hydraulic Diameter (cm)	1.977						
# Elements	110	127.0000		lattice positions			
# Control Rods	4	4		1 TR and 3 CR			
Element Cross Section (cm2)	10.949	11.0241	cm^2	using 1.475 in OD			
Control Rod Cross Section1 (cm2)	9.58	9.5799	cm^2	using 1.375 in FF OD			
Transient Rod Cross Section (cm2)	7.917	7.9173	cm^2	using 1.25 in OD			
Central Thimble Cross Section (cm2)	11.401	11.4009	cm^2	using 1.5 in OD			
Core Cross Section (cm2)	2208.99	2140.6389	cm^2	plate diameter + 1 FE pitch (1.7658 in)			
Total Flow Area (cm2)	824.209	747.6463	cm^2	total-CT-TR-3CR-122FE			
Area/Rod2 (cm2)	8.382	5.9812	cm^2	total FA/125 (122 FE + 3 FF)			
Hydraulic Diameter (cm)	2.858						

Figure 1

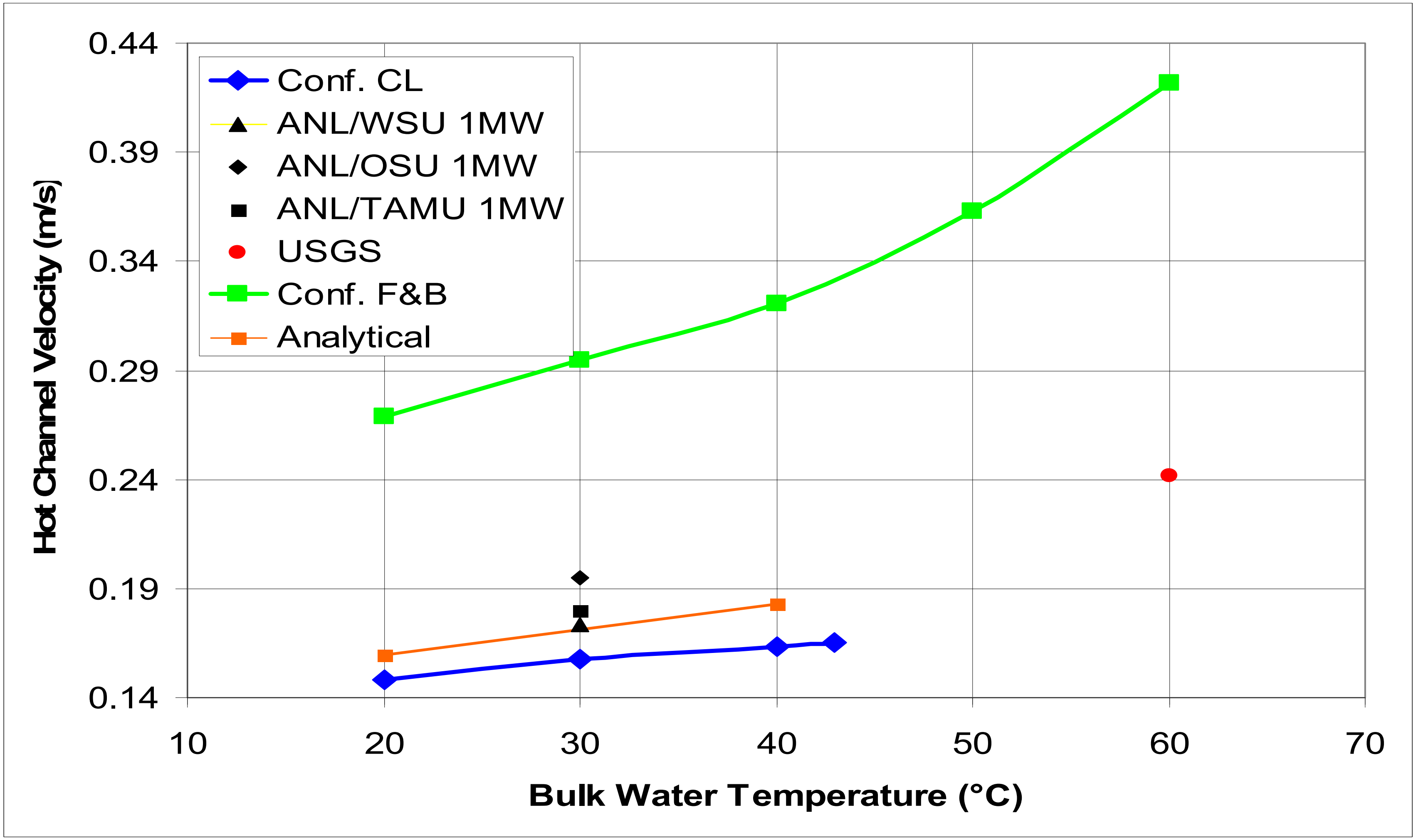
Conf. CL
ANL/WSU 1MW
ANL/OSU 1MW
ANL/TAMU 1MW
USGS
Conf. F&B
Analytical
Hot Channel Velocity (m/s)
0.44
0.39
0.34
0.29
0.24
0.19
0.14
10
20
30
40
50
60
70
Bulk Water Temperature (°C)

Table 2

Location	Distance (meter)	Radiation Dose to Member of Public NRC Confirmatory Calculation (GSTR SAR Table 13.6) TEDE (mrem)
Building 15 south door	11	53 (53)
Emergency assembly area	32	10 (6.1)
Building 21 east entrance (West of Building 15)	49	7.8 (4.3)
Average of eastern intersections	100	2.9 (2.4)
Building 16 west entrance	175	1 (0.96)
-	200	0.8 (0.76)
-	250	0.52 (0.5)
Nearest Unrestricted Location	475	0.15 (0.14)
Residence	640	0.082 (0.081)
School	720	0.065 (0.065)