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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 2019 through 30 June 2020. 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,

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The University of Utah TRIGA Reactor (UUTR)

Annual Operating Report

for the period
1 July 2019 through 30 June 2020

Matthew Lund
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 165.163.212 hours and generated 5,411.842 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*

None.

C. *Surveillance Tests*

Documentation of all surveillance activities is retained and stored by the facility. The following surveillances have been completed during the 2019-2020 operating year.

i. Control Rod Worth

The control rod worth, shutdown margin, and excess reactivity were measured on 10/14/2019, 2/13/2020, and 6/24/2020, using the control rod drop method with values, as shown in Table 1.

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

Core Configuration Date	#24-B 10/14/19	#24-B 2/13/20	#24-C 6/24/20
	Worth ($)	**Worth ($)**	**Worth ($)**
Safety Rod	2.210	2.113	2.097
Shim Rod	1.540	1.610	1.567
Regulating Rod	0.393	0.320	.320
Excess Reactivity	0.799	0.697	.858
Shutdown Margin	1.134	1.233	1.02

ii. Control Rod Inspection

The biennial control rod inspection was performed during May of 2020. The Safety rod was inspected on 4/14/2020 after the rod failed to drop as expected on 3/30/2020. Corrosion and buildup was discovered in the dashpot that prevented the rod from moving freely. The shim and regulating rod were inspected on 5/27/2020-5/28/2020. All control rods were cleaned of all corrosion, fully disassembled for inspection, and adjusted. The inspection noted that the control rod guide tubes were pitted, showing minor aging, so new guide tubes are being constructed for replacement during next fuel inspection. The control rods have minor spotting and streaking. All welds appeared in good condition, and all rods are fully functional and in service.

iii. Thermal Power Calibrations

Calorimetric power calibrations were performed on 8/18/2019, 2/14/2020, and

6/24/2020 with the results shown in Table 2. The calibration on 9/18/2019 was for final calibration of the new neutron instrumentation channels, using the old percent power channel. The new channels were initially calibrated at 50 kW against the old percent power and log power channel. The new channels were within 3% of the calculated thermal power, and the power channels were adjusted to match the calculated thermal power. The calibrations on 2/14/2020 and 6/24/2020 for the power channels were < 5% from the calculated power, and no power channel adjustments were required.

Table 2. Summary of calorimetric power calibrations

Date	Percent Power Indication	Linear Power Indication	Thermal Calculated Power Level
8/18/2019	89.6	90.0	92.9
2/14/2020	90.1	90.0	89.8
6/24/2020	87.9	87.3	91.4

iv. Fuel Inspection

The biannual fuel inspection was performed from May to June of 2020. During inspection, two fuel rods were pulled from operational service as damaged, moved to rack storage in the pool, and replaced with similar stainless steel and aluminum rods, respectively. The rod in core location C-5 had a large pit in the fuel rod. The fuel rod in location F-9 had a deep horizontal crease across the fuel element. All other fuel rods were within Technical Specifications, and passed visual inspection.

v. Fuel Temperature Calibration

Fuel temperature channels were calibrated on 8/30/2019 and 2/19/2020. The channels were calibrated to less than or equal to 2°C error over the range from 20 °C to 400 °C.

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. 2019 to 30 Jun. 2019	Ryan Schow
Operations and Maintenance	1 Jul. 2019 to 31 Dec. 2019	Ryan Schow
Radiation Safety and ALARA	1 Jul. 2019 to 30 Jun. 2020	David Dolan

vii. Environmental Surveys

Fifteen environmental monitors are located in the areas surrounding the University of Utah and UUTR. Maximum exposure of 23 mrem in a quarter to an environmental dosimeter situated in Building 180 was measured; Table 4 shows the average dose recorded in the last five years. 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)
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 165.163 hours and produced 0.225 megawatt·days (5,411.842 kilowatt·hours) of energy during this reporting period. Since initial criticality, the reactor has been operated for a total of 4,254.956 hours with an accumulated total energy output of 9.853 megawatt·days (236,464.515 kilowatt·hours).

III. EMERGENCY SHUTDOWNS AND INADVERTENT SCRAMS:

One inadvertent SCRAMs occurred during this period on 8/15/2019. Summary of the inadvertent scram and unplanned shutdown is given in Table 5.

Table 5. Summary of Inadvertent SCRAMS and Unplanned Shutdowns

Date	Run Number	Type	Cause	Action
8/15/2019	2030	Linear Power	With the reactor at ~ 20 kW as denoted by Power channel and fuel temperature, the linear power channel suddenly increased in power without a known cause.	The old compensated ion-chamber failed with high readings and was replaced with a new compensated ion-chamber and new linear power channel.

IV. MAJOR MAINTENANCE

A. PI was pulled from the core and disassembled to remove a stuck new designed test capsule that was longer in length than the older capsules. Since the new test capsule was not compatible, several brand new capsules were made by the campus machine shop, fitting the specifications from the original design. The capsules were tested and work correctly.
B. The old linear channel failed during reactor run. The connection cables were tested, and the resistance was low from the signal indicating a detector short. So instead of fixing the existing detector, the new neutron monitor channels were tested to finish installation. The new compensated chamber and linear channel are working correctly.
C. Safety and shim rod continuity lights were replaced.
D. Safety control rod 10 turn potentiometer was loose on drive and rotating slightly, causing

the percent withdrawn to be off by ~1%.

E. During fuel inspection, the following maintenance items were completed:
   i. Safety and Regulating Rod up light sometimes would not eliminate even thou rod reached top of travel, so the magnet up microswitches were readjusted to fully engage when the rod is up illuminating the light.
   ii. Regulating rod would slip downwards between 60-70% withdrawn. The regulating rod was cleaned, drive motor was replaced, and limit switches adjusted.
   iii. Safety rod was cleaned, especially in the guide tube by the core and in the dash-pot and piston. The limit switches were adjusted. The rod down rod was replaced.
   iv. Shim rod was cleaned and limit switches adjusted.
   v. Tank was cleaned and signal cables reorganized around reactor.
   vi. Continuous Air Monitor air pump was taken apart, cleaned, oil changed, bearings checked, and belt replaced, during fuel inspection.

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

Two screenings were complete pursuant to 10 CFR 50.59, both screened out of requiring an evaluation according to 10 CFR 50.59. The two screenings include:

A. The neutron power monitoring channels were replaced with new Thermo-Fisher Gamma-Metrics channels: including a new fission chamber with TR-10 electronics to replace the fission chamber, a new log power channel TR-20 to replace the percent power channel, and new TR-40 wide range linear channel with new uncompensated ion chamber to replace the linear channel.

B. The shim rod control rod drive motor, a Bodine geared servo motor model KCI-22RM, was replaced with a newer equivalent model Bodine model KCI-22T4.

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
Matthew Lund, 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: 165.163 μCi.

The UUTR was operated for 165.163 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 average annual calculated concentration of Ar-41 generated during operation is estimated to be 3.00×10^{-10} μCi/ml which is approximately 0.01 % of the DAC. The total amount of Ar-41 released was estimated to be 165.163 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 165.163μCi.

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
Jul 2019	892.737	10.233	4.943×10^{-11}	0	0.0016%
Aug 2019	1.153	1.167	6.385×10^{-14}	0	0.0000%
Sep 2019	576.929	13.2	3.195×10^{-11}	0	0.0011%
Oct 2019	108.072	7.453	5.984×10^{-12}	0	0.0002%
Nov 2019	1160.552	64.999	6.426×10^{-11}	0	0.0021%
Dec 2019	498.997	20.383	2.763×10^{-11}	0	0.0009%
Jan 2020	33.479	1.8	1.854×10^{-12}	0	0.0001%
Feb 2020	1012.755	24.715	5.608×10^{-11}	0	0.0019%
Mar 2020	566.903	11.317	3.134×10^{-11}	0	0.0010%
Apr 2020	0.045	1.53	2.492×10^{-15}	0	0.0000%
May 2020	360.162	4.283	1.994×10^{-11}	0	0.0007%
Jun 2020	200.058	4.083	1.108×10^{-11}	0	0.0004%
Total	**5411.842**	**165.163**	**3.00×10^{-10}**	**0**	**0.010%**

VIII. PERSONNEL RADIATION EXPOSURES

A. UNEP Personnel

The University of Utah Radiation Safety has issued to all personnel with duties in the reactor laboratory on either a regular or occasional basis a Mirion Instadose 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

Name	Monitoring Period	Duty Category
Albright, Lucas	07/01/19-9/06/19	Regular/Terminated
Bohanon, Reid	07/01/19-10/01/19	Regular/Terminated
Carver, Alexandra	07/01/19-6/30/20	Regular
Cazales, Edward	07/01/19-6/30/20	Regular
Diehl, George	10/01/19-6/30/20	Regular
Eckley, Courtney	01/01/20-6/30/20	Regular
Farrar, Kraig	07/01/19-08/30/19	Regular/Terminated
Faure, Quentin	07/01/19-06/30/20	Regular/Terminated
Feist, Donovan	07/01/19-6/30/20	Regular
Fitzhugh, Richard	07/01/19-6/30/20	Regular
Foley, Amanda	07/01/19-6/30/20	Regular
Foster, Logan	01/01/20-06/30/20	Regular
Goodell, Edward	10/04/19-06/30/20	Regular
Hartos, Michael	3/28/20-06/30/20	Regular
Landeros, Jeri	01/15/20-06/30/20	Regular
Leon, Rodrigo	10/04/19-06/30/20	Regular
Lund, Matthew	07/01/19-6/30/20	Regular
Mastren, Tara	07/01/19-6/30/20	Regular
Messinger, Gabriel	07/01/19-6/30/20	Regular
Miller, Scott	3/23/20-6/30/20	Regular
Olson, Codey	9/21/19-06/30/20	Regular
Pappas, Steven	07/01/19-6/30/20	Regular
Payne, Rachel	07/01/19-6/30/20	Regular
Quist, Teancum	07/01/19-6/30/20	Regular
Reifsnyder, Alexander	07/01/18-11/22/19	Regular/Terminated
Saenz, Brittney	07/01/19-6/30/20	Regular
Sjoden, Glenn	01/15/19-06/30/20	Regular
Snow, Jessie	09/06/19-06/30/20	Regular
Ulloa, Carlos	07/01/19-6/30/20	Regular
Wang, Meng-Jen	01/11/20-06/30/20	Regular

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	31
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 7/1/2010-6/30/2020, the average personal dose was 7.5 mRem with

the highest individual dose of 86 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

348 individuals visited the reactor facility during the period 1 July 2010 to 30 June 2020. 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. J. 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: Matthew Lund, Reactor Supervisor — Date: 7/27/2019

Submitted by: Matthew Lund, Reactor Supervisor — Date: 7/27/2019