



U.S. Geological Survey

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Monday, March 29, 2021

Attn: Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

SUBJECT: U.S. Geological Survey TRIGA Reactor, Docket Number 50-274, License Number R-113, Annual Report Submittal in Accordance with Technical Specification 6.7.1 Rev. 00

Purpose

By way of this letter, the U.S. Geological Survey (USGS) is submitting the annual operating report as required by Technical Specification 6.7.1 of license number R-113, covering the period of January 1st, 2020 through December 31st, 2020.

Contact

If you have any questions regarding this matter, please contact me at (303) 236-4726.

Sincerely,
Jonathan Wallick, Reactor Director

Copied to:
Dr. Robert Horton, Reactor Administrator, USGS
Geoffrey Wertz, Project Manager, US NRC
Craig Bassett, Inspector, US NRC

Attachments:

- (1) U. S. Geological Survey TRIGA Reactor Facility Annual Report 2020

2020

U. S. Geological Survey TRIGA Reactor Facility Annual Report

FACILITY LICENSE R-113 – DOCKET NUMBER 50-274

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SECTION 1: OPERATIONS SUMMARY

During CY20, the U.S. Geological Survey TRIGA Reactor Facility (GSTR) remained in an administrative shutdown, which began in October of 2018. This shutdown has limited operations to only those required for operator requalification and surveillance/maintenance. The COVID-19 pandemic further limited attendance of the facility to only that required to conduct the required activities, otherwise restricting personnel to a teleworking condition.

Typically, operation of this facility supports research and development by the U.S. Geological Survey, Colorado School of Mines (CSM), and a collection of other academic, commercial, and industrial collaborators. Research is typically conducted using geochronology techniques, such as argon/argon comparison and fission track analysis, but also includes student research projects and radiotracer production. Operator training and education is also a component of the GSTR program, primarily as a class conducted by CSM and supported by the reactor staff, providing hands on experience in reactor operations, engineering, and neutron activation techniques. Additionally, tours and visits by various members of the public generally take place but were not possible this calendar year due to the shutdown and pandemic.

One routine NRC inspection has taken place this year between November 17th and November 21st, resulting in no violations or negative findings. One audit took place on October 29th, in support of a license amendment request to allow a larger inventory of reactor fuel to be received and possessed by the GSTR. The audit resolved several questions and requests for additional information that the NRC had in the license amendment process, streamlining the license amendment process and providing an overall expedited amendment. Two license amendments were granted this year, numbers 13 and 14. In 2020, two Reactor Operations Committee meetings were held on April 17th and October 16th.

A new facility director / supervisor has been onboarded as of April 27th, 2020, Jonathan Wallick, previously reactor supervisor of the University of California, Irvine 250 kW TRIGA Mk I facility, and prior to that a servicemember of the U.S. Navy nuclear program.

One new operator trainee (Wallick) has entered training this year, but no examination has been scheduled yet, owing primarily to the COVID-19 pandemic, and attempting to achieve restart of the facility. As of December 31st, 2020, 2 senior operators and no reactor operators were licensed. Another operator candidate has been identified, but training has not yet started for that individual, though they previously held a license at another TRIGA reactor facility.

TABLE I – General Information

Experiment Authorizations on File	84
Experiments Performed	0
Samples Irradiated	0
Energy Generated this Period (Megawatt-hours)	1.93
Total Energy Generated since Initial Criticality (Megawatt-hours)	40259.28
Pulse Operations this Period	0
Total Pulses since Initial Criticality	286
Hours Critical this Period	27.29
Total Hours since Initial Criticality	43878.68
Inadvertent Scrams	0
Total Scrams since Initial Criticality	1144

SECTION 2: INADVERTENT SCRAMS, UNPLANNED SHUTDOWNS, EVENTS AT POWER

TABLE II – Scrams, Unplanned Shutdowns, Events at Power

Date	Time	Power	Type and Cause
None	N/A	N/A	No unscheduled scrams, shutdowns, or events at power occurred during this reporting period.

SECTION 3: MAINTENANCE, SURVEILLANCE, AND OTHER INCIDENTS

The following non-routine maintenance/surveillance activities were carried out during this period. Any reactor operation related items have been included above and are not repeated here.

TABLE III – Maintenance, Surveillance, and Other Incidents

Date	Time	Title and Description
2020-01-07	All Day	<i>Rod Down Limit Switch Replacement.</i> The Shim 2 Down Limit Switch was replaced with a spare like-for-like component due to damage during reinstallation of the Regulating Rod Drive. Switch tested for operability, rod travel times, and rod drop times satisfactorily.
2020-01-22	All Day	<i>Rod Down Limit Switch Replacement.</i> The Transient Rod Down Limit Switch was replaced with a spare like-for-like component due to damage during reinstallation of the Regulating Rod Drive. Switch tested for operability, rod travel times, and rod drop times satisfactorily.
2020-01-27	All Day	<i>Uninterruptable Power Supply Replacement.</i> A UPS was replaced in the reactor bay due to a failing battery. Unit replaced and tested SAT.
2020-03-17	All Day	<i>Fume Hood Filter Replacements.</i> The fume hood pre-filter and HEPA filter were replaced to restore proper air flow. Blocking of the filters was determined to be the cause and air flow was measured to be in the satisfactory range of operation on 2020-06-03 by a USGS Safety Manager (delay due to COVID-19 restrictions).
2020-09-01	All Day	<i>CAM Pump Removed from Service.</i> The CAM pump was removed from service due to excessive noise. With no operations underway or scheduled, this was permitted by the technical specifications. Troubleshooting would later reveal internal issues with the pump.
2020-09-10	All Day	<i>CAM Pump Replaced.</i> The CAM pump was replaced with a spare like-for-like on hand due to failure of the pump. It was discovered through a tear down of the pump that grease had penetrated into the air handling portion of the pump, clogging it beyond operability, resulting in the excessive noise. Replacement of the bearings was more resource consuming than simply replacing with the spare on hand. Replacement installed and tested satisfactory. CAM returned to service.
2020-09-17	All Day	<i>Hoist Cable Replacement and Leak Maintenance.</i> The steel cable of the 5 ton hoist installed in the facility was removed for replacement, which was completed on 2020-09-18. The crane was also serviced to stop an oil leak that had been occurring for several months, approximately 5 mL per day. The leak repair was finally satisfactory after several visits by the maintenance contractor in late October.
2020-10-06	All Day	<i>Console CSC Computer Fan Replacements.</i> Three fans in the reactor control console CSC computer drawer were replaced due to excessive noise. The fans were discovered to be misaligned in their housings, bearings troubled or failing, and replacements were purchased and installed. Tested satisfactory.

SECTION 4: FACILITY CHANGES AND SPECIAL EXPERIMENTS APPROVED

Three 10 CFR 50.59 changes have been initiated and completed during the course of the year.

Change 2020-01 – Environmental Monitoring was a 50.59 change that screened out, but additional evaluation and documentation was performed for completeness of the change. This change served to remove the requirement to perform biennial soil and offsite water environmental sampling, as it had been discovered that sampling soil on the Denver Federal Center was against regulations, and prior approval had never been sought to gather such samples. To offset this restriction, additional environmental dosimetry was installed outside the licensed area (5 dosimeters up from 2) and increased well water monitoring (from semi-annually to quarterly). This change was approved by the reactor operations committee at the October meeting.

Change 2020-02 – Continuous Air Monitor Model Change was a 50.59 change that screened out as well. This change replaced the old model continuous air monitor, a custom assembly of several different systems and components, with a new up to date model from Mirion/Canberra, the iCAM. The new unit was specified to meet or exceed the performance of the previous unit and granted several new large improvements, such as a background subtraction channel to mitigate the heightened radon levels of the Denver area. It has also been equipped with a new pump accommodating the reduced air flow requirements of the iCAM, which is a grease free version matching the portable air sampling system in use at the facility. The iCAM was installed and fully operational alongside the previous CAM unit for several weeks for comparative performance measurements and found to be an exceptional upgrade.

Change 2020-03 – Fuel Rack Installations and Modified Model was a change that screened out as well. This change allowed for the installations of several additional fuel racks in the reactor tank and a modified version of the existing fuel rack design to be used for the storage of sealed damaged fuel canisters. The analyses performed on the fuel racks previously were cited and re-evaluated as part of license amendment request 14. The modified rack was elongated to accommodate the canister design and limited to hold only 6 elements total in 3 sealed damaged fuel canisters, reducing the criticality possibility by an extreme margin when compared to the typical 19 elements held by a rack. The racks were installed with the new mounting solution with no issues and replaced all of the existing mounting solutions. Racks were also permanently marked with new designations to make differentiation easier.

SECTION 5: RADIOACTIVE EFFLUENT RELEASE

(A) GASES

The major direct release to the environment is Argon-41 produced during normal operations. Very small amounts of other gases may be released from irradiated materials in experiments.

Releases of Argon-41 are measured directly from the effluent of the reactor bay utilizing a shielded sodium iodide detector equipped with both single channel analyzer and multichannel analyzer capabilities, and are presented below by month:

<i>Period</i>	<i>Average Concentration ($\mu\text{Ci/mL}$)</i>	<i>Allowable Monthly Release ($\mu\text{Ci/mL}$)</i>	<i>% of Monthly Allowable Release</i>
January	0.00E+00	4.8E-06	0.000%
February	1.14E-09	4.8E-06	0.024%
March	2.45E-10	4.8E-06	0.005%
April	0.00E+00	4.8E-06	0.000%
May	0.00E+00	4.8E-06	0.000%
June	2.45E-10	4.8E-06	0.005%
July	0.00E+00	4.8E-06	0.000%
August	0.00E+00	4.8E-06	0.000%
September	2.45E-10	4.8E-06	0.005%
October	0.00E+00	4.8E-06	0.000%
November	0.00E+00	4.8E-06	0.000%
December	0.00E+00	4.8E-06	0.000%
Annual Averages:	1.57E-10	4.8E-06	0.003%

Note: Argon-41 releases continue to be near-zero due to no high-power operations taking place.

Releases of Tritium are calculated using 1) the volume of water that is calculated to have evaporated from the tank in a given month, and 2) the primary water tritium concentration that is measured by an outside vendor at regular intervals throughout the year.

The Tritium releases are presented below, by month:

TABLE V – Hydrogen-3 (Tritium) Effluent Releases

<i>Period</i>	<i>Average Concentration (uCi/mL)</i>	<i>Allowable Monthly Release (uCi/mL)</i>	<i>% of Monthly Allowable Release</i>
January	6.35E-11	1E-07	0.063%
February	4.82E-11	1E-07	0.048%
March	3.51E-11	1E-07	0.035%
April	3.06E-11	1E-07	0.031%
May	3.16E-11	1E-07	0.032%
June	2.28E-11	1E-07	0.023%
July	2.41E-11	1E-07	0.024%
August	3.07E-11	1E-07	0.031%
September	2.97E-11	1E-07	0.030%
October	2.92E-11	1E-07	0.029%
November	4.38E-11	1E-07	0.044%
December	5.16E-11	1E-07	0.052%
Annual Averages:	3.67E-11	1E-07	0.037%

(B) LIQUIDS AND SOLIDS

Liquid and solid wastes from utilization of by-product materials are disposed through a vendor contract. Disposals to this custody are given below. It is important to note that activity values are estimated at the time of transfer. Since few shipments are being made from the federal center, decay to negligible levels occurs for all short and medium-lived radionuclides. No waste shipments were made in CY 2020.

SOLID, DRY WASTE:

No solid, dry waste transfers took place this reporting period.

LIQUID WASTE:

No liquid waste transfers took place this reporting period.

SECTION 6: ENVIRONMENTAL SURVEILLANCE

Calcium Sulfate/Dysprosium thermo luminescent dosimeters are in place at 11 locations around the GSTR for environmental monitoring purposes. These are provided by Mirion Technologies, an NVLAP accredited dosimetry vendor and processor. The environmental packs have three chips in each pack which are averaged for exposure recording. Mirion runs multiple control samples in addition to the locations listed below. Those located outside are in sealed weatherproof boxes, while those inside the facility are generally mounted to different walls and surfaces. The table below lists the locations.

Routine contamination surveys consisting of wipe tests and G-M surveys have shown mostly a “clean” facility with significant, removable contamination only in areas coming into direct contact with samples removed from the reactor, and on sample handling tools. Trash is surveyed before disposal and not disposed of unless found to be free of removable and fixed contamination.

Table VI - Locations for Environmental Dosimeters

1. Reactor Bay Exhaust
2. Vehicle Gate
3. Room 151 Door Gate
4. Cooling Tower Fence
5. West Light Pole
6. Southwest Light Pole
7. Northwest Light Pole
8. Northeast Light Pole
9. East Light Pole
10. Reactor Fence by Dock
11. Basement Tunnel

**Table VII – Environmental Dosimetry Data
Average Total Exposures in mrem (Including Control Background)**

<u>Location</u>	<u>Quarter</u>				<u>Annual</u>	<u>Prior Year</u>	<u>Difference</u>
	2020 Q1	2020 Q2	2020 Q3	2020 Q4			
1. Reactor Bay Exhaust	16	0	0	23	39	54	-15
2. Vehicle Gate	10	0	0	15	25	28	-3
3. Room 151 Door Gate	55	54	22	42	173	117	+56
4. Cooling Tower Fence	0	0	0	0	0	12	-12
5. West Light Pole	0	0	0	0	0	0	0
6. Southwest Light Pole	0	0	0	0	0	0	0
7. Northwest Light Pole	-	-	0	28	28	-	+28
8. Northeast Light Pole	-	-	0	0	0	-	0
9. East Light Pole	-	-	0	21	21	-	+21
10. Reactor Fence by Dock	40	29	0	26	95	76	+19
11. Basement Tunnel	29	36	17	33	115	113	+2

Notes:

1. Above totals have the background subtracted. All TLDs were supplied and analyzed by Mirion Technologies, NVLAP accredited dosimetry vendor.
2. Additional dosimeters were installed at locations 7, 8, and 9 as a compensatory measure of removing the soil sampling requirement.
3. Due to the ongoing COVID-19 pandemic, Mirion Technologies has experienced significant delays in shipping new TLD personnel and environmental badges to the GSTR. As a result:
 - a. 1st Quarter badges monitored from 2020-01-01 to 2020-04-14.
 - b. 2nd Quarter badges monitored from 2020-04-14 to 2020-08-20.
 - c. 3rd Quarter badges monitored from 2020-08-20 to 2020-10-13.
 - d. 4th Quarter badges monitored from 2020-10-13 to 2021-01-12.

Discussion

Raw data is presented here, along with controls and prior year comparisons. Within this range, the data sets vary relatively little. Locations nearer to the facility, in particular a stored, long-lived reactor component, such as 3, 10, and 11, are usually the highest, remote locations, such as the light pole series are the lowest. Data for this year reflects several issues:

- Installation of several new dosimeters at points 7, 8, and 9.
- Locations 3, 10, and 11 are positioned near a dry storage tank containing a previously installed rotary specimen rack, which has a substantial amount of Cobalt-60. This source presents no realistic hazard to personnel, unless they were to enter the tank with the device. Reactor operations have been minimal throughout the year owing to the pandemic and the administrative shutdown.

Exposure estimated to a single individual in an uncontrolled area at this facility is minimal. With the exception of three locations near the facility, all dosimetry associated with exposures from the facility indicates minor doses higher than control levels, possible owing to radon activity in those remote zones. Locations 3 and 10 are physically closest to the facility's walls and highest source of exposure, which was the logic in choosing those locations. Location 11 is a service tunnel with restricted access and may not be entered without the reactor staff's knowledge and never during operation of the core. The Denver Federal Center itself has a limited public occupancy, as it is only open to the public from 0600-1800 during the week. So the possible maximum exposure to any one point that is accessible to the layperson is approximately 36%, not accounting for holidays nor the fact that any person occupying space near the facility would be challenged and removed if they had no just cause. Over many years, the data at each specific location has shown remarkable consistency. The net conclusion is that, within precision of measurement, and compared to distant control areas, we are operating with very minimal levels of potential public exposure over normal background levels.

SECTION 7: RADIATION EXPOSURE TO PERSONNEL

The GSTR issues TLD badges to reactor staff only. Finger dosimetry (TLD) rings are also issued to all staff personnel, as there is a strong likelihood of regularly handling radioactive sources. TLDs are read monthly by Mirion Technologies, and results are presented in Table VIII. Data is compiled into the complete year of operations since January 1, 2020. Reporting categories are deep, eye, shallow, and extremity. Other individuals visiting or intermittently working in the facility were issued electronic dosimeters which are documented in the facility’s Visitor Log and have no appreciable exposures.

TABLE VIII Personnel Exposure (mrem) 2020-01-01 to 2020-12-31				
Employee Code	Whole Body			Ring
	Deep	Eye	Shallow	Shallow
166	7	7	7	21
167	7	7	13	23
259	0	0	0	21
Total	14	14	20	65

Personnel exposures continue to be very low at this facility in keeping with ALARA efforts.

SECTION 8: FUEL INSPECTIONS

No fuel inspections took place this reporting period.

SECTION 9: CLOSING REMARKS

This facility continues to remain in an administrative shutdown state. Efforts are being made daily to achieve restart authorization and continually improve the facility, readying for the inevitable resumption of operations. Quality management of the facility is a priority, as the administrative shutdown primarily continues due to concerns of quality assurance and controls stemming from the failures of other laboratories and a subsequent congressional hearing. Several new programs and efforts have been established, including the development of a robust database to track and report nearly all aspects of facility operations, such as:

- An improved and expanded new training program for reactor operator candidates in partnership with the Colorado School of Mines.
- A renewed neutron activation analysis laboratory, which shutdown as a result the retirement of the only analyst in conjunction with the reactor facility's administrative shutdown.
- To improve operational flexibility, work is currently underway on neutronic and thermal-hydraulic studies of the reactor for a license amendment request in the coming year for a resolution to the thermal-hydraulic restriction imposed by the NRC's Safety Evaluation Report during license renewal.
- In expanding research capabilities, the installation of a new reflector and horizontal beamlines is being examined for feasibility and stakeholder interest, with plans for a license amendment request in the coming 3-5 years.
- A fourth, and possibly fifth, full time position to be established at the reactor facility, restoring full operational staff and accommodating for the resumption/expansion of research support.

Given the extended administrative shutdown of this facility, establishing or re-establishing users and collaborators is a critical upcoming activity. Expansion of the user base is also critical, as it is for so many other research reactor facilities, in order to maintain relevancy and become less burdensome on the congressional budget, as this facility is capable of becoming a net-zero cost science center. The leadership of USGS has obviously demonstrated their commitment to this scientific resource, and the shutdown period for this facility is nearing a close, which will never be repeated through the efforts of the reactor staff and leadership, allowing the growth and impact of the facility to progress.