



## Nuclear Engineering

COLLEGE OF ENGINEERING | THE UNIVERSITY OF UTAH

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To whom it may concern:

Enclosed please find the Annual Operating Report for the University of Utah TRIGA Nuclear Reactor, License No. R-126, Docket number 50-407, for the period of 1 July 2020 through 30 June 2021. This report fulfills the requirements of the TRIGA Technical Specifications 6.7.1.

If there are any further questions or concerns regarding this report, please contact me.

Respectfully,

Amanda Foley  
Reactor Supervisor, University of Utah Nuclear Engineering Program  
50 South Central Drive, Room 1206  
The University of Utah, Salt Lake City, UT 84112  
Phone: 801.581.4188  
E-mail: [amanda.foley@utah.edu](mailto:amanda.foley@utah.edu)  
URL: <http://www.nuclear.utah.edu>

Cc: Xiaosong Yin, USNRC  
Craig Bassett, USNRC

ADZO  
NRR



**Nuclear Engineering**

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UUTR Annual Report

1 July 2020 - 30 Jun 2021

# **The University of Utah TRIGA Reactor (UUTR)**

## **Annual Operating Report**

**for the period  
1 July 2020 through 30 June 2021**

**Amanda Foley  
Reactor Supervisor**



I. NARRATIVE

A. Operating Experience

The University of Utah TRIGA Reactor (UUTR), License No. R-126, Docket No. 50-407, was critical for 43.408 hours and generated 1,929.385 kilowatt-hours of thermal energy during this reporting year. The reactor was used for educational demonstrations and training, laboratory experiments, reactor systems tests, reactor power measurements, and sample irradiations.

B. Changes in Facility Design

The TRIGA Mark III console was upgrade to a Thermo-Fisher designed console. The control rod drives were rebuilt. The ARMs were replaced with Mirion DRM-1/2/2E. The relevant 50.59s are located in the facility.

C. Surveillance Tests

Documentation of all surveillance activities is retained and stored by the facility. The following surveillances have been completed during the 2020-2021 operating year.

i. Control Rod Worth

The control rod worth, shutdown margin, and excess reactivity were measured on 9/2/2020 and 6/21/2021 using the control rod drop method with values, as shown in Table 1. The reactor was defueled for upgrades between 10/19/2020 to 6/16/21. Control rod drops were performed on 6/19/21, but the recorded data was not set to a fine enough step report point and was unusable. The calibration was re-accomplished on 6/21/21. Note: the run date for measurement was 6/21/21 but the data analysis was finalized on 6/23/21.

Table 1. Summary of control rod worth, SDM, and ER

Table with 3 columns: Core Configuration Date, #24-C 9/2/20, #24-C 6/23/21. Rows include Safety Rod, Shim Rod, Regulating Rod, Excess Reactivity, and Shutdown Margin.

ii. Control Rod Inspection

The biennial control rod inspection was performed during May of 2020, so no further inspections are required until May 2022. Drop time for control rods were tested and verified to be < 2s, during each semi-annual control rod calibrations.

iii. Thermal Power Calibrations

Calorimetric power calibrations were performed on 8/21/2020, 6/16/2021 with the results shown in Table 2. The calibration on 6/16/2020 was after the console installation and was done at 80 kW with results <5%. The reactor was defueled



for upgrades between 10/19/2020 to 6/16/21.

*Table 2. Summary of calorimetric power calibrations*

Date	Percent Power Indication	Linear Power Indication	Thermal Calculated Power Level
8/21/2020	92.2	91.4	89.6
6/16/2021	77.8	79.9	78.9

**iv. Fuel Inspection**

Next inspection is May 2022.

**v. Fuel Temperature Calibration**

Fuel temperature channels were calibrated on 8/31/2020 and 6/7/2021. The channels were calibrated to less than or equal to 2°C error over the range from 20 °C to 400 °C. The reactor was defueled for upgrades between 10/19/2020 to 6/16/21.

**vi. Reactor Safety Committee (RSC) Audits**

Three RSC audits were completed during this reporting period. The data are shown in Table 3. These audits identified no significant deviations from standard operating practices.

*Table 3. Audit summary*

Audit	Period	Auditor
Operations and Maintenance	1 Jan. 2020 to 30 Jun. 2020	Ryan Schow
Operations and Maintenance	1 Jul. 2020 to 31 Dec. 2020	Gregory Moffit
Radiation Safety and ALARA	1 Jul. 2020 to 30 Jun. 2021	David Dolan

**vii. Environmental Surveys**

Sixteen environmental monitors are located in the areas surrounding the University of Utah and UUTR. Maximum exposure of 8 mrem in a quarter to an environmental dosimeter situated in Building 80 was measured; Table 4 shows the average dose recorded since 2011. In 2019, The University of Utah changed dosimeter manufacturer from Landuar to Mirion, resulting in the change of values from 2018 to 2019.

*Table 4. Summary of environmental monitoring around the UUTR*

Year	Average quarterly readings for the eight environmental monitors (mrem)
2020	0.29
2019	1.0
2018	34.56
2017	31.78
2016	31.18
2015	32.06
2014	33.81
2013	33.88
2012	35.56
2011	35.13

**II. ENERGY OUTPUT**



The UUTR reactor was critical for 43.408 hours and produced 0.08 megawatt-days (1,929.385 kilowatt-hours) of energy during this reporting period. Since initial criticality, the reactor has been operated for a total of 4,298.364 hours with an accumulated total energy output of 9.933 megawatt-days (238,393.95 kilowatt-hours).

III. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS:

Two inadvertent SCRAMs occurred during this period the first on 8/19/2020 and the second on 6/16/2021. Summary of the inadvertent scram and unplanned shutdown is given in Table 5.

Table 5. Summary of Inadvertent SCRAMS and Unplanned Shutdowns

Table with 5 columns: Date, Run Number, Type, Cause, Action. It contains two rows of data detailing SCRAM events on 8/16/2020 and 6/16/2020.

IV. MAJOR MAINTENANCE

- A. The TRIGA Mark III console was replaced with a Thermo-Fisher designed console. With this console upgrade, the following items were replaced/upgraded:
- SCRAM relay logic (still completely analog; 10 CFR 50.59 actions accomplished)
- Controller for control rods, magnet power, and interlocks
- Chart recorder
- Displays
- Ultra-sonic water sensor
- Water float level alarms
- Damper wiring
- High radiation bell
- Air pressure gauges
- Conductivity sensors
- Water flow rate sensor
- pH sensor
B. The control rod drives were rebuilt including:
- Draw tube sleeve bearings
- Pinion shaft outrigger bearing



- Resistors R902, 903, 904
  - Switches S901, 902, 903
  - Connectors P901, J901
  - Bodine motors from shim and safety
  - R901, changed from 10K to 5K
  - A flexible guide and wire system
  - CR901 was changed to a 1N4007 diode
  - The terminal board is now a printed circuit board
  - R905 has been eliminated as it is no longer necessary
- C. The ARMs were replaced with Mirion DRM-1/2/2E and integrated into the new console using Televue 3000 and a Direct Logic 205 PLC controller to change the state of a 24VDC relay.
- D. The CAM blower Universal RAI blower model 22U-RAI was replaced with a Howder Roots blower model 22U-RAI.

## V. CHANGES, TESTS AND EXPERIMENTS PURSUANT TO 10 CFR 50.59

Three screenings were complete pursuant to 10 CFR 50.59, one (control rods) screened out of requiring an evaluation according to 10 CFR 50.59 and two (console and ARMs) required an evaluation according to 10 CFR 50.59.

- A. The UUTR control console was replaced with a new Thermo-Fisher Gamma-Metrics (TFGM) Console. This replacement included SCRAM relay logic (still analog), controller for control rods, magnet power, and interlocks. Replacement of the chart recorder with a digital recorder. Replacement of support systems such as the float sensors, water level sensor, water flow rate, pH sensor, conductivity sensors, air pressure sensors, high radiation alarm bell, PI power supply. The damper ventilation was rewired. Digital displays were added to the console to relay the information from the neutron power drawers.
- B. The control rod drives were rebuilt after it was discovered in the console upgrade that they were wired incompatibly, and required refurbishment. The control rod rebuilds replaced with “like for like” for the draw tube sleeve bearings, the pinion shaft outrigger bearing, resistors R902/903/904, switches S901/902/903, and connectors P901, J901. The safety and shim rods received Bodine motors that are the modern equivalent of the old motors. Changes that were made include resistor R901 from 10K to 5K to reduce noise. The flexible guide and wire replaced the old magnet coiled cord. The CR901 is now a 1N4007 diode instead of a bi-diode transient voltage suppressor to reduce inductive kick from the magnet. The terminal board is now a printed circuit board. The R905 resistor is no longer necessary and has been removed.
- C. The Eberline model #DA1-1CS ARMs were replaced with Mirion DRM-1/2/2E due to the fact that there were beyond their designed lifetime and of the 4 in place only 2 were still operational. They were integrated into the new console system via Televue 3000 connected to a Direct Logic 205 PLC that controls a 24VDC relay that is powered open.

## VI. REACTOR SAFETY COMMITTEE



As of the end of the reporting period, the current members of the RSC as designated by the Licensee are as follows:

- Ryan Schow, Chair
- Glenn Sjoden, Director Utah Nuclear Engineering Program
- Amanda Foley, Reactor Supervisor
- Fred Monette, RSO of University of Utah
- Donald Wall
- Benjamin Huffman
- Greg Moffitt

The UNEP staff continues to review and update facility documentation to assure compliance with all applicable regulations.

**VII. RADIOACTIVE EFFLUENTS**

- A. *Liquid Waste - Total activity released: none*
- B. *Solid Waste - Total activity: none.*
- C. *Gaseous Waste - Total estimated activity released: 24.021 μCi.*

The UUTR was operated for 43,408 hours at power levels up to approximately 90 kW. At this power level, Ar-41 production is substantially below MPC values for unrestricted areas. The minimum detectable concentration of Ar-41 from the CAM system for the stack monitor has been found to be less than two-thirds of 10 CFR 20 appendix B limits for release to unrestricted areas. The annual calculated concentration of Ar-41 generated during operation is estimated to be  $1.07 \times 10^{-10}$  μCi/ml, which is approximately 0.004 % of the DAC. The total amount of Ar-41 released was estimated to be 24.021 μCi. No phosphorus-32 was released from the UUTR or associated facilities during this period. A monthly summary of gaseous releases is given in Table 6. The total amount of all gaseous radioactivity released was estimated to be 24.021 μCi.

*Table 6. Summary of Monthly Gaseous Radioactive Effluent*

Month	Power (kWh)	Ar-41 (μCi)	Ar-41 (μCi/ml)	Estimated Release P-32 and all others	% of DAC
July	0	0.000	0.00E+00	0	0.000%
August	594.068	7.396	3.29E-11	0	0.001%
September	873.318	10.873	4.84E-11	0	0.002%
October	7.027	0.087	3.89E-13	0	0.000%
November	0	0.000	0.00E+00	0	0.000%
December	0	0.000	0.00E+00	0	0.000%
January	0	0.000	0.00E+00	0	0.000%
February	0	0.000	0.00E+00	0	0.000%
March	0	0.000	0.00E+00	0	0.000%
April	0	0.000	0.00E+00	0	0.000%
May	0	0.000	0.00E+00	0	0.000%
June	454.972	5.664	2.52E-11	0	0.001%
<b>Total</b>	<b>1929.385</b>	<b>24.021</b>	<b>1.07E-10</b>	<b>0</b>	<b>0.004%</b>



VIII. PERSONNEL RADIATION EXPOSURES

A. UNEP Personnel

The University of Utah Radiation Safety has issued to all personnel with duties in the reactor laboratory a Mirion gamma and neutron dosimeter. The duty category and monitoring period of personnel are summarized in Table 7. A summary of the whole-body exposures to the UNEP personnel is presented in Table 8.

Table 7. Summary of Monitored Personnel

Table with 5 columns: Last Name, First Name, Start Date, End Date, Duty Category. Lists 40 personnel with their respective dates and categories.





Wang	Meng-jen	7/1/2020	6/30/2021	Regular
Weeks	Rory	10/1/2020	3/31/2021	Regular/Terminated

Table 8. Summary of whole-body exposures to the UNEP personnel

Estimated whole-body exposure range (rem)	Number of individuals in each range
Less than 0.1	41
0.10 to 0.25	0
0.25 to 0.50	0
0.50 to 0.75	0
0.75 to 1.00	0
1.00 to 2.00	0
2.00 to 3.00	0
3.00 to 4.00	0
4.00 to 5.00	0
Greater than 5 rem	0

B. Measured Doses

During the period of 7/1/2020-6/30/2021, the average personal dose was 16.97 mRem with the highest individual dose of 63 mRem.

i. Dose Equivalent Limit

- a. Maximum Permissible Dose Equivalent = 5000 mrem/year (1250/quarter).
- b. Minimum Detectable Dose per Monthly Badge = 1 mrem.

C. Visitors

20 individuals visited the reactor facility during the period 1 July 2020 to 30 June 2021. None of the visitors received a measurable dose.

IX. LABORATORY SURVEYS

The University of Utah Radiation Safety Office conducted monthly surveys of the facility during the reporting period. The studies have not indicated any unusual radiation levels over previous years. The facility retains records of surveys.

X. ENVIRONMENTAL STUDIES

Environmental monitoring conducted by the University of Utah Radiation Safety indicated no unusual dose rates in the areas surrounding the Merrill Engineering Building, which houses the UUTR reactor facility.

Prepared by: Amanda Foley  
Reactor Supervisor

Date: 7/27/2021

Submitted by: Amanda Foley  
Reactor Supervisor

Date: 7/30/2021