Texas A&M University System

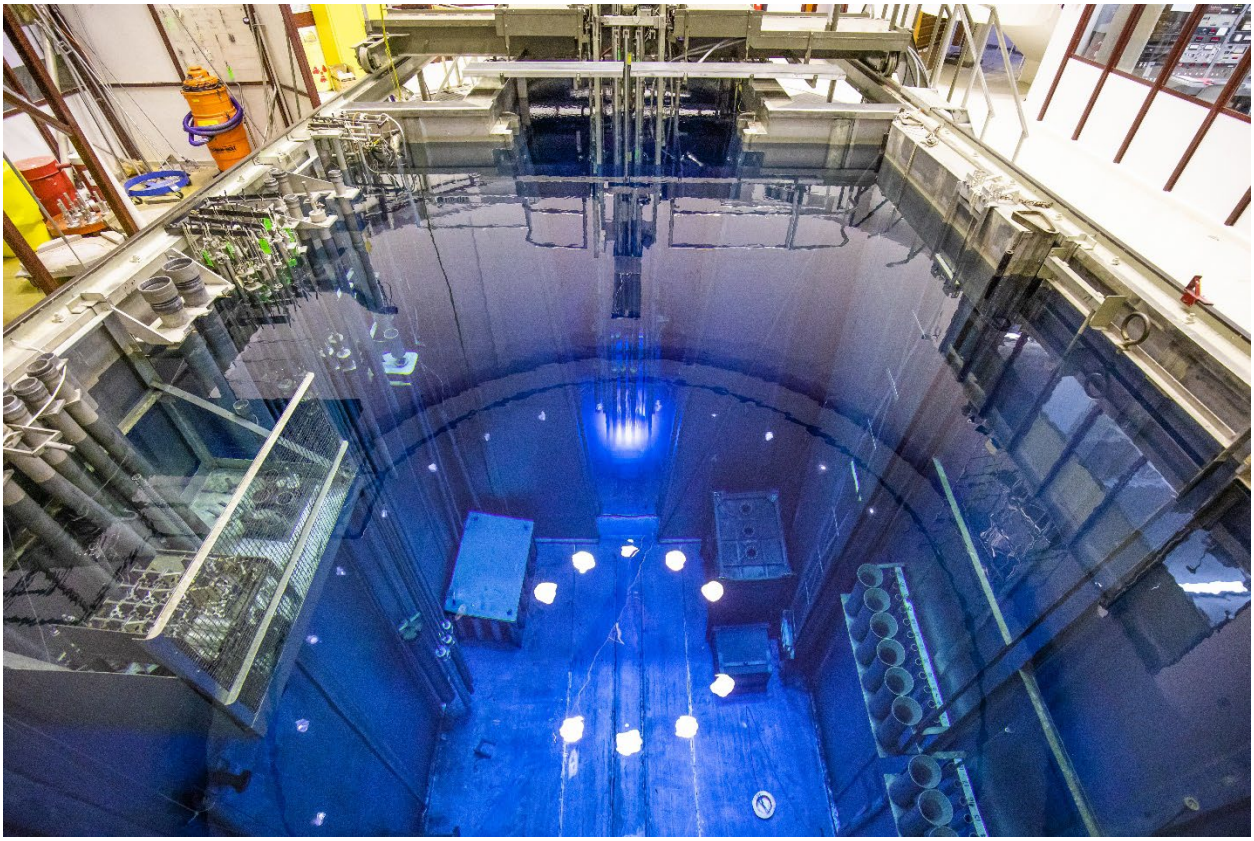
Texas A&M Engineering Experiment Station

Annual Report 2022

Nuclear Science Center Reactor

Facility Operating License R-83

Docket No. 050-00128



THE TEXAS A&M UNIVERSITY SYSTEM

TEXAS A&M ENGINEERING EXPERIMENT STATION
Nuclear Engineering & Science Center

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1 Introduction

The Texas A&M Engineering Experiment Station (TEES) Nuclear Science Center (NESC) is a multi-disciplinary research and education center supporting basic and applied research in nuclear related fields of science and technology as well as providing educational opportunities for students in these fields as a service to the Texas A&M University System (TAMUS) and the state of Texas. The NESC also provides services to commercial ventures requiring radiation or isotope production services.

The NESC reactor is a 1 MW TRIGA research reactor in a large (108,000-gal.) pool. The size of the NESC reactor pool provides great flexibility in the experiments that may be conducted near the reactor. The NESC reactor facility includes five neutron beam ports, a neutron/gamma irradiation cell, hot cells with manipulator arms, and other supporting facilities.

Laboratory facilities include counting laboratories with gas flow proportional detectors and high purity germanium detectors, a pneumatics sample transfer system, and a fast neutron irradiation system.

The NESC reactor design allows for easy loading/unloading of various types of samples. The NESC actively produces a variety of radioisotopes for academic and industry users. The NESC provides neutron activation analysis (NAA) services to many research and academic institutions in the United States. The Nuclear Engineering Department on campus is a major user of the NESC reactor. The NESC is also one of the major attractions on campus. For the calendar year 2022, the NESC hosted a limited number of visitors due to the continued Covid restrictions placed on TAMUS facilities.

This annual report has been prepared to satisfy the reporting requirements of Technical Specification 6.6.1 of the facility operating license R-83 and of the Department of Energy University Reactor Fuel Assistance Program subcontract No. C87-101594 (DE-AC07-76ER02426).

1.1 Nuclear Science Center Staff

The staff at the Nuclear Science Center consists of three major groups: Reactor Operations, Radiation Safety, and Engineering. Personnel directly involved with the operation and maintenance of the reactor are NRC-licensed operators. The NESC is committed to its educational responsibilities and many members of the staff are part or full-time students at Texas A&M University.

The Texas A&M Engineering Experiment Station (TEES) of the Texas A&M University System operates the NESC. The Director of the NESC is responsible to the Director of the TEES for the administration and the proper and safe operation of the facility. The NESC Radiation Safety Officer is responsible to the Director of the NESC for matters relating to safety and for maintaining a proper radiation safety program. In addition to the internal structure, the Reactor Safety Board (RSB) advises the Director of the TEES and the Director of the NESC on issues or policy pertaining to reactor safety. Texas A&M Environmental Health and Safety (EHS) provides assistance when required for emergencies and for special operations as agreed. The Texas A&M University Police Department provides security support on a daily basis and is a key support group in the event of a security incident. The College Station Fire Department and Scott & White Medical Center provide offsite emergency support when required as per agreement.

There were several changes to the NESC staff related to the reactor license structure in 2022:

- Sean McDeavitt was moved from Director to the position of Executive Director of the NESC on 1 June 2022 and was no longer included in the reactor license.
- Jere Jenkins was promoted to Director—Reactor Facilities on 1 June 2022, becoming the new Level 2 licensee.
- Richard (Rich) Waer as hired part-time as the Associate Director for Operations and Research in June 2022.
- Donna Rios left her position as Radiation Safety Officer taking a new position outside the NESC in June 2022.
- Scott Miller was move from the position of Manager of Operations to Reactor Supervisor in June 2022. The Manager of Operations position was deleted.
- Abby Kurwitz was hired as the NESC Radiation Safety Officer in September 2022.

Other changes within NESC but outside of the license organization included:

- Viktor Vlassov was promoted to Assistant Director of Engineering.
- Johnathan Grissom joined the NESC fulltime as the Lead Reactor Engineer.
- Noah Morton joined the NESC fulltime as a Reactor Engineer.
- Gerald Norman joined the NESC as an Engineering Technician in August 2022.

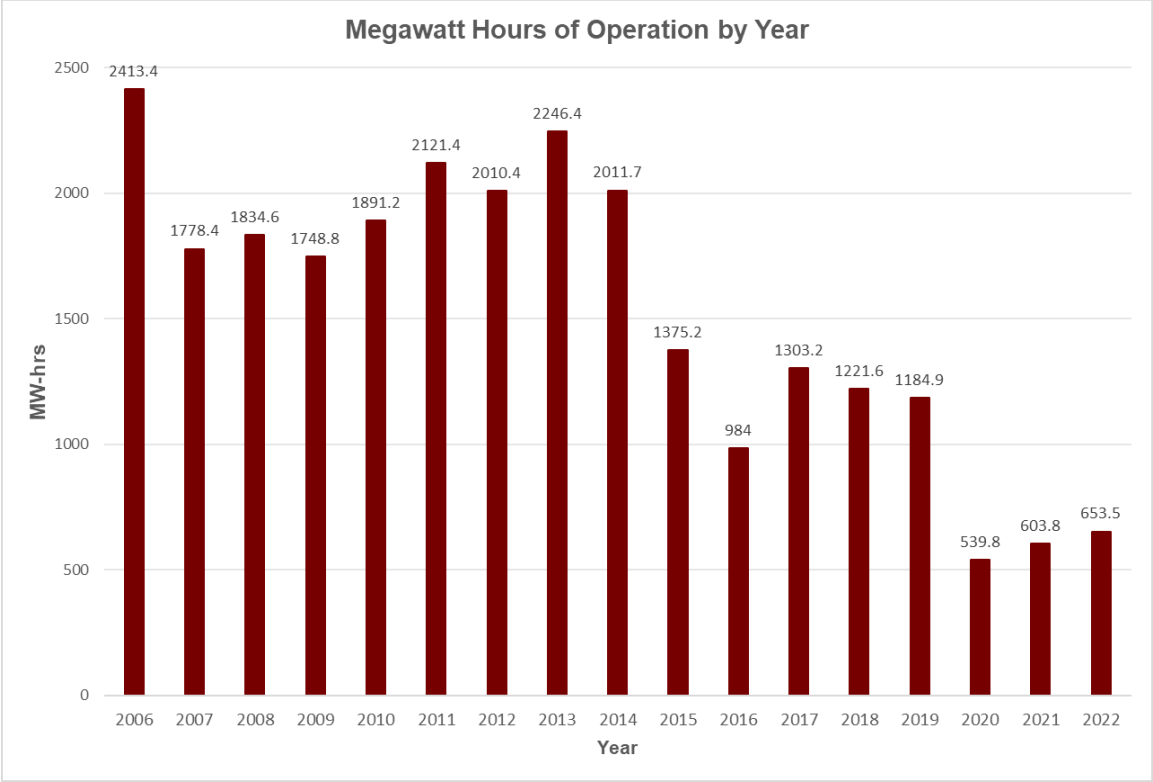
2 Reactor Utilization for 2022

The NESC reactor has been in operation since 1961. The reactor is a 1 MW MTR-converted TRIGA reactor. Core IX is the current core configuration and has been in use since September 2006. The NESC reactor is pulse operational and was pulsed up to $1.78 for nuclear engineering laboratories, staff training, and public tours.

The NESC reactor operated for 829.3 hours in 2022 with a total integrated power of 27.2 MW-days. There were 236 “Requests for Services” processed at the NESC during the reporting period. The NESC provided services to TAMU departments, other universities, research centers, secondary schools, and industry partners in and outside the state of Texas. The cumulative total energy output since initial criticality of the LEU fuel is 1080.1 MW-days. Table 2 shows the reactor utilization summary for 2022 and Figure 2 shows the annual reactor utilization in MW-hrs of operation.

Table 2: Reactor Utilization Summary in 2022

Days of Reactor Operation	178
Integrated Power (MW-days)	27.2
Number of Hours at Steady-State	829.3
Number of Pulses	16
Number of Reactor Irradiations (RFS)	236
Unscheduled Shutdowns	5



[1] includes FLIP fuel; total TRIGA fuel operation after fuel conversion in 2006 was 387.9 MW-hr.

Figure 2. Annual Reactor Utilization in MW-hrs of Operation

2.1 Financial Support by TEES

The Texas A&M Engineering Experiment Station provides a significant level of support to the NESC each year with funds that support staff salaries. TEES initiated a substantial increase in support of the NESC in June of 2022 with the staff reorganization and addition of new positions. At the beginning of 2022 the number of permanent FTE positions was nine, by the end of the calendar year that number had increased to thirteen.

2.2 TAMU Academic Support Program

The School of Nuclear Engineering at Texas A&M University provides funding for the reactor for such academic activities as nuclear engineering laboratories. The wide range of academic users from the university reflects in the NESC's reputation as a multi-disciplinary institution.

2.3 Commercial Activity and External Research

The NESC provides services to a variety of users that provide their own funding. The majority of commercial activities focus on production of radioactive tracers for the petroleum and chemical industries. Outside research grants fund a significant amount of the NESC's research. The NESC has many years of experience producing radioisotopes and has developed several customer-specific methods for radioactive sample production and handling. The production of radioisotopes generally involves handling radioactive material with high activities. The NESC

staff takes precautions to minimize the exposures during the transfer of radioactive materials to shipping shields.

3 Facility and Procedure Changes

3.1 Facility Modifications

There were no modifications of the facility in 2022.

3.2 Experiment Authorization and Modification Authorization

There were no new Experiment Authorizations (EA) or Modification Authorizations (MA) in 2022.

4 Reactor Maintenance and Surveillance

4.1 Scheduled Maintenance

NESC personnel performed regular maintenance on all channels as required by the Technical Specifications. Control rod worth and scram time measurements performed in June 2022 gave the following results. The total rod worth was $15.36. The most reactive control rod was Shim Safety #4 with a worth of $4.15. The shutdown margin was $4.13 and core excess was $5.52. Scram times on all rods were less than 1.2 seconds. In addition, operators performed calorimetric calibration following each maintenance period, and fuel inspections with no abnormalities noted (as required by the Technical Specification).

4.2 Unscheduled Shutdowns

There were eight unscheduled reactor shutdowns during 2022. Their respective causes are listed below in Table 4-2.

Table 4-2: Unscheduled Shutdowns

06/02/22	Directed SCRAM due to false fire alarm trip.
08/22/22	Safety Amplifier trip during transient between 200 kW and 900 kW.
09/22/22	Safety Amplifier trip during transient between 200 kW and 400 kW.
09/23/22	Directed SCRAM following magnet failure on SS#2.
11/28/22	Directed SCRAM due to indeterminate power excursion during steady-state operations at 900 kW

4.3 Emergency Plan and Review

The Emergency Plan was revised in November of 2021 to incorporate the existence of the AGN reactor onsite, and these revisions were reviewed and approved by the Reactor Safety Board.

4.4 Reactor Safety Board

The Reactor Safety Board is responsible for providing an independent review and audit of the safety aspects of the NESC reactor in accordance with Section 6.2 of the NSCR Technical Specifications. The Reactor Safety Board met as required in the year 2022.

4.5 Audits

A modification to the conduct of audits was made with the approval of the Reactor Safety Board such that an outside person very familiar with research and test reactor facilities was brought in. That audit was conducted in July of 2022, and there were several findings and recommendations made by the auditor. The results of the audit were shared with the RSB members, and the NESC is working to resolve the audit findings. The RSB is tracking the resolutions of the findings as they are completed.

4.6 NRC Inspection Results

An inspection was performed by the U.S. Nuclear Regulatory Commission in November 2022 over the following topics:

- Organization and Staffing
- Procedures
- Health Physics
- Design Changes
- Committees, Audits, and Review
- Transportation Activities

There were no major findings. Additionally, one unresolved item and one inspector follow-up item were closed. A full report is available at ML23031A255.

5 Radiation Safety Surveillance

The purpose of radiation safety surveillance is to ensure safe use of radioactive materials in the Nuclear Science Center's research and service activities and to fulfill the regulatory requirements of the U.S. Nuclear Regulatory Commission and State agencies. The NSC maintains a Radiation Safety Program as an integral part of the organization. It is responsible for radiological as well as chemical and physical safety concerns. The Radiological Safety staff at the TAMU Environmental Health and Safety Department provides additional support to the NSC Radiation Safety Office upon request.

5.1 Personnel Monitoring

Personnel occupational dose was monitored monthly for approximately 12 full-time employees, 29 students, 2 Texas A&M Professors/Senior Reactor Operators, and 19 external users. All personnel doses were less than 8.1% of the regulatory limit of 5000 mrem whole body. The highest measured annual occupational doses to an individual were 405 mrem whole body and 1322 mrem for extremities. There was no contribution from airborne activity to occupational dose.

5.2 Facility Monitoring

The NSC monitors radiation and contamination levels by conducting routine surveys, strategic placement of area radiation monitors, and the use of optically stimulated luminescence (OSL) dosimeters. Table 5-2 summarizes the annual accumulated dose equivalent recorded by the building and area OSLs.

Table 5-2: Total Accumulated Dose Equivalent (mrem)

Monitor ID	Location	Accumulated Dose Equivalent (mrem)
BLDG MNTR 1	Upper Research Level Mezzanine	464
BLDG MNTR 2	Lower Research Level Mezzanine	1196[a]
BLDG MNTR 3	Lower Research Level	18348[a]
AREA	Upper Research Level	283[b]
AREA	Control Room	122
AREA	Clean Zone of Material Handling Area	581[b]

[a]Radioactive shipments were stored in the Lower Research Level (LRL) pending transport.

[b]Radioactive sample extraction and shipment packaging occur near these areas.

5.3 Environmental/Public Dose Monitoring

In conjunction with the Texas Department of State Health Services (TDSHS) Radiation Control, a quarterly environmental survey is conducted to ensure compliance with federal and state regulations for public dose. The TDSHS provides the NSC with OSLs to place at various locations around the NSC site boundary and two background locations. Monthly radiation measurements are also conducted at each location monthly by NSC staff.

In 2022, approximately 500 visitors toured the NSC. Visitors were monitored using pocket ionization chambers (PICs) for the duration of their time at the facility. The PICs indicated minimal exposure.

Table 5-3: Site Boundary OSL Data

Site #	Location	Quarterly Gross Exposure (mrem)				OSL Dose (total)
2	300 ft. W of reactor building, near fence corner	31	50	49	47	89
3	250 ft W-SW of reactor building, on SW chain link fence	25	37	39	38	51

4	200 ft NW of reactor building, on chain link fence	38	44	44	42	80
5	225 ft NE of reactor building, on fence N of driveway	23	33	34	31	33
10	190 ft SE of reactor building, near fence corner	28	35	36	32	43
11	300 ft NE of reactor building, near fence corner	22	30	33	32	29
*14	3.84 miles NW of facility	25	31	33	32	33
18	375 ft NE of reactor building	24	32	39	32	39
19	320 ft NE of reactor building	21	35	36	34	38
*23	0.25 miles SE of facility	21	29	***	31	-7
24	SW of reactor building, near fence corner	74	73	74	39	172

* Background OSL station

**OSL was located near a container that was storing thorium salt. The thorium salt was removed in October of 2022.

***Station 23's OSL was lost due to outside construction for quarter 3.

5.4 Particulate Effluent Monitoring

Radioactive particulates were monitored at the base of the central exhaust stack and summarized monthly. The annual dilution concentration was 1.36E-15 µCi/cc and the total activity released was 1.30E-08 Ci. Table 5-3 summarizes monthly particulate effluents during 2022.

Table 5-4: Particulate Effluent Releases

Quarter	Month	Particulate Activity from channel 1 (µCi)	Exhaust Volume (cc)	Additional releases (µCi)	Dilution Concentration (µCi/cc)	Total activity released (Ci)
I	January	1.73E-03	9.96E+12	0.00E+00	1.74E-16	1.73E-09
	February	3.43E-03	8.99E+12	0.00E+00	3.81E-16	3.43E-09
	March	<BG	9.96E+12	0.00E+00	<BG	<BG
	Sum:	**5.16E-03**	**2.89E+13**	**0.00E+00**	**5.55E-16**	**5.16E-09**

II	April	2.24E-03	9.64E+12	0.00E+00	2.32E-16	2.24E-09
	May	1.12E-03	9.96E+12	0.00E+00	1.12E-16	1.12E-09
	June	<BG	9.64E+12	0.00E+00	<BG	<BG
	Sum:	**3.35E-03**	**2.92E+13**	**0.00E+00**	**3.44E-16**	**3.35E-09**
III	July	<BG	9.96E+12	0.00E+00	<BG	<BG
	August	7.40E-04	9.96E+12	0.00E+00	7.43E-17	7.40E-10
	September	2.74E-04	9.64E+12	0.00E+00	2.84E-17	2.74E-10
	Sum:	**1.01E-03**	**2.96E+13**	**0.00E+00**	**1.03E-16**	**1.01E-09**
IV	October	3.22E-03	9.96E+12	0.00E+00	3.23E-16	3.22E-09
	November	2.96E-04	9.64E+12	0.00E+00	3.07E-17	2.96E-10
	December	<BG	9.96E+12	0.00E+00	<BG	<BG
	Sum:	**3.52E-03**	**2.96E+13**	**0.00E+00**	**3.54E-16**	**3.52E-09**
Summary YTD		**1.30E-02**	**1.17E+14**	**0.00E+00**	**1.36E-15**	**1.30E-08**

1. Activity released from the stack: Activity sampled from Ch 3 multiplied by volume of air going through the stack
2. Diluted Concentration equal to: Activity Released/exhaust volume * 0.005 (Technical Specification 3.5.2, dilution value for release concentration at exclusion boundary)
3. Exhaust Volume equal to: (# days/month)*(24hrs/day)*(60min/hr)*(7875 cfm)/ 3.53E-5cc)
4. Additional Release equal to: (Individual releases calculated from facility air monitoring data)
5. Total Release equal to: (Activity Released+Additional Releases)*conversion factor

5.5 Gaseous Effluent Monitoring

Argon-41 was monitored at the base of the central exhaust stack and summarized monthly. The annual dilution concentration was 2.23E-10 µCi/cc and the total activity released was 2.20E-03 Ci. Table 5-5 summarizes monthly Argon-41 effluents during 2022.

Table 5-5: Gaseous Effluent (Ar-41) Releases

Quarter	Month	Argon-41 Activity from Channel 3 (µCi)	Exhaust Volume (cc)	Additional releases (µCi)	Dilution Concentration (µCi)	Total activity released (Ci)
I	January	1.33E+01	9.96E+12	0.00E+00	1.34E-12	1.33E-05
	February	<BG	8.99E+12	0.00E+00	<BG	<BG
	March	8.27E+02	9.96E+12	0.00E+00	8.31E-11	8.27E-04
	Sum:	**8.41E+02**	**2.89E+13**	**0.00E+00**	**8.44E-11**	**8.41E-04**

II	April	6.88E+02	9.64E+12	0.00E+00	7.14E-11	6.88E-04
	May	<BG	9.96E+12	0.00E+00	<BG	<BG
	June	<BG	9.64E+12	0.00E+00	<BG	<BG
	Sum:	**6.88E+02**	**2.92E+13**	**0.00E+00**	**7.14E-11**	**6.88E-04**
III	July	1.59E+02	9.96E+12	0.00E+00	1.59E-11	1.59E-04
	August	3.44E+02	9.96E+12	0.00E+00	3.46E-11	3.44E-04
	September	<BG	9.64E+12	0.00E+00	<BG	<BG
	Sum:	**5.03E+02**	**2.96E+13**	**0.00E+00**	**5.05E-11**	**5.03E-04**
IV	October	1.27E+02	9.96E+12	0.00E+00	1.28E-11	1.27E-04
	November	3.09E+01	9.64E+12	0.00E+00	3.20E-12	3.09E-05
	December	1.15E+01	9.96E+12	0.00E+00	1.16E-12	1.15E-05
	Sum:	**1.69E+02**	**2.96E+13**	**0.00E+00**	**1.71E-11**	**1.69E-04**
Summary YTD		**2.20E+03**	**1.17E+14**	**0.00E+00**	**2.23E-10**	**2.20E-03**

1. Activity released from the stack: Activity sampled from Ch 3 multiplied by volume of air going through the stack
2. Diluted Concentration equal to: Activity Released/exhaust volume * 0.005 (Technical Specification 3.5.2, dilution value for release concentration at exclusion boundary)
3. Exhaust Volume equal to: (# days/month)*(24hrs/day)*(60min/hr)*(7875 cfm)/ 3.53E-5cc)
4. Additional Release equal to: (Individual releases calculated from facility air monitoring data)
5. Total Release equal to: (Activity Released+Additional Releases)*conversion factor

5.6 Liquid Waste Disposal

Radioactive liquid waste is maintained in collection tanks prior to release to the sanitary sewer. Liquid waste is analyzed for radioactivity content before authorization for release. For this reporting period, the NESC made 8 releases to the sanitary sewer. The total radioactivity released was 1.43E-04 Ci. Table 5-6 summarizes the annual liquid waste release data for 2022.

Table 5-6: Liquid Waste Disposals to Sanitary Sewer

Quarter	Month	Number of Releases	Volume Released (cc)	Total Activity Released (Ci)	Total Concentration Released (µCi/cc)
I	January	0	0	0	0
	February	0	0	0	0
	March	0	0	0	0
	Sum	**0**	**0**	**0**	**0**
II	April	0	0	0	0
	May	1	5.06E+07	2.51E-05	4.96E-07
	June	0	0	0	0
	Sum	**1**	**5.06E+07**	**2.51E-05**	**4.96E-07**

III	July	2	8.49E+07	2.28E-05	5.39E-07
	August	1	5.48E+07	1.43E-05	2.61E-07
	September	2	1.54E+08	5.00E-05	6.59E-07
	Sum	**5**	**2.90E+08**	**8.71E-05**	**1.46E-06**
IV	October	1	6.68E+07	2.18E-05	3.26E-07
	November	1	1.13E+11	9.38E-06	8.31E-11
	December	0	0	0	0
	Sum	**2**	**1.30E+08**	**3.11E-05**	**3.26E-07**
Annual Summary	**Total**	**8**	**4.71E+08**	**1.43E-04**	**3.04E-07**

5.7 Radioactive Waste Shipments

In 2022, TAMU-EHS conducted a radioactive waste disposal shipment of sixty-two ten-gallon drums of thorium tetrafluoride. All disposal was conducted through the TAMU broad-scope license. The NRC license R-83 conducted no radioactive waste shipments.