REED COLLEGE

Reed Research Reactor
3203 SE Woodstock Boulevard, Portland, Oregon 97202-8199
phone: 503/777-7222. email: reactor@reed.edu

August 4, 2021 2021-063

ATTN: Document Control Desk

U.S. Nuclear Regulatory Commission

Washington, DC 20555-0001

Enclosed is the annual report for Reed College (Docket 50-288, License No. R-112) for the period July 1, 2020 through June 30, 2021.

Please contact me if you have any questions or concerns.

Jerry Newhouse

Digitally signed by Jerry Newhouse
Date: 2021.08.04 14:46:37 -07'00'

Jerry Newhouse

Director, Reed Research Reactor

Enclosure: Reed Research Reactor Annual Report July 1, 2020 – June 30, 2021

REED RESEARCH REACTOR ANNUAL REPORT

July 1, 2020 -- June 30, 2021

3203 Southeast Woodstock Blvd.
Portland, Oregon 97202-8199
503-777-7222
https://reactor.reed.edu
reactor@reed.edu

Table Of Contents

OVERVIEW

This report covers the period from July 1, 2020 to June 30, 2021, and is intended to fulfill the reporting requirements of the U.S. Nuclear Regulatory Commission License No. R-112, Docket 50-288, the U.S. Department of Energy, and the Oregon Department of Energy Rule No. 345-030-010.

Reed College operates a 250 kW TRIGA® Mark I reactor. The Reed College Research Reactor has been a resource for research and educational projects in the Portland area since 1968. The main uses of the Reed Research Reactor are instruction and research.

Due to the pandemic, Reed College was closed to most visitors during the reporting period. As a result, outside visits to the reactor did not occur.

During the year the reactor was taken critical 172 times on 75 days. The total energy produced was 12.63 megawatt-hours.

The reactor staff consists of a Director, a Reactor Operations Manager, and Reed College undergraduate students. The student staff consist of technicians, trainees, and students who are licensed by the Nuclear Regulatory Commission as reactor operators or senior reactor operators. During the reporting period, 15 RO candidates and 5 SRO candidates received licenses.

In early October 2020 a new permanent Director was hired and completed turnover from the Interim Director in November 2020. The U.S. NRC was notified of this change in a letter dated September 21, 2020.

There were no radiation exposures to individuals in excess of any limits during the year. There were no releases of liquid radioactive material from the facility. Airborne releases were well within regulatory limits. There was one shipment of low-level radioactive waste from the facility.

The Nuclear Regulatory Commission conducted two inspections during this reporting period: July 20-24, 2020 and April 19-22, 2021. One external audit was performed in May 2021.

The Covid-19 pandemic continued throughout this reporting year. Beginning in the Fall 2020, the reactor resumed limited operations to maintain operator requalification, support student thesis research, and conduct new operator training. Occupancy was severely limited compared to normal and new operator training was especially limited as a result.

PEOPLE

Reactor Staff

During the reporting period the staff consisted of the following:

Table 1 Supervisory Staff

Reactor Director	Jerry Newhouse Stephen Frantz (Interim)	10/20 - present 3/20 – 11/20
Reactor Operations Manager	Toria Ellis	6/19 - present
Radiation Safety Officer	April Sams	5/16 - present
Operations Supervisor	Kees Benkendorfer Amelia Schaeffer	5/20 - 6/21 5/21 - present
Training Supervisor	Nemo Shen M Benesch Genna Childers	5/20 - 6/21 5/20 – present 5/21 – present
Requalification Supervisor	Kaitlyn Li	5/20 - present
Projects Supervisor	Addison Guynn Nicholas Lutz	5/19 - 6/21 5/21 – present

Table 2 Staff

Senior Reactor Operators (SRO)			
M Benesch	Addison Guynn	Yilian Liu	
Kees Benkendorfer	Jonathan Li	Patrick Park	
Toria Ellis	Kaitlyn Li	Nemo Shen	
Reactor Operators (RO)			
Abdur-Rauf Ahmed	Ashlee Cook	Matt Hwang	Henry Scheffer
Hima Aramona	Ismayn Ditter	Henry Jacques	Ethan Shek
Conor Bekaert	Riyaz Ditter	Pratik Kafle	Maxwell VanLandschoot
Sol Bixby	Gavin Dury	Orion Lee	Tommy Yoon
Leandra Bruggink	Marie Faulkner	Nicholas Lutz	ZiQi Xie
Ryen Burris	Yu Fu	Natalie Murphy	Nicole Xu
Vivian Chen	Segovia Garcia	Hope Palmer	
Genna Childers	Emanuel Gordis	Amelia Schaeffer	
Reactor Technicians			
Laura Estridge	Segovia Garcia	Samantha Hordyk	Gianmatteo Martinez
Natalie Murphy	Anika Nicholas		

The list of operators includes everyone who held a license at any time during the reporting period. Reactor Operators who upgraded their licenses to Senior Reactor Operators during the reporting period are listed under Senior Reactor Operators. On June 30, 2021 there were 24 licensed operators at Reed College.

Reactor Operations Committee (ROC)

The membership of the Reactor Operation committee during the reporting period is listed.

Reactor Operations Committee

- Lucas Illing, ROC Chair (Physics Faculty, Reed College)
- Steve Reese (Radiation Center Director, Oregon State University)
- Wayne Lei (Portland General Electric-retired)
- Norm Dyer (OAR Services-retired)
- Kathy Oleson (Dean of the Faculty, Reed College)
- April Sams (Director, Reed Environmental Health and Safety)
- Jerry Shurman (Math Faculty, Reed College)
- Dan Gerrity (Chemistry Faculty, Reed College)
- Jerry Newhouse (Director, RRR)
- Stephen Frantz (Interim Director, RRR)
- Toria Ellis (Reactor Operations Manager, RRR)
- Kees Benkendorfer (Supervisor, RRR)

FACILITIES

Reactor Facility

In addition to the reactor, the Reed Research Reactor has a radiochemistry lab. The equipment includes: high purity germanium gamma spectrometers, ion chambers, beta counters, Geiger Muller tubes, and alpha detectors. These instruments are used for experiments, and training in nuclear science and radiation detection. One exit monitor is in the control room. A liquid scintillation detector serves both the reactor and broad scope license users. The reactor facility has several systems for performing irradiations, described below.

Rotating Specimen Rack Facility

The rotating specimen rack is located in a well on top of the graphite reflector surrounding the core. The rack consists of a circular array of 40 tubular receptacles, each of which can hold two irradiation tubes. The rack automatically rotates during irradiation to ensure each sample receives the same neutron fluence. The thermal neutron flux in a rotating rack position at full power is approximately 1.7 $x10^{12}$ n/cm^2s with a cadmium ratio of 6.

Pneumatic Transfer System

The pneumatic transfer system ("rabbit") consists of an irradiation chamber in the outermost F-ring of the core and its associated glovebox, blower, and piping. This allows samples to be transferred in and out of the reactor core very rapidly while the reactor is at power. The flux in the core terminal at full power is approximately $5x10^{12}$ n/cm^2s.

In-Core Facilities

The central thimble is a water-filled irradiation chamber about 3 cm in diameter. It provides the highest available neutron flux at full power, approximately $1x10^{13}$ n/cm^2s.

Foil-insertion holes, 0.8 cm in diameter, are drilled at various positions through the grid plates. These holes allow the insertion of special holders containing flux wires into the core to obtain three-dimensional neutron flux maps of the core.

In-Pool Facilities

Near core, in-pool irradiation facilities can accommodate larger samples. Neutron fluxes are lower than in the rotary specimen rack. An iridium gamma irradiator is also in the reactor pool for gamma-only irradiations.

Beam Facilities

The central thimble can be evacuated with gas, producing a vertical neutron beam. The flux above the beam exit at full power is approximately $1x10^6$ n/cm^2s.

INSPECTIONS AND AUDITS

The U.S. Nuclear Regulatory Commission conducted two inspections during this reporting period: July 20-24, 2020 and April 19-22, 2021.

The July 20-24, 2020 inspection was both a routine inspection and a confirmatory order follow-up inspection. Per Inspection Report No. 05000288/2020201, one Severity Level VI violation was identified as part of the routine inspection and there were no findings as part of the confirmatory order follow-up inspection.

The Severity Level VI violation resulted from operating the reactor from May 25, 2018 through July 26, 2018 with the isolation mode of the ventilation system inoperable. Corrective actions were completed and the violation was closed during the April 19-22, 2021 inspection.

It was noted in the conclusion of the confirmatory order inspection that "various Order requirements are part of the RRR license, and the licensee must continue to comply with these requirements in the future." This requirement of continuing compliance with the Confirmatory Order is understood and continues to be implemented.

The April 19-22, 2021 inspection was a routine inspection. Per Inspection Report No. 05000288/2021201, on Severity Level VI violation was identified.

The situation responsible for the Severity Level VI violation was self-identified to the U.S. NRC on October 28, 2020. Between August 30, 2020 and October 12, 2020 two operators operated the reactor while out of requalification. The combination of nearly all operators being out of requalification during the pandemic, the changeover between requalification years, and the changeover between requalification supervisors, all contributed to the situation. Corrective actions are partially completed, but continuing, and include: updating the requalification SOP, delivering a requalification lecture on the cause of the violation, and revising the requalification database to be robust enough to handle extreme circumstances in the future.

Dr. Wayne Lei of the Reed Research Reactor ROC conducted an audit in May 2021. The audit discovered no significant concerns, but included six follow-up items to improve organization, and clarity improvements to various checklists.

USERS

Reactor Operations Seminar

The Reed Research Reactor conducts an annual seminar series. This non-credit course serves as an introduction to nuclear reactor theory, health physics, and reactor operation. Up to 15 of the students are hired each year to continue with in-depth reactor operator training. Most subsequently apply for a Reactor Operator (RO) license.

The NRC administered two exams during the reporting period: one in October 2020 and one in March 2021. The October 2020 exam included both SRO upgrades and initial RO exams that were originally postponed due to the pandemic. The March 2021 exam included initial RO exams; all candidates trained online with only very limited access to the reactor.

Figure 1 shows the pass rate for RO and SRO for the past ten years. Figure 2 shows the number of RO and SRO license candidates for the past ten years.

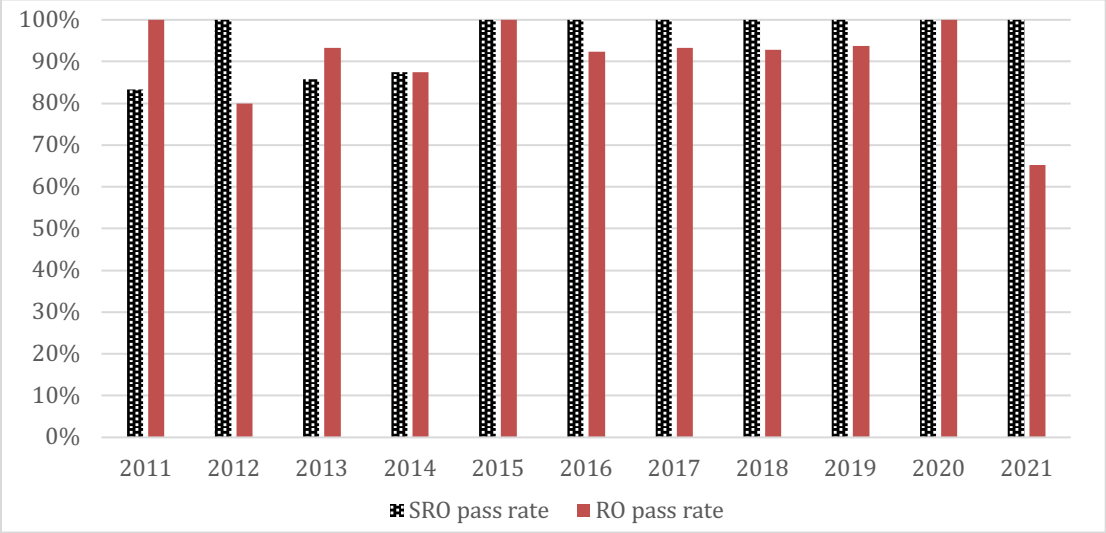

Figure 1 NRC License Exam Results

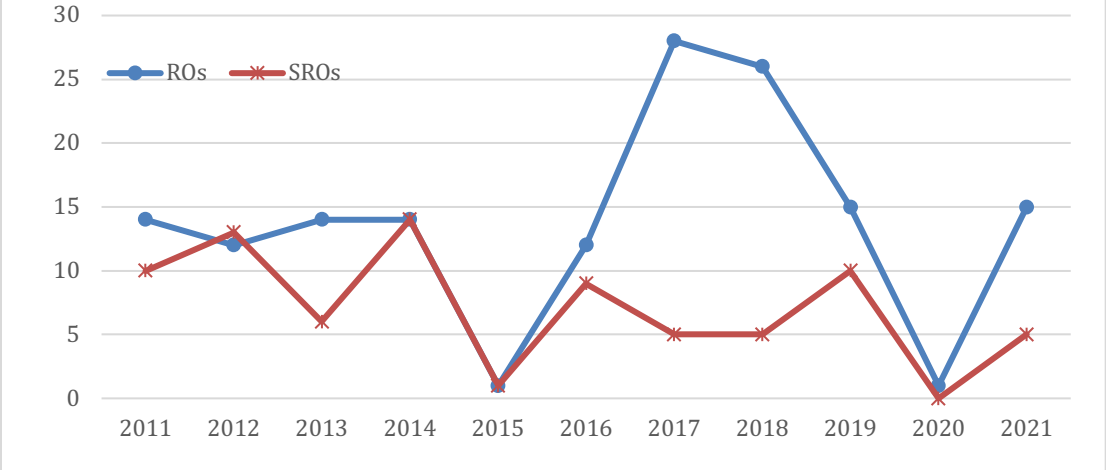

Figure 2 NRC License Candidates

Outside Users

Due to the pandemic, Reed College was closed to most visitors during the reporting period. As a result, outside visits to the reactor did not occur.

Figure 3 is a graph showing the history of visiting groups for the past 10 years.

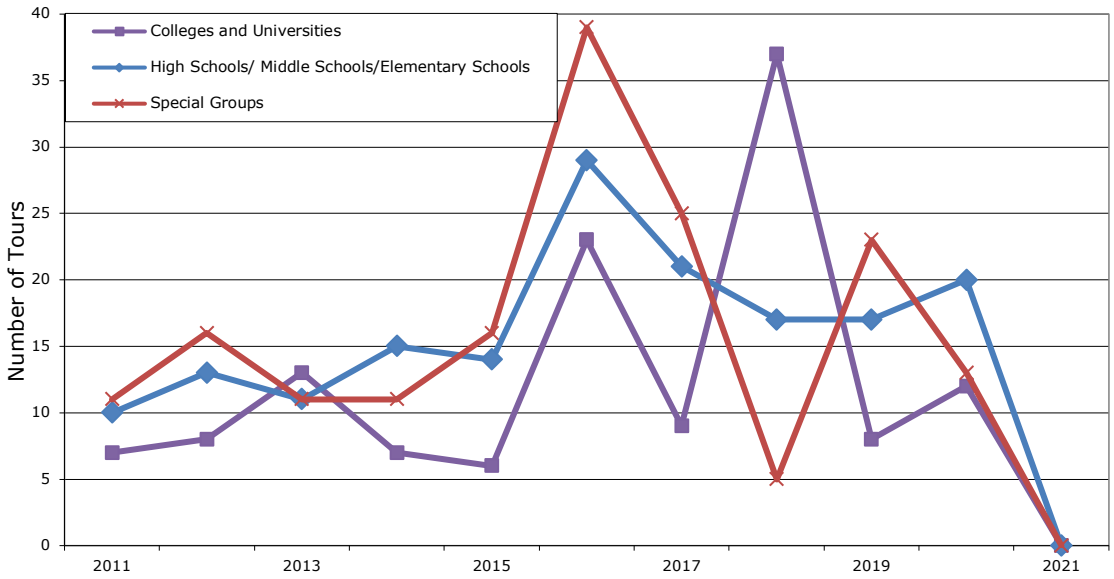

Figure 3 Visiting Groups

High School Student Projects

The reactor typically supports two high school interns during the summer months through the ASE organization. However, due to the Covid-19 pandemic, we did not participate during this reporting period.

There are two interns on site currently whose work will be covered in next year's report.

Reed Classes

The Spring 2021 Geology course used the facility's NAA capability.

Theses:

- Two chemistry majors used activated products and detection capabilities: one studied bismuth and phosphorus samples, and the other studied residual CS gas ("tear gas") in soil samples.

Industrial and Commercial Applications

The Reed Research Reactor is available for industrial or commercial concerns when it does not conflict with our educational goals. The facility also provides radiation protection training to interested parties and schools in the area, including an annual Radiation Safety Officer (RSO) class. We also provide radiation meter calibration if requested.

REACTOR OPERATIONS

Operations

During the reporting period the reactor was taken critical 172 times on 75 days. The total energy produced was approximately 12.63 megawatt-hours. Operating history by month appears in Table 3. A history of the data is shown in Figure 4.

Table 3 Operating History by Month

	Times Critical	Days Operated	MW-Hours
July 2020	4	2	0.11
August 2020	4	3	0.00002
September 2020	18	7	3.28
October 2020	20	7	0.59
November 2020	12	4	1.09
December 2020	2	2	0.86
January 2021	4	3	1.36
February 2021	38	12	1.91
March 2021	45	15	1.56
April 2021	6	4	0.99
May 2021	9	5	0.35
June 2021	10	8	0.53
Total	**172**	**75**	**12.63**

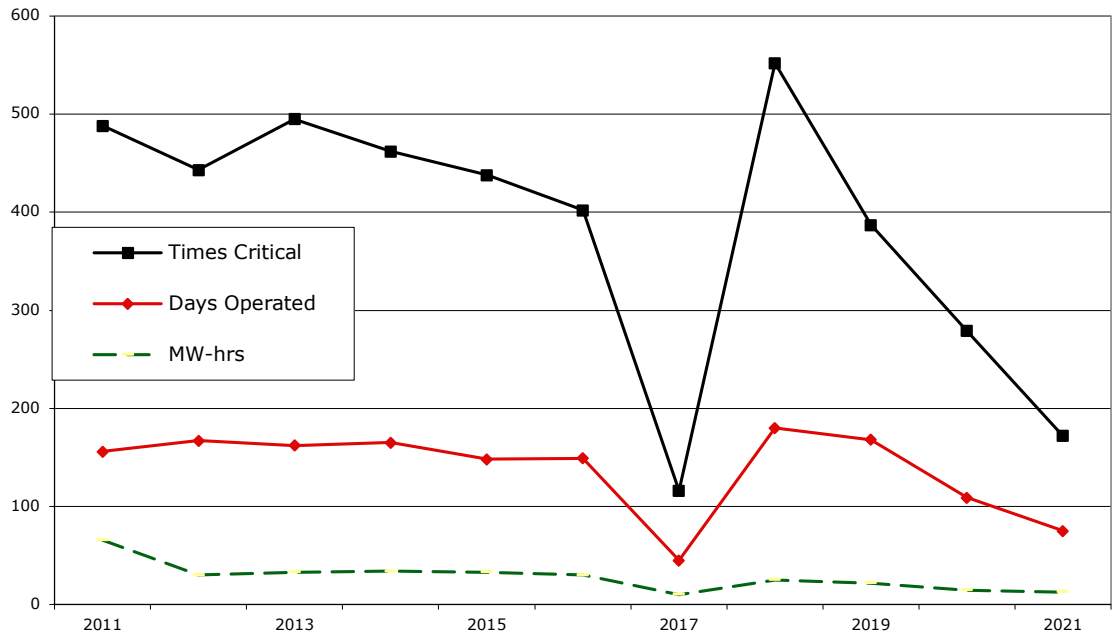

Figure 4 Operating History

Unplanned Reactor Shutdowns

There were four inadvertent reactor shutdowns (scrams) during the reporting period as shown in Table 4. The number of unplanned reactor shutdowns in the past 10 years is shown in Figure 5.

Table 4 Unplanned Shutdowns

Date	Scram Channel	Cause of Scram
Sept 7, 2020	Linear, Percent	Loss of power in facility
Mar 6, 2021	Percent	Trainee operating under direction made an error
May 13, 2021	Linear	RO attempted large power change using the auto-rod
June 24, 2021	Linear	RO overshot desired power

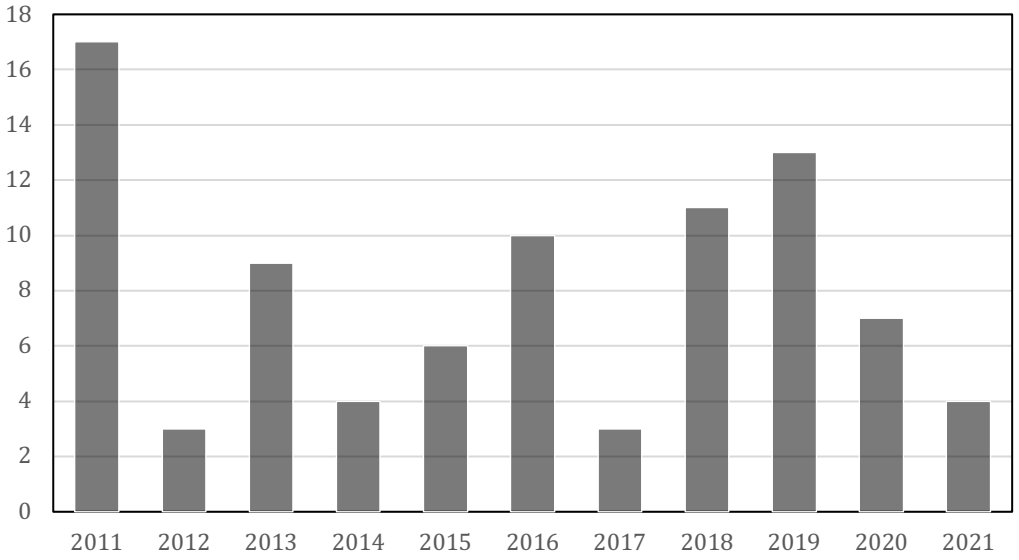

Figure 5 Unplanned Shutdowns

REACTOR MAINTENANCE

Significant Maintenance

Most maintenance items do not require a 50.59 Safety Review because they are screened out by our procedures. There were no 50.59 Safety Reviews required during the reporting period. Reactor staff performed routine equipment checks on a daily, biweekly, bimonthly, semiannual (January and July) and annual (January) basis as required by facility procedures. Reed College maintenance personnel assisted with routine preventative maintenance to auxiliary equipment. The following significant maintenance items were competed during the reporting period:

- Replaced primary coolant loop highpoint vent
- In support of the ventilation system repair:
    - Reset ventilation damper motor contact points
    - Rewired and reprogrammed damper motors
- Replaced chart recorder
- Replaced the APM air pump
- Replaced the pull rod on the regulating control rod motor

RADIATION PROTECTION

Personnel Dosimetry

Dosimeters are changed on a calendar quarter schedule. Individuals are issued beta-gamma sensitive ring badges and whole-body badges.

The highest individual doses received were 1 mrem/quarter Deep Dose Equivalent (DDE) and 35 mrem/quarter Shallow Dose Equivalent (SDE). These doses are well below occupational dose limits and no further action was required.

Fixed Area Dosimetry

Radiation levels are continually monitored to provide an indication of the average radiation levels in the reactor bay and dose outside the facility. All dosimeters monitor beta and gamma radiation. Five locations also measure neutron dose.

The Deep Dose Equivalent (DDE) radiation measured by fixed dosimeters during the period April 1, 2020 to March 31, 2021 are shown in Table 5. The dosimeters from April 1, 2021 to June 30, 2021 are currently being processed. An "M" indicates less than 1 mrem above background during the quarter.

Table 5 Area Radiation Dosimeters
(doses are in mrem per calendar quarter)

Location	Height (m)	Radiation Detected	Apr 1 - Jun 30	Jul 1 - Sep 30	Oct 1 - Dec 31	Jan 1 - Mar 31	Total
Reactor East Wall	1.5	β, γ, n	1	1	1	2	**5**
Reactor North Wall	1.6	β, γ, n	2	4	4	5	**15**
Reactor West Wall	1.0	β, γ, n	2	1	2	3	**8**
Reactor South Wall	1.6	β, γ, n	1	2	3	3	**9**
Reactor North Wall - High	2.3	β, γ	M	2	3	2	**7**
Control Room	1.5	β, γ	2	6	5	4	**17**
Outside North	2.8	β, γ	M	M	M	1	**1**
Outside Roof	0.4	β, γ, n	M	M	M	M	**M**
Outside East	1.5	β, γ	M	M	M	M	**M**
Outside South	0.4	β, γ	M	M	M	M	**M**
Counting Room	1.5	β, γ	M	M	M	M	**M**

Gaseous Releases

The only routine release of gaseous radioactivity is from ^{41}Ar (1.83-hour half-life) and ^{16}N (7.13-second half-life). These come from activation of pool water and air in the pool water and in the irradiation facilities. For the reporting period, the average gaseous activity at the site boundary was 1.39 x 10^{-10} μCi/ml, which would deliver a dose to a member of the public of approximately 0.7 mrem, well below regulatory guidelines and constraints. Figure 6 shows the gaseous releases for the past 10 years.

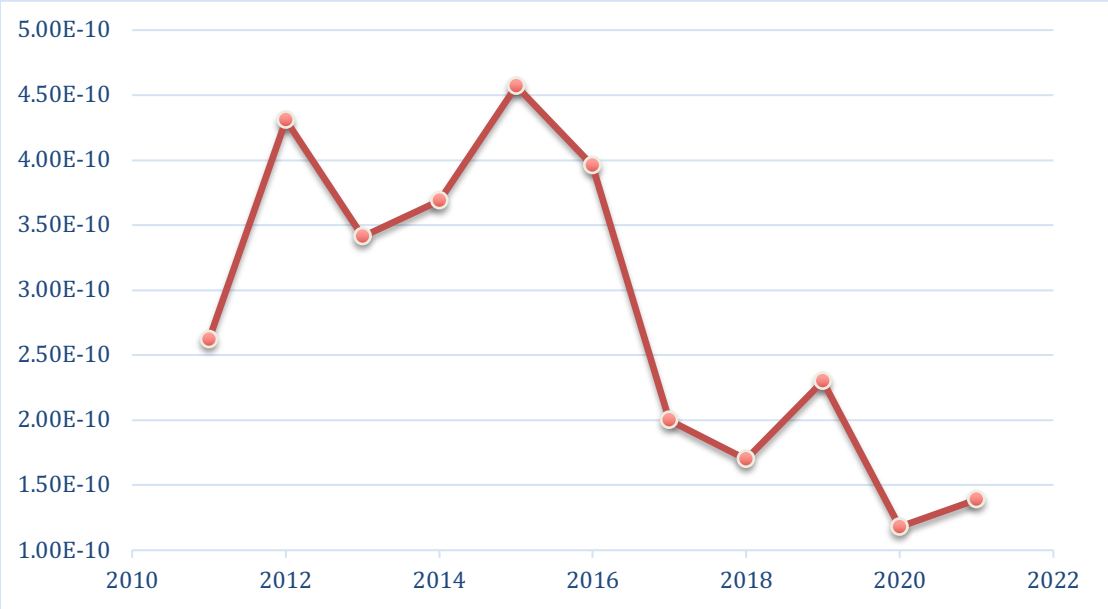

Figure 6 Gaseous Release Activity (μCi/ml) at Site Boundary

Liquid Waste Releases

No liquid radioactive waste was released from the Reed Research Reactor during this reporting period.

Solid Waste Disposal

There was one shipment of low-level radioactive waste from the facility during this reporting period.

Environmental Sampling

All environmental samples were counted in a high purity gamma spectroscopy system. Soil samples taken from the area surrounding the facility showed no activity above background. Water from the facility's secondary cooling system and the nearby canyon were sampled for activation products and tritium; the water samples showed no activity above background.