REED COLLEGE

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August 18, 2022 2022-039

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, 2021 through June 30, 2022.

This submission replaces in its entirety the previous report that was submitted in error on August 17, 2022.

Please contact me if you have any questions or concerns.

Jerry Newhouse

Digitally signed by Jerry Newhouse
Date: 2022.08.18 08:46:18 -07'00'

Jerry Newhouse

Director, Reed Research Reactor

Enclosure: Reed Research Reactor Annual Report July 1, 2021 – June 30, 2022

cc Dr. Kathryn C. Oleson, Dean of the Faculty, Reed College

REED RESEARCH REACTOR ANNUAL REPORT

July 1, 2021 -- June 30, 2022

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OVERVIEW

This report covers the period from July 1, 2021 to June 30, 2022, 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.

Tours were reopened to the general public during the Spring of 2022. Through tours, the reactor facility supports Reed College's community outreach efforts. Tours for local high schools typically include a laboratory portion in which students monitor the decay of radioactive Vanadium-52 and calculate its half-life. During the reporting period 631 visitors toured the reactor facility.

During the reporting period the reactor was taken critical 273 times on 133 days. The total energy produced was approximately 17.89 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 U.S. Nuclear Regulatory Commission as reactor operators or senior reactor operators. During the reporting period, 19 RO candidates and 1 SRO-I staff candidate received licenses.

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 were no shipments of low-level radioactive waste from the facility.

The U.S. Nuclear Regulatory Commission conducted two inspections during this reporting period: April 25-28, 2022 and May 2-4, 2022.

Reactor operations largely returned to normal as vaccinations and other methods of coping with the Covid-19 pandemic became available. In-person operator requalification training and initial licensing training resumed with good results.

Reed College students successfully petitioned the American Nuclear Society for a student chapter. While the ANS chapter is administratively separate from the reactor facility, it is expected to generate additional student interest in nuclear research and increased reactor utilization.

PEOPLE

Reactor Staff

During the reporting period the staff consisted of the following:

Table 1 Supervisory Staff

Reactor Director	Jerry Newhouse	10/20 - present
Reactor Operations Manager	Toria Ellis	6/19 - present
Radiation Safety Officer	April Sams	5/16 - present
Operations Supervisor	Amelia Schaeffer	5/21 - present
Training Supervisor	Montreal Benesch Genevieve Childers Hope Palmer	5/20 - 5/22 5/21 – present 5/22 – present
Requalification Supervisor	Kaitlyn Li Henry Jacques	5/20 – 5/22 5/22 – present
Projects Supervisor	Nicholas Lutz Vivian Chen	5/21 – present 5/22 – present

Table 2 Staff

Senior Reactor Operators (SRO)			
Montreal Benesch	Jerry Newhouse		
Toria Ellis			
Kaitlyn Li			
Reactor Operators (RO)			
Abdur-Rauf Ahmed	Ismayn Ditter	Hart Monyatovsky	Kathryn Trent
Amelie Andreas	Riyaz Ditter	Auden Oliveri	Maxwell VanLandschoot
Hima Aramona	Gavin Dury	Hope Palmer	Elijah Whitlam-Sandler
He Bai	Sarah Ellis	Ali Pardini	Valerie Wu
Conor Bekaert	Joaquin Fernandez Odell	Victoria Parker	Ziqi Xie
Sol Bixby	Henry Jacques	Owen Ross	Nicole Xu
Leandra Bruggink	Pratik Kafle	Amelia Schaeffer	Tommy Yoon
Vivian Chen	Orion Lee	Laura Smith	
Genevieve Childers	Nicholas Lutz	Sydney Stitt	
Daniel Collier	Miles McCall	Sophia Subramanian	
Reactor Technicians			
Laura Estridge	Gianmatteo Martinez	Nat Mills	Kyle Petersen
Mikey Graves	Sol McClain	Anika Nicolas	Ethan Shek
Samantha Hordyk	Clementine McTaggart-Ivezic	Patrick Park	Teddie Stewart

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, 2022 there were 40 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

- Dan Gerrity, ROC Chair (Chemistry Faculty, Reed College)
- Steve Reese (Radiation Center Director, Oregon State University)
- Wayne Lei (CTO, Restoration Fuels)
- 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)
- Mark Beck, (Physics Faculty, Reed College)
- Jerry Newhouse (Director, RRR)
- Toria Ellis (Reactor Operations Manager, RRR)
- Amelia Schaeffer (Operations 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: April 25-28, 2022 and May 2-4, 2022.

The April 25-28, 2022 inspection was a routine safety inspection, and there were no items opened. Details of the inspection may be found in Inspection Report No. 05000288/2022202.

The May 2-4, 2022 inspection was a routine security inspection. Details of the inspection may be found in Inspection Report No. 05000288/2022201.

Dr. Mary Lou Dunzik-Gougar of Idaho State University will perform an audit of the Reed Research Reactor for the Reactor Operations Committee in August 2022. Results of this audit will be discussed in the 2022-2023 annual report.

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 license.

The NRC administered three exams during the reporting period: one in October 2021, one in March 2022, and one in May 2022. The October 2021 exam included both an SRO-I exams and initial RO. The March 2021 exam included initial RO exams. The May 2022 exam included SRO upgrade exams.

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.

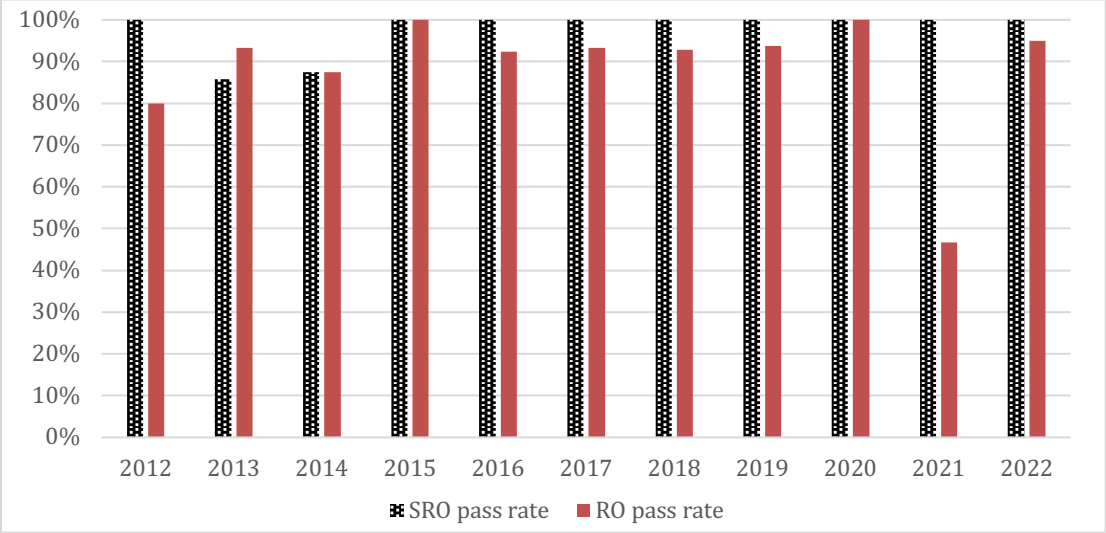

Figure 1 NRC License Exam Results

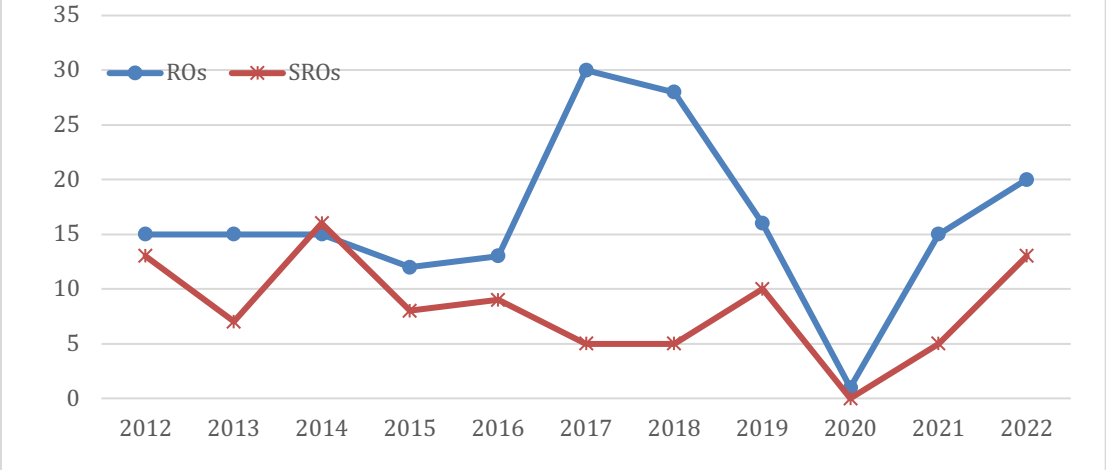

Figure 2 NRC License Candidates

Reed College Research

Theses:

- One Biochemistry and Molecular Biology major used the reactor facility to support her thesis, "Radioresistant Bacteria of the Reed Research Reactor."

Other Work:

- 30 students produced 14 internal research papers using the reactor and associated radiation facilities.
- 2 students made presentations regarding reactor associated research or instructional work at the 2021 TRTR conference.
- Reed College students successfully petitioned the American Nuclear Society for a student chapter. While the ANS chapter is administratively separate from the reactor facility, it is expected to generate additional student interest in nuclear research and increased reactor utilization.
- Work proceeded on a research grant application for environmental pollution characterization in collaboration with Gonzaga University and Warner Pacific University.

Academic Use by Other Institutions

Research

Students and professors from area institutions without nuclear facilities commonly conduct experiments at the Reed Research Reactor. During this reporting period the facility supported:

- Pacific University modern physics course's phantom lung experiment.
- Pacific University student's capstone research on TLD efficiency.
- George Fox University student's research on the efficacy a cell phone radiation app.

Tours

Tours reopened to the public in the Spring of 2022. Between that time and the end of the reporting period, there were 371 visitors from schools, institutions of higher learning, and special groups. Additionally, 260 individuals visited as part of Reed College Activities (prospective students, newly admitted students, family members of students, Reed classes, etc.). Figure 3 shows the history of visiting groups for the past 10 years.

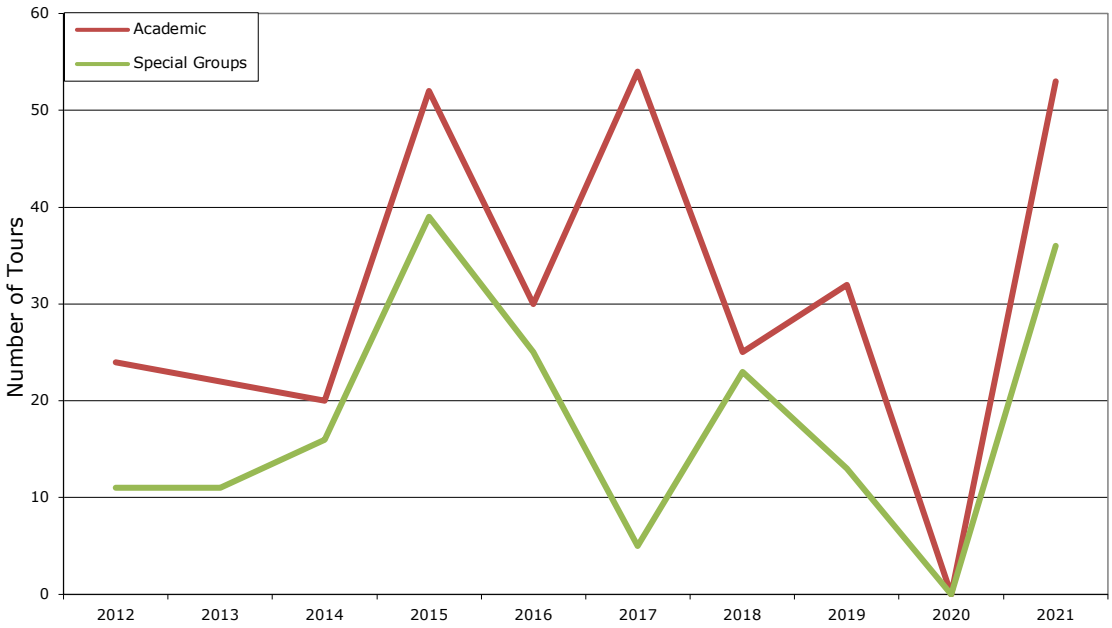

Figure 3 Visiting Groups

High School Student Projects

The reactor facility resumed hosting two high school interns through the ASE Saturday Academy program. The 2021 summer interns learned the basics of nuclear science, experiment design, and completed independent research projects monitoring environmental pollution.

In the fall of 2021, a high school student collaborated with a Reed College student to test a detection system and associated 3-D visualization software.

Industrial and Commercial Applications

The Reed Research Reactor is available for industrial or commercial concerns when it does not conflict with our educational goals. During the reporting period we completed an extensive material purity project in collaboration for Ultra Safe Nuclear Corporation's EmberCore project.

The facility also provides radiation protection training to interested parties and schools in the area, including an annual Radiation Safety Officer (RSO) class, as well as provides radiation meter calibration if requested.

REACTOR OPERATIONS

Operations

During the reporting period the reactor was taken critical 273 times on 133 days. The total energy produced was approximately 17.89 megawatt-hours. Operating history by month appears in Table 3. A history of criticality and operating days data is shown in Figure 4. A history of energy production is shown in Figure 5.

Table 3 Operating History by Month

	Times Critical	Days Operated	MW-Hours
July 2021	9	9	1.40
August 2021	21	9	0.58
September 2021	21	12	0.78
October 2021	14	8	1.01
November 2021	24	18	2.01
December 2021	23	9	0.32
January 2022	7	4	1.17
February 2022	21	9	3.36
March 2022	52	18	2.57
April 2022	36	14	2.00
May 2022	23	10	1.97
June 2022	22	13	0.72
Total	**273**	**133**	**17.89**

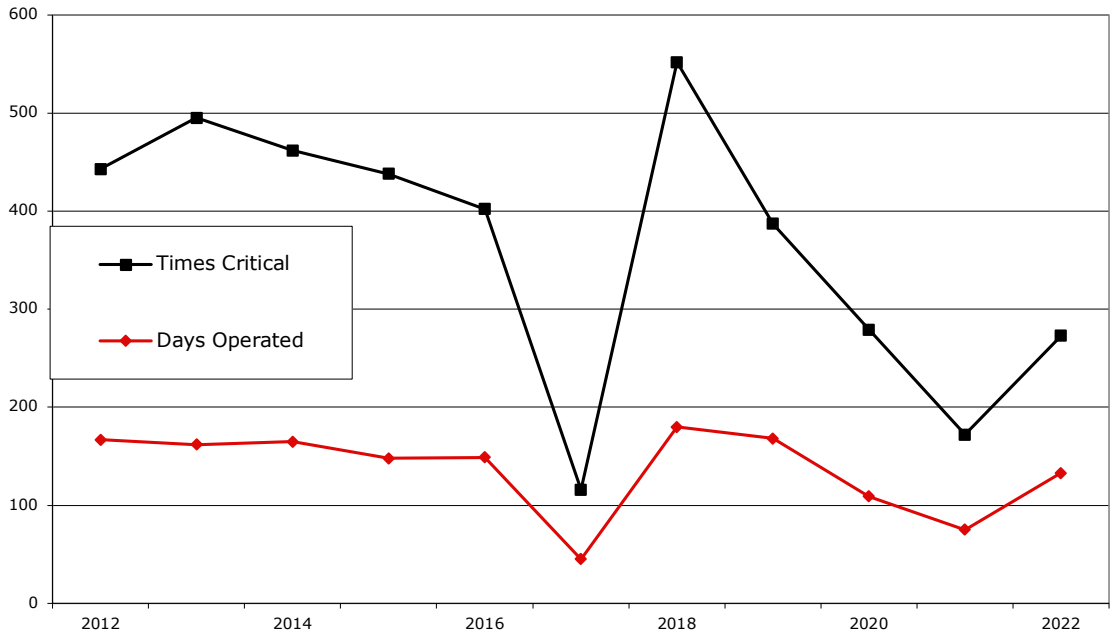

Figure 4 Operating History

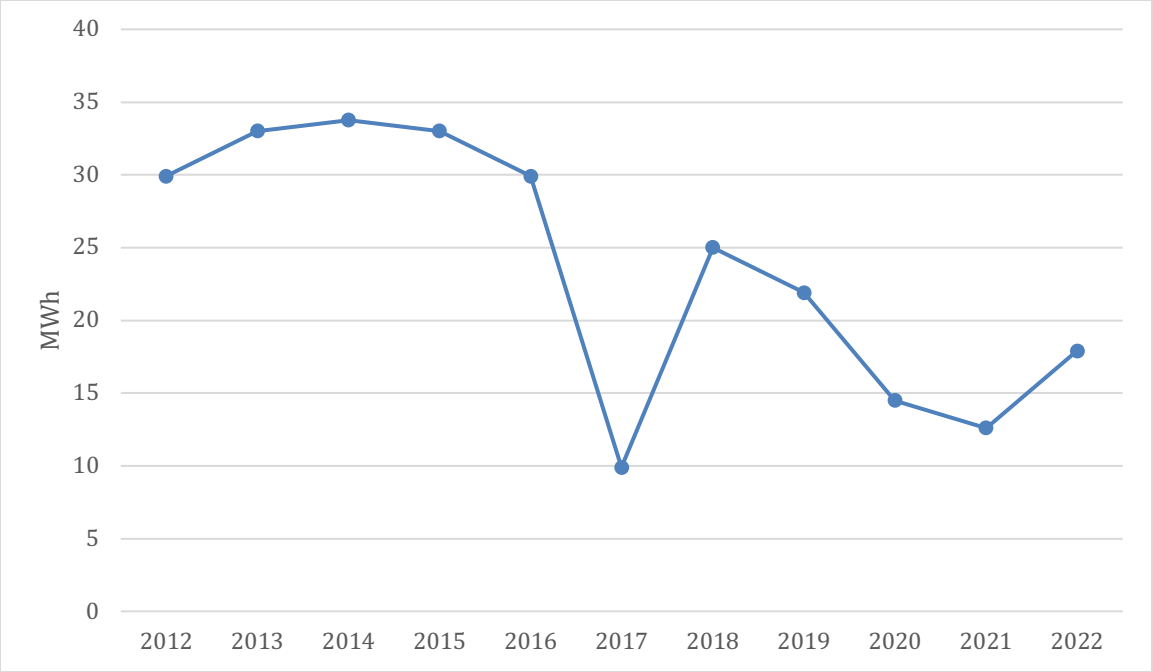

Figure 5 Energy Production History

Unplanned Reactor Shutdowns

There were five 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 6.

Table 4 Unplanned Shutdowns

Date	Scram Channel	Cause of Scram
Feb 16, 2022	All	Trainee operating under direction reset console
Mar 22, 2022	Linear	Trainee operating under direction increased power too quickly for the linear channel to range up from the 25kW scale
Mar 31, 2022	Percent	RO overshot desired power
May 13, 2022	Linear	RO increased power too quickly for the linear channel to range up from the 25kW scale
May 25, 2022	Linear	Trainee operating under direction increased power too quickly for the linear channel to range up from the 25kW scale

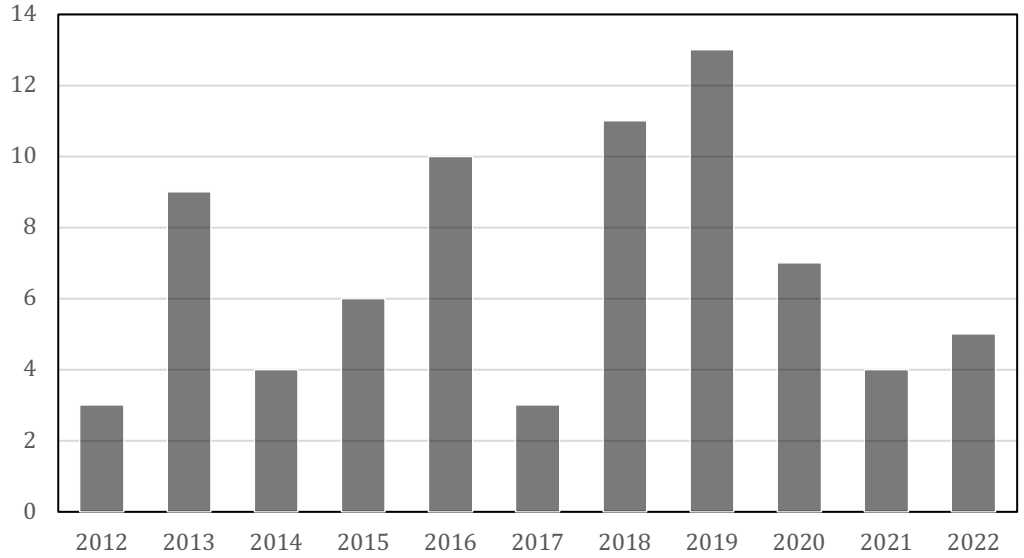

Figure 6 Unplanned Shutdowns

REACTOR MAINTENANCE

Significant Maintenance

Most maintenance items do not require a 50.59 Evaluation because they screen out. There were no 50.59 Evaluations 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 pump impeller
- Replaced a valve and portion of piping in the secondary coolant chemical loop
- Opened and cleaned the heat exchanger
- Replaced primary coolant loop highpoint vent
- Replaced a worn nut on the regulating rod down limit switch to improve reliability
- Replaced tubing on the Gaseous Stack Monitor to reduce embrittlement
- Remounted Air Particulate Monitor and Gaseous Stack Monitor detector housings to improve stability
- Repaired a leak in the Air Particular Monitor and Gaseous Stack Monitor pump to improve airflow rate

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 4 mrem/quarter Deep Dose Equivalent (DDE) and 76 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, 2021 to March 31, 2022 are shown in Table 5. The dosimeters from April 1, 2022 to June 30, 2022 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	3	3	3	3	**12**
Reactor North Wall	1.6	β, γ, n	4	7	7	2	**20**
Reactor West Wall	1.0	β, γ, n	3	4	6	5	**18**
Reactor South Wall	1.6	β, γ, n	1	3	4	M	**8**
Reactor North Wall - High	2.3	β, γ	3	4	3	3	**13**
Control Room	1.5	β, γ	2	3	3	4	**12**
Outside North	2.8	β, γ	M	5	M	M	**5**
Outside Roof	0.4	β, γ, n	M	M	M	M	**<1**
Outside East	1.5	β, γ	M	M	M	M	**<1**
Outside South	0.4	β, γ	M	M	M	M	**<1**
Counting Room	1.5	β, γ	M	M	M	M	**<1**

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 1.93 x 10^{-10} μCi/ml. This release is well below the Technical Specification limit of 1 x 10^{-8} μCi/ml. The release was calculated to deliver a dose to a member of the public of approximately 0.97 mrem, well below regulatory limits. Figure 7 shows the gaseous releases for the past 10 years.

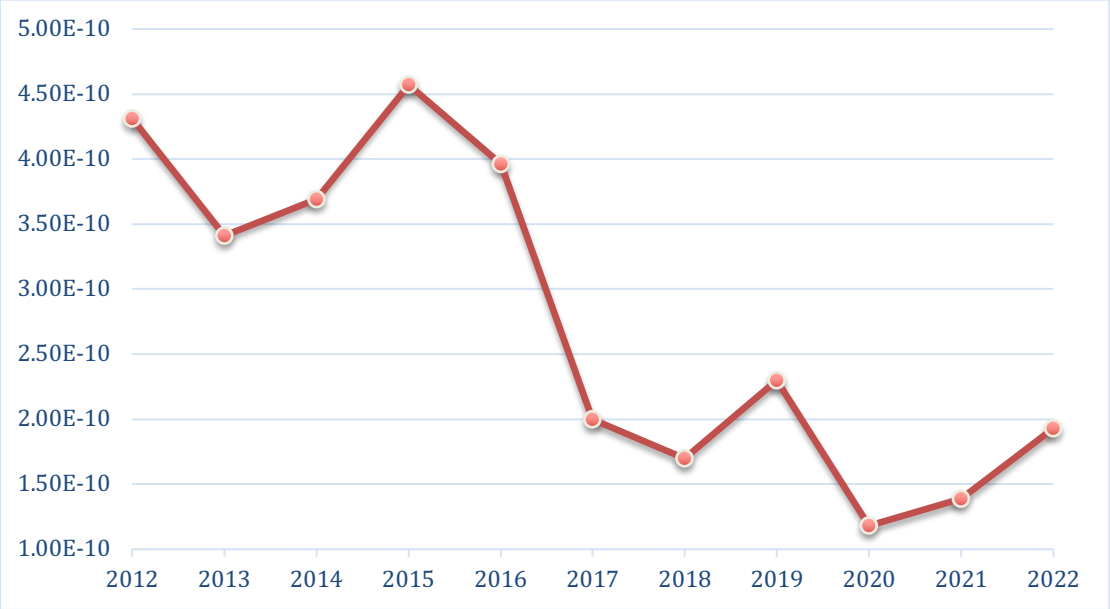

Figure 7 Gaseous Release Activity (μCi/ml) at Site Boundary

Liquid Waste Releases

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

Solid Waste Disposal

There were no shipments 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.