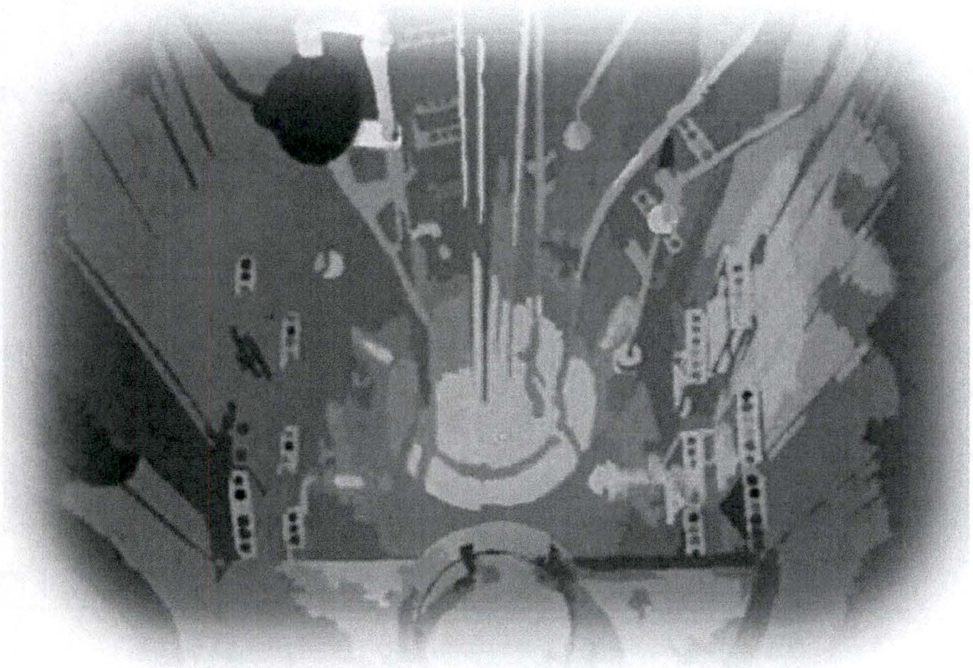
The University of Texas at Austin

Nuclear Engineering Teaching Laboratory



2017 Annual Report

NRC Docket 50-602

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Department of Mechanical Engineering
THE UNIVERSITY OF TEXAS AT AUSTIN
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FORWARD

The mission of the Nuclear Engineering Teaching Laboratory at The University of Texas at Austin is to:

- Educate the next generation of leaders in nuclear science and engineering
- Conduct leading research at the forefront of the international nuclear community
- Apply nuclear technology for solving multidisciplinary problems
- Provide service to the citizens of the State of Texas, the U.S., and the international community

This objective is achieved by carrying out a well-balanced program of education, research, and service. The NETL research reactor and related laboratory facilities support hands-on education in reactor physics, radiation detection, nuclear forensics, and nuclear science. In addition, students in non-nuclear fields such as physics, chemistry, and biology use the reactor in laboratory course work. The NETL is also used in education programs for nuclear power plant personnel, secondary schools students and teachers, and the general public.

The NETL research reactor benefits a wide range of on-campus and off-campus users including academic, medical, industrial, and government organizations. The principal services offered by our reactor involve material irradiation, trace element detection, material analysis, and radiographic analysis of objects and processes. Such services provide direct benefit to off-campus users, support faculty and students in conducting multidisciplinary research to discover new knowledge, support the commercial applications of nuclear science, and generate resources to help support Nuclear Engineering activities.

William S. Charlton, Ph.D.
Director, Nuclear Engineering Teaching Laboratory
John J. McKetta Energy Professor of Mechanical Engineering

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EXECUTIVE SUMMARY

The Nuclear Engineering Teaching Laboratory (NETL) facility supports the academic and research missions of The University of Texas, and provides these support functions to other institutions. Activities during the 2017 calendar year associated with the UT TRIGA of the NETL are provided. For context, the organization and administration are described along with various aspects of the facility. Operational and radiological data show a positive impact with little or no potential for radiological consequences.

The environmental research and analysis services performed by the NETL during the past year have been used to support Idaho National Laboratories, Pacific Northwest National Laboratory, Environment Canada, the Comprehensive Test Ban Treaty Organization, and numerous corporate clients. .

1.0 NUCLEAR ENGINEERING TEACHING LABORATORY ANNUAL REPORT

The Nuclear Engineering Laboratory Annual Report covers the period from January through December 2017. The report includes descriptions of the organization, NETL facilities, the reactor, experiment and research facilities and summaries of operations and radiological impact.

1.1 General

The NETL facility serves a multipurpose role, with the primary function as a "user facility" for faculty, staff, and students of the Cockrell School of Engineering. The NETL supports development and application of nuclear methods for researchers from other universities, government organizations and industry. The NETL provides nuclear analytic services to researchers, industry, and other laboratories for characterization, testing and evaluation of materials. The NETL provides public education through tours and demonstrations.

Figure 1-1, NETL - Nuclear Engineering Teaching Laboratory

Activities at NETL are regulated by Federal and State agencies. The nuclear reactor is subject to the terms and specifications of Nuclear Regulatory Commission (NRC) License R-129, a class 104 research reactor license. A second NRC license for special nuclear materials, SNM-180, authorizes possession of a subcritical assembly, neutron sources, and various equipment. The NETL is responsible for administration and management of both licenses. Activities at the University using radioisotopes are conducted under a State of Texas license, L00485. Functions of the broad license are the responsibility of the University Office of Environmental Health and Safety.

1.2 Purpose of this Report

This report meets requirements of the reactor Technical Specifications and the Department of Energy Fuels Assistance program, and provides an overview of the education, research, and service programs of the NETL for the calendar year 2017.

1.2.1 TRIGA II Reactor Technical Specifications

The NETL TRIGA II reactor Technical Specifications (section 6.6.1) requires submission of an annual report to the Nuclear Regulatory Commission. Table 1.1 correlates specified requirements to the report.

Table 1.1, TRIGA Mark II Technical Specification and the Annual Report

Specification	Section
A narrative summary of reactor operating experience including the energy produced by the reactor or the hours the reactor was critical, or both.	5.0, 6.1, 6.3
The unscheduled shutdowns & corrective action taken to preclude recurrence	6.2
Major preventive & corrective maintenance operations with safety significance	6.4, 6.5
Major changes in the reactor facility and procedures, tabulation of new tests or experiments, or both, significantly different from those performed previously, including conclusions that no unreviewed safety questions were involved	6.6
A summary of radioactive effluents (nature & amount) released or discharged to the environs beyond effective control of the university as determined at or before the point of such release or discharge, including to the extent practicable an estimate of individual radionuclides present in the effluent or a statement that the estimated average release after dilution or diffusion is less than 25% of the concentration allowed or recommended	7.2
A summary of exposures received by facility personnel and visitors where such exposures are greater than 25% of that allowed or recommended.	7.3
A summarized result of environmental surveys performed outside the facility	7.4

1.2.2 The Department of Energy Fuels Assistance Program

The DOE University Fuels Assistance program (DE-AC07-05ID14517, subcontract 00078206) supports the facility for utilization of the reactor in a program of education and training of students in nuclear science and engineering, and for faculty and student research. The contract requires an annual progress report in conjunction with submittal of a Material Balance Report and Physical Inventory Listing report. Specific technical details of the report (listed in Table 1.2) are sent under separate cover to the DOE with this Annual Report.

Table 1.2, DOE Reactor Fuel Assistance Report Requirements

Fuel usage (grams Uranium 235 & number of fuel elements)
Inventory of unirradiated fuel elements in storage
Inventory of fuel elements in core
Inventory of useable irradiated fuel elements outside of core
Projected 5-year fuel needs
Current inventory of other nuclear material items with DOE-ID project identifier (i.e., “J”)
Point of contact for nuclear material accountability

2.0 ORGANIZATION AND ADMINSTRATION

The University of Texas System (UTS) was established by the Texas Constitution in 1876, and currently consists of eight academic universities and six health institutions. The UTS mission is to provide high-quality educational opportunities for the enhancement of the human resources of Texas, the nation, and the world through intellectual and personal growth.

The Board of Regents is the governing body for the UTS. It is composed of members appointed by the Governor and confirmed by the Senate. Terms are of six years each and staggered, with the terms of three members expiring on February 1 of odd-numbered years. Current members of the current Board of Regents are listed in Table 2.1.

Table 2.1

The University of Texas Board for 2017
Members with term set to expire May 2018
Student Regent Jaciel Castro
Members with term set to expire February 2019
Vice Chairman Jeffery D. Hildebrand
Vice Chairman Paul L. Foster
Regent Ernest Aliseda
Members with term set to expire February 2021
Chairman Sara Martinez Tucker
Regent R. Steven Hicks
Regent David J. Beck
Members with term set to expire February 2023
Regent Janiece Longoria
Regent James C. "Rad" Weaver
Regent Kevin P. Eltife

http://www.utsystem.edu/board-of-regents/current-regents, 02/14/2018

The chief executive officer of the UTS is the Chancellor. The Chancellor has direct line responsibility for all aspects of UTS operations, and reports to and is responsible to the Board of Regents. The current Chancellor and Staff are listed in Table 2.2.

Table 2.2

University of Texas System Chancellor's Office
William H. McRaven, *Chancellor*
David E. Daniel, PhD, *Deputy Chancellor*

http://www.utsystem.edu/chancellor, 02/14/2018

UT Austin is the flagship campus of the UTS. The facility operating license for the TRIGA Mark II at the NETL is issued to the University of Texas at Austin. Figure 2-1 reflects the organizational structure for 4 levels of line management of the NETL reactor, as identified in the Technical Specifications, as well as oversight functions. Other NETL resources (in addition to line management positions) include staff with specialized functions, and faculty and facility users. NETL support is through a combination of State allocation, research programs, and remuneration for service.

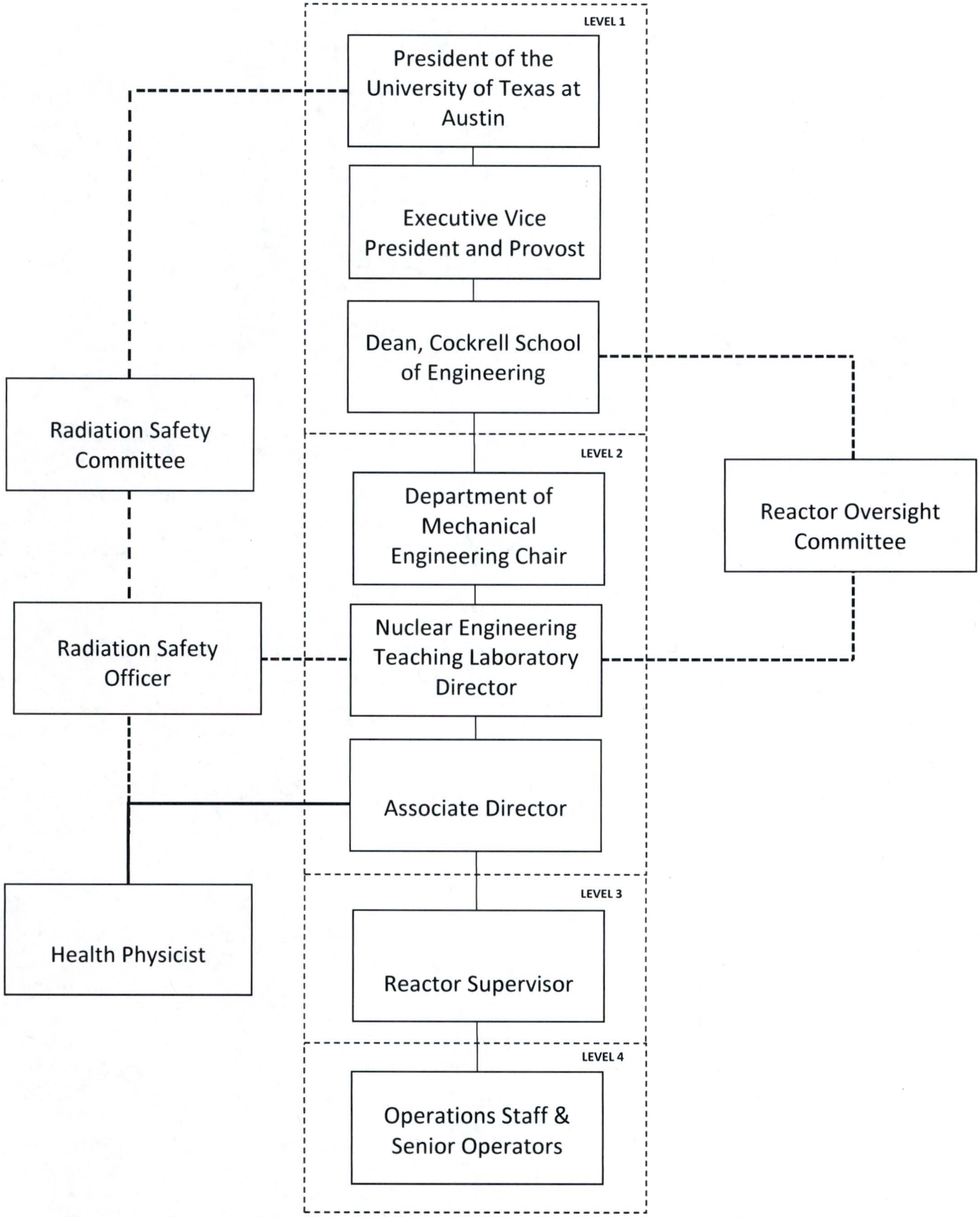


Figure 2-1: Organizational Structure for the University of Texas at Austin TRIGA Reactor

LEVEL 4

2.1 Level 1 Personnel and The University of Texas at Austin Administration

Level 1 represents the central administrative functions of the University and the Cockrell School of Engineering. The University of Texas at Austin is composed of 16 separate colleges and schools; the Cockrell School of Engineering manages eight departments with individual degree programs. The Nuclear Engineering Teaching Laboratory (NETL) is one of several education and research functions within the School. Current Level 1 personnel are reported in Table 2.3.

Table 2.3, Level 1 Personnel

The University of Texas at Austin Administration (Level 1)
Greg L. Fenves, PhD, President
Maurie McInnis PhD, Executive Vice President and Provost
Sharon L. Wood, PhD, Dean, Cockrell School of Engineering

President of the University of Texas at Austin	Responsibility for all aspects of the University is vested in the President.
Vice President and Provost	Research and academic educational programs are administered through the Office of the Executive Vice President and Provost. Separate officers assist with the administration of research activities and academic affairs with functions delegated to the Dean of the College of Engineering and Chair of the Mechanical Engineering Department.
Executive Vice President and Chief Financial Officer Provost	Financial and Administrative Services are administered through the Office of the Senior Vice President and Provost. This office is responsible for management of financial, business, information technology (IT), safety and security, physical infrastructure, and operational service units.
Dean, Cockrell School of Engineering	Management of the Cockrell School of Engineering Academic programs is provided by the Dean.

2.2 Level 2 Personnel

The Nuclear Engineering Teaching Laboratory operates as a unit of the Department of Mechanical Engineering at The University of Texas. Level 2 personnel are those with direct responsibilities for administration and management of resources for the facility, including the Chair of the Mechanical Engineering Department, the NETL Director and Associate Director. Oversight roles are provided at Level 2 by the Radiation Safety Committee, the Radiation Safety Officer and the Nuclear Reactor Committee. The current complement of Level 2 personnel is reported along with the NETL facility staff and the Nuclear and Radiation Engineering program faculty in Table 2.4.

Chair, Depart. of Mechanical Engineering	The Nuclear Engineering Teaching Laboratory supports the Nuclear and Radiation Engineering area of study in the Department of Mechanical Engineering, with the Department managed by the Chair.

Director, Nuclear Engineering Teaching Laboratory

Nuclear Engineering Teaching Laboratory programs are directed by a senior classified staff member or faculty member. The Director oversees strategic guidance of the Nuclear Engineering Teaching Laboratory including aspects of facility operations, research, and service work. The Director must interact with senior University of Texas at Austin management regarding issues related to the Nuclear Engineering Teaching Laboratory.

Associate Director, Nuclear Engineering Teaching Laboratory

The Associate Director is responsible for safe and effective conduct of operations and maintenance of the TRIGA nuclear reactor. The Associate Director performs the day-to-day duties of directing the activities of the facility. The Associate Director is knowledgeable of regulatory requirements, license conditions, and standard operating practices.

Other activities performed by the Associate Director and staff include neutron and gamma irradiation service, operator/engineering training courses, and teaching reactor short courses. In addition to Level 3 staff, an Administrative Assistant and an Electronics Technician report to the Associate Director. Many staff functions overlap, with significant cooperation required.

2.3 Level 3 Personnel

Reactor Supervisor

The Reactor Supervisor function is incorporated in a Reactor Manager position, responsible for daily operations, maintenance, scheduling, and training. The Reactor Manager is responsible for the maintenance and daily operations of the reactor, including coordination and performance of activities to meet the Technical Specifications of the reactor license. The Reactor Manager plans and coordinates emergency exercises with first responders and other local support (Austin Fire Department, Austin/Travis County EMS, area hospitals, etc.).

The Reactor Manager, assisted by Level 4 personnel and other NETL staff, implements modifications to reactor systems and furnishes design assistance for new experiment systems. The Reactor Manager assists initial experiment design, fabrication, and setup. The Reactor Manager provides maintenance, repair support, and inventory control of computer, electronic, and mechanical equipment. The Administrative Assistant and Reactor Manager schedule and coordinate facility tours, and support coordination of building maintenance.

The Reactor Supervisor is required to be knowledgeable of regulatory requirements, license conditions, and standard operating practices. The Reactor Supervisor is responsible for directing or performing reactor operations. The Reactor Manager may delegate responsibilities for supervising operations to a licensed senior operator.

2.4 Level 4 Personnel

Reactor Operators	Reactor operators (and senior reactor operators) are licensed by the USNRC to operate the UT TRIGA II nuclear research reactor. University staff and/or students may be employed as reactor operators.
Non-licensed Operators	Auxiliary positions and operators in training

Table 2.4

Facility Staff & NRE Faculty		
NETL Facility Staff		NRE Faculty
Director	S. Biegalski (to 3/17)	S. Biegalski
Interim Director	D. E. Klein (3/17 to 12/17)	D. E. Klein
Associate Director	P. M. Whaley	S. Landsberger
Reactor Supervisor	L. Hall	D. Haas
Health Physicist & Lab manager	T. Tipping	E. Schneider
Administrative Associate	D. Judson	
Electronics Technician/Reactor Operator	C. Holloway (5/18-11/18)	
Health Physics Technician	A. Copeland *(1st half of 2017)* L. Davis *(2nd half of 2017)*	

2.5 Other Facility Staff

In addition to the line management positions defined in Figure 2-1, NETL staff includes an Administrative Assistant, an Electronics Technician, and variously one or more Undergraduate Research Assistants assigned either non-licensed maintenance support (generally but not necessarily in training for Reactor Operator licensure) or to support the Laboratory Manager as Health Physics Technicians and/or research support.

Health Physicist. NETL is a radiological facility operating in the State of Texas under a facility operating license issued by the Nuclear Regulatory Commission (NRC). Radioactive material and activities associated with operation of the reactor are regulated by the NRC, and the uses of radioactive materials at the NETL not associated with the reactor are regulated by the Texas Department of State Health Services (TDSHS) Radiation Control Program. The NETL Health Physicist ensures operations comply with these requirements, and that personnel exposures are maintained ALARA ("as low as is reasonably achievable"). The Health Physicist function is incorporated into a Laboratory Manager position, responsible for radiological protection (Health Physics), safe and effective utilization of the facility (Lab Management), and research support. Each of these three functions is described below. The Laboratory Manager is functionally responsible to the NETL Associate Director, but maintains a strong reporting relationship to the University Radiation Safety Officer and is a member of the Radiation Safety Committee. This arrangement allows the Health Physicist to operate independent of NETL operational constraints in consideration of radiation safety. One or more part-time Undergraduate Research Assistant (URA) may assist as Health Physics Technicians.

Lab Management. The lab management function is responsible for implementation of occupational safety and health programs at the NETL. The Laboratory Manager supports University educational activities through assistance to student experimenters in their projects by demonstration of the proper radiation work techniques and controls. The Laboratory Manager participates in emergency planning for NETL and the City of Austin to provide basic response requirements and conducts off-site radiation safety training to emergency response personnel such as the Hazardous Materials Division of the Fire Department, and Emergency Medical Services crews.

Research Support. The mission of The University of Texas at Austin is to achieve excellence in the interrelated areas of undergraduate education, graduate education, research and public service. The Laboratory Manager and research staff supports the research and educational missions of the university at large, as well as development or support of other initiatives.

The Laboratory Manager is responsible for coordinating all phases of a project, including proposal and design, fabrication and testing, operation, evaluation, and removal/dismantlement. Researchers are generally focused on accomplishing very specific goals, and the research support function ensures the NETL facilities are utilized in a safe efficient manner to produce quality data. The Laboratory Manager obtains new, funded research programs to promote the capabilities of the neutron beam projects division for academic, government and industrial organizations and/or groups.

The NETL provides unique facilities for nuclear analytic techniques, including but not limited to elemental analysis (instrumental neutron activation analysis, prompt gamma analysis), measurements of physical characteristics (neutron depth profiling, neutron radiography) and experimental techniques investigating fundamental issues related to nuclear physics and condensed matter. Nuclear analytical techniques support individual projects ranging from class assignments to measurements for faculty research.

The Laboratory Manager manages the use of the five beam ports with the Texas Cold Neutron Source, Neutron Depth Profiling, Neutron Guide and Focusing System, Prompt Gamma Activation Analysis Neutron Radiography and Texas Intense Positron Source. Projects are supported in engineering, chemistry, physics, geology, biology, zoology, and other areas. Research project support includes elemental measurements for routine environmental and innovative research projects. The neutron activation analysis technique is made available to different state agencies to assist with quality control of sample measurements.

2.6 Safety Oversight

Safety oversight is provided for radiation protection and facility safety functions. A University of Texas Radiation Safety Committee is responsible programmatically for coordination, training and oversight of the University radiation protection program, with management of the program through a Radiation Safety Officer. Current personnel on the Radiation Safety Committee are listed in Table 2.5.

Nuclear reactor facility safety oversight is the responsibility of a Nuclear Reactor Committee; a request has been made to the Nuclear Regulatory Commission to change the name "Nuclear Reactor Committee" to "Reactor Oversight Committee" to better describe the committee function for the University and avoid confusion with other NRC organizations. "Reactor Oversight Committee" will be used in this report pending approval. Current personnel on the Reactor Oversight Committee are listed on Table 2.6.

Radiation Safety Committee. The Radiation Safety Committee reports to the President and has the broad responsibility for policies and practices regarding the license, purchase, shipment, use, monitoring, disposal and transfer of radioisotopes or sources of ionizing radiation at The University of Texas at Austin. The President appoints at least four members to the Committee and appoint one as Chairperson. The Committee will meet at least once each year on a called basis or as required to approve formally applications to use radioactive materials. The Radiation Safety Committee is consulted by the University Safety Office concerning any unusual or exceptional action that affects the administration of the Radiation Safety Program. The Committee meets at least three times each calendar year.

Table 2.5

Radiation Safety Committee 2016-2017
Jack L. Ritchie, Ph.D., Professor, Department of Physics
W. Scott Pennington, ex-officio, Environmental Health and Safety
Rick Russell, Ph.D., Professor, Department of Molecular Biosciences
John M. Salsman, CHP, Director, Environmental Health and Safety
Daniel T. Jaffe, Ph.D., Vice President, Research
Christopher S. Sullivan, Ph.D., Associate Professor, Department of Molecular Biosciences
Tracy N. Tipping, CHP, Health Physicist Laboratory Manager, Nuclear Engineering Teaching Laboratory
J. Steven Swinnea, Ph.D., Research Associate, Chemical Engineering and Texas Materials Institute
Karen M. Vasquez, Ph.D., Professor, Division of Pharmacology and Toxicology
Kevin N. Dalby, Ph.D., Professor, Chemical Biology and Medicinal Chemistry

Texas Department of State Health Services License L00485, 07/28/2017

Radiation Safety Officer. A Radiation Safety Officer holds delegated authority of the Radiation Safety Committee in the daily implementation of policies and practices regarding the safe use of radioisotopes and sources of radiation as determined by the Radiation Safety Committee. The Radiation Safety Officer's responsibilities are outlined in *The University of Texas at Austin Radiation Safety Manual*. The Radiation Safety Officer has an ancillary function reporting to the

NETL Director as required on matters of radiological protection. The Radiation Safety Program is administered through the University Office of Environmental Health and Safety.

A NETL Health Physicist manages daily radiological protection functions at the NETL, and reports to the Radiation Safety Officer as well as the Associate Director. This arrangement assures independence of the Health Physicist through the Radiation Safety Officer while maintaining close interaction with NETL line management.

Reactor Oversight Committee (ROC). The Reactor Oversight Committee is established through the Office of the Dean of the College of Engineering of The University of Texas at Austin. The Reactor Oversight Committee (formerly known as the Nuclear Reactor Committee) evaluates, reviews, and approves facility standards for safe operation of the nuclear reactor and associated facilities. The ROC meets at least semiannually.

The Dean appoints at least three members to the Committee that represent a broad spectrum of expertise appropriate to reactor technology The ROC provides reports to the Dean on matters as necessary throughout the year and submits a final report of activities no later than the end of the spring semester. The ROC makes recommendations to the NETL Director for enhancing the safety of nuclear reactor operations.

Specific requirements in the Technical Specifications are incorporated in the committee charter, including an audit of present and planned operations. The ROC is chaired by a professor in the Cockrell School of Engineering. ROC Membership varies, consisting of ex-officio and appointed positions. The Dean appoints at least three members to the Committee that represent a broad spectrum of expertise appropriate to reactor technology, including personnel external to the School.

Table 2.6

Reactor Oversight Committee 2017-2018
Derek Haas (ME), Chair
Howard Liljestrand (CAEE)
Dale Klein (ME)
Rick Neptune, ex-officio (ME)
John G. Ekerdt, ex-officio
Lawrence R. Jacobi (External Representative)
Larry Hall, ex-officio (NETL)
Tracy Tipping, ex-officio (NETL)
Mike Whaley, ex-officio (NETL)
Scott Pennington (Radiation Safety Officer)

https://www.engr.utexas.edu/faculty/committees/225-roc, 02/14/2018

2.7 Faculty and Facility Users

The complement of faculty and facility users at the NETL is extremely variable. Functionally faculty and facility users are associated with the NETL in the capacity of academic utilization, other educational efforts, or research & service.

2.6.1 Academic Utilization

The NETL is integrated in the Nuclear and Radiation Engineering program (NRE) of Mechanical Engineering (ME). The ME faculty complement directly supporting the nuclear education program is listed in Table 2.7. Successful participation in the undergraduate program results in a Bachelor of Science in Mechanical Engineering, Nuclear Engineering certification; the degree is essentially a major in Mechanical Engineering with a minor in Nuclear Engineering. All Mechanical Engineering degree requirements must be met with an additional set of specific nuclear engineering courses successfully completed.

Table 2.7

University of Texas Nuclear and Radiation Engineering Program Faculty
Dr. Erich Schneider, Nuclear and Radiation Engineering Associate Professor
Dr.Mitch Pryor, Robotics Research Group Research Scientist
Dr. William Charlton, Nuclear and Radiation Engineering Professor
Dr. Dale Klein, Associate Vice Chancellor for Research
Dr. Sheldon Landsberger, Nuclear and Radiation Engineering Professor
Dr. Derek Haas, Nuclear and Radiation Engineering Assistant Professor

https://nuclear.engr.utexas.edu/index.php/faculty-and-staff, 02/14/2018

Of the five undergraduate Nuclear Engineering courses and the dozen graduate Nuclear Engineering courses, five courses make extensive use of the reactor facility. Table 2.8 lists the courses currently in the UT course catalog, many of which use the reactor and its experiment facilities.

Table 2.8, Nuclear Engineering Courses

Undergraduate
ME 136N, 236N: Concepts in Nuclear and Radiological Engineering
ME 337C: Introduction to Nuclear Power Systems
ME337F: Nuclear Environmental Protection
ME 337G: Nuclear Safety and Security[1]
ME 361E: Nuclear Operations and Reactor Engineering
ME 361F: Radiation and Radiation protection Laboratory

Table 2.8, Nuclear Engineering Courses

Graduate
ME 388C: Nuclear Power Engineering
ME 388D: Nuclear Reactor Theory I[1]
ME 388F: Computational Methods in Radiation Transport[1]
ME 388G: Nuclear Radiation Shielding[1]
ME 388H: Nuclear Safety and Security[1]
ME 388J: Neutron Interactions and their Applications in Nuclear Science and Engineering[1]
ME 388M: Mathematical Methods for Nuclear and Radiation Engineers[1]
ME 388N: Design of Nuclear Systems I[1]
ME 388P: Applied Nuclear Physics[1]
ME 388S: Modern Trends in Nuclear and Radiation Engineering[1]
ME 389C: Nuclear Environmental Protection
NE 389F: The Nuclear Fuel Cycle[1]
ME 390F: Nuclear Analysis Techniques
ME 390G: Nuclear Engineering Laboratory
ME390T: Nuclear- and Radio-Chemistry

NOTE[1], Academic courses with minimal or no use of the reactor facilities

The NRE program's graduate degrees are completely autonomous; they are Master of Science in Engineering (Concentration in Nuclear Engineering) and Doctor of Philosophy (Concentration in Nuclear Engineering). Course requirements for these degrees and the qualifying examination for the Ph.D. are separate and distinct from other areas of Mechanical Engineering. A Dissertation Proposal and Defense of Dissertation are required for the Ph.D. degree and acted on by a NRE dissertation committee.

2.6.2 Other Education Efforts

The NETL has participated in the IAEA Fellowship programs for the past decade. Several Fellows and Visiting Scientists spend 3-6 months at the NETL per year.

The Nuclear Engineering Teaching Lab also extends its facilities to two Historically Black Colleges or Universities (HBCUs). Both Hutson-Tillotson University in Austin and Florida Memorial University in Miami Gardens, Florida have participated in this these educational efforts.

In addition to formal classes, the NETL routinely provides short courses or tours for Texas agencies, high schools and pre-college groups such as the Boy Scouts of America. Tours and special projects are available to promote public awareness of nuclear energy issues. A typical tour is a general presentation for high school and civic organizations. Other tours given special consideration are demonstrations for interest groups such as physics, chemistry and science groups.

2.6.3 Research & Service

A more comprehensive description of the nuclear analytic techniques and facilities available at the NETL is provided in section 5. Personnel support for these activities includes faculty, graduate and undergraduate research assistants, and NETL staff.

2.8 NETL Support

NETL funding is provided by state appropriations, research grants, and fees accrued from service activities. Research funding supplements the base budget provided by the State and is generally obtained through competitive research and program awards. Funds from service activities supplement base funding to allow the facility to provide quality data acquisition and analysis capabilities. Both sources of supplemental funds (competitive awards and service work) are important to the education and research environment for students.

3.0 FACILITY DESCRIPTION

3.1 NETL History

Nuclear engineering program development nuclear engineering program was an effort of both physics and engineering faculty in the late 1950's and early 1960's. The program now resides with the Mechanical Engineering Department. The program installed and operated the first UT TRIGA nuclear reactor in Taylor Hall on the main campus, with initial criticality in August 1963. Licensed power was 10 kilowatts, power upgraded to 250 kilowatts in 1968. Total burnup during the 25 year period (to April 1988) was 26.1 megawatt-days. Pulse capability of the reactor was 1.4% $\Delta k/k$ with a total of 476 pulses during the operating history.

In October 1983, planning was initiated for the NETL to replace the original UT TRIGA. Construction was initiated December 1986, completed May 1989. The NETL facility operating license was issued in January 1992, with initial criticality on March 12, 1992. Dismantling and decommissioning of the first UT TRIGA reactor facility was completed in December 1992.

3.2 NETL SITE, J.J. Pickle Research Campus

Land development in the area of the current NETL installation began as an industrial site during the 1940's. Following the 1940's, lease agreements between the University and the Federal government led to the creation of the Balcones Research Center. The University became owner of the site in the 1960's, and in 1994 the site name was changed to the J.J. Pickle Research Campus (PRC) in honor of retired U.S. Congressman James "Jake" Pickle. The PRC is a multidiscipline research campus on 1.87 square kilometers. The site consists of two approximately equal east and west. An area of about 9000 square meters on the east tract is the location of the NETL building. Sixteen separate research units and at least five other academic research programs conduct research at locations on the PRC. Adjacent to the NETL site are the Center for Research in Water Resources, the Bureau of Economic Geology, and the Research Office Complex, illustrating the diverse research activities on the campus. A Commons Building provides cafeteria service, recreation areas, meeting rooms, and conference facilities.

3.3 NETL Building Description

The NETL building is a 1950 sq meter (21,000 sq ft), facility with laboratory and office spaces. Building areas consist of two primary laboratories of 330 sq m (3600 sq ft) and 80 sq m (900 sq ft), eight support laboratories (217 sq m, 2340 sq ft), and six supplemental areas (130 sq m, 1430 sq ft). Conference and office space is allocated to 12 rooms totaling 244 sq m (2570 sq ft). One of the primary laboratories contains the TRIGA reactor pool, biological shield structure, and neutron beam experiment area. A second primary laboratory consists of 1.3 meter (4.25 ft) thick walls for use as a general purpose radiation experiment facility. Other areas of the building include shops, instrument & measurement laboratories, and material handling facilities. The NETL Annex was installed in 2005, a 24 by 60 foot modular class room building adjacent to the NETL building. The building provides classroom space and offices for graduate students working at the NETL.

4.0 UT-TRIGA MARK II RESEARCH REACTOR

TRIGA is an acronym for Training, Research, Isotope production, General Atomics. The TRIGA Mark II reactor is a versatile and inherently safe research reactor conceived and developed by General Atomics to meet education and research requirements. The UT-TRIGA reactor provides sufficient power and neutron flux for comprehensive and productive work in many fields including physics, chemistry, engineering, medicine, and metallurgy

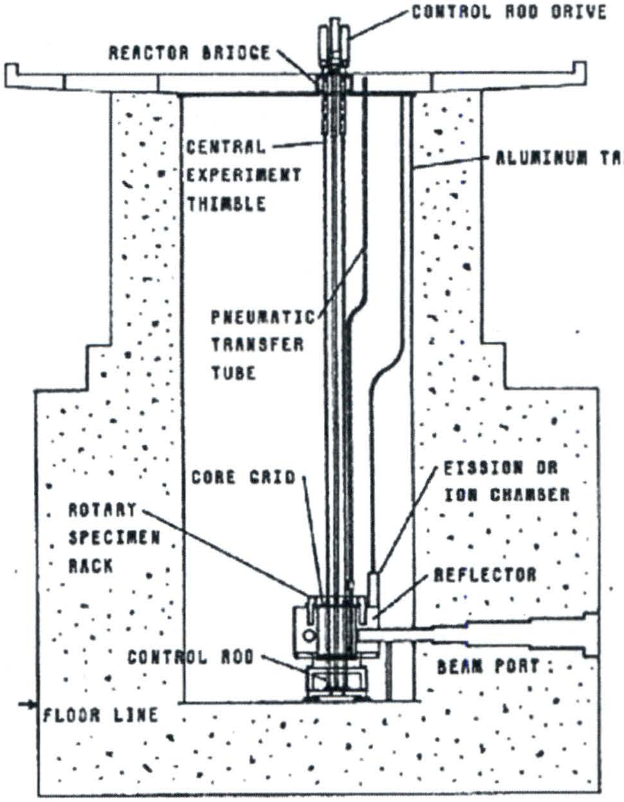


Figure 4-1, UT TRIGA Mark II Nuclear Research Reactor

The NETL UT-TRIGA reactor is an above-ground, fixed-core research reactor. The reactor core is located at the bottom of an 8.2 meter deep water-filled tank surrounded by a concrete shield structure. The water serves as a coolant, neutron moderator, and transparent radiation shield. The reactor core is surrounded by a reflector, a 1 foot thick graphite cylinder. The reactor is controlled by manipulating cylindrical "control rods" containing boron.

4.1 Reactor Core.

The reactor core is an assembly of about 100 fuel elements surrounded by an annular graphite neutron reflector. Fuel elements are positioned by an upper and lower grid plate, with penetrations of various sizes in the upper grid plate to allow insertion of experiments. Each fuel element consists of a fueled region with graphite sections at top and bottom, contained in a thin-walled stainless steel tube. The fuel region is a metallic alloy of low-enriched uranium in a zirconium hydride (UZrH) matrix. Physical properties of the TRIGA fuel provide an inherently safe operation. Rapid power transients to high powers are automatically suppressed without using mechanical control; the reactor quickly and automatically returns to normal power levels. Pulse operation, a normal mode, is a practical demonstration of this inherent safety feature.

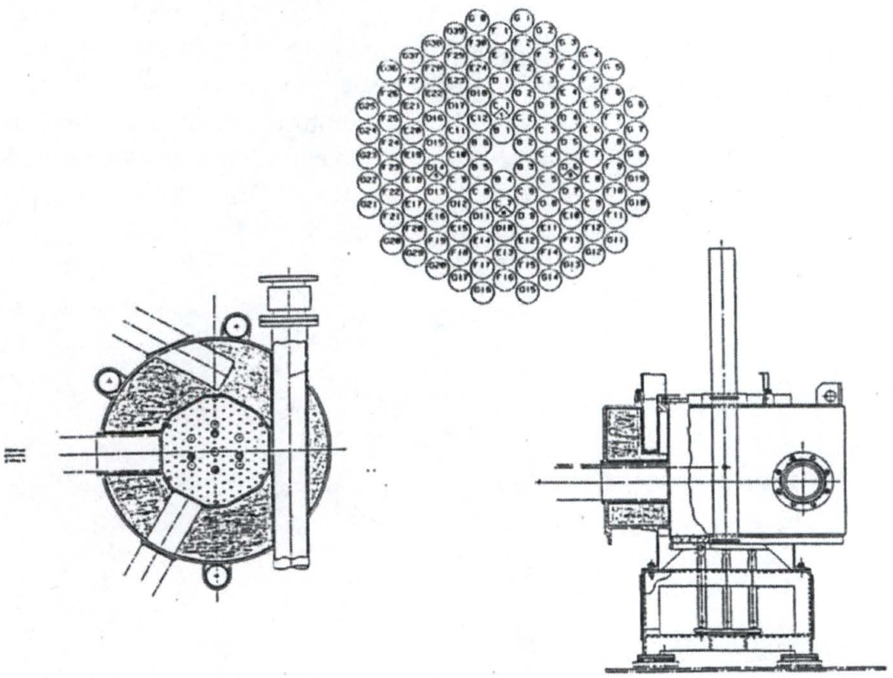


Figure 4-2, Core and Support Structure Details

4.2 Reactor Reflector.

The reflector is a graphite cylinder in a welded aluminum-canister. A 10" well in the upper surface of the reflector accommodates an irradiation facility, the rotary specimen rack (RSR), and horizontal penetrations through the side of the reflector allow extraction of neutron beams. In 2000 the canister was flooded to limit deformation stemming from material failure in welding joints. In 2004, the reflector was replaced with some modification, including a modification to the upper grid plate for more flexible experiment facilities.

4.3 Reactor Control.

The UT-TRIGA research reactor can operate continuously at nominal powers up to 1.1 MW, or in the pulsing mode with maximum power levels up to 1500 MW (with a trip setpoint of 1750 MW) for durations of about 10 msec. The pulsing mode is particularly useful in the study of reactor kinetics and control. The UT-TRIGA research reactor uses a compact microprocessor-driven control system. The digital control system provides a unique facility for performing reactor physics experiments as well as reactor operator training. This advanced system provides for flexible and efficient operation with precise power level and flux control, and permanent retention of operating data.

The power level of the UT-TRIGA is controlled by a regulating rod, two shim rods, and a transient rod. The control rods are fabricated with integral extensions containing fuel (regulating and shim rods) or air (transient rod) that extend through the lower grid plate for full span of rod motion. The regulating and shim rods are fabricated from B_4C contained in stainless steel tubes; the transient rod is a solid cylinder of borated graphite clad in aluminum. Removal of the rods from the core allows the rate of neutron induced fission (power) in the UZrH fuel to increase. The regulating rod can be operated by an automatic control system that adjusts the rod position to maintain an operator-selected reactor power level. The shim rods provide a coarse control of reactor power. The transient rod can be operated by pneumatic pressure to permit rapid changes in control rod position. The transient rod moves within a perforated aluminum guide tube.

5.0 EXPERIMENT AND RESEARCH FACILITIES

Neutrons produced in the reactor core can be used in a wide variety of research applications including nuclear reaction studies, neutron scattering experiments, nuclear analytical techniques, and irradiation of samples. Facilities for positioning samples or apparatus in the core region include cut-outs fabricated in the upper grid plate, a central thimble in the peak flux region of the core, a rotary specimen rack in the reactor graphite reflector, and a pneumatically operated transfer system accessing the core in an in-core section. Beam ports, horizontal cylindrical voids in the concrete shield structure, allow neutrons to stream out away from the core. Experiments may be performed inside the beam ports or outside the concrete shield in the neutron beams. Areas outside the core and reflector are available for large equipment or experiment facilities. In addition to reactor facilities, the NETL has a subcritical assembly, various radioisotope sources, radiation producing machines, and laboratories for spectroscopy and radiochemistry.

In 2017 there were 186 days of operation to support experiments (there was concurrent training operations on 53 days), including 1784 samples irradiations. Specific facility utilization is provide in Table 5.1, with a description of the facilities following.

Experiment Facility Utilization

Facility	*Operating Days*	*Utilization*
Epithermal Pneumatic Tube	62	32%
Rotary Specimen Rack	41	21%
Beam Port 3	34	17.7%
Thermal Pneumatic Tube	47	24.5 %
Cadmium lined 3L	3	1.5%
Lead Lined 3L	10	5.2%
Beam Port 5	14	7.3 %
Beam Port 2	0	0%
Beam Port 1	0	0%
Beam Port 4	7	3.6%

5.1 Upper Grid Plate 7L and 3L Facilities

The upper grid plate of the reactor contains four removable sections configured to provide space for experiments otherwise occupied by fuel elements (two three-element and two seven-element spaces). Containers can be fabricated with appropriate shielding or neutron absorbers to tailor the gamma and neutron spectrum to meet specific needs. Special cadmium-lined facilities have been constructed that utilize three element spaces.

5.2 Central Thimble

The reactor is equipped with a central thimble for access to the point of maximum flux in the core. The central thimble is an aluminum tube extending through the central penetration of the top and bottom grid plates. Typical experiments using the central thimble include irradiation of small samples and the exposure of materials to a collimated beam of neutrons or gamma rays.

5.3 Rotary Specimen Rack (RSR)

A rotating (motor-driven) multiple-position specimen rack located in a well in the top of the graphite reflector provides for irradiation and activation of multiple samples and/or batch production of radioisotopes. Rotation of the RSR minimizes variations in exposure related to sample position in the rack. Samples are loaded from the top of the reactor through a tube into the RSR using a specimen lifting device. A design feature provides the option of using pneumatic pressure for inserting and removing samples.

5.4 Pneumatic Tubes

A pneumatic transfer system supports applications using short-lived radioisotopes. The in-core terminus of the system is normally located in the outer ring of fuel element positions, with specific in-core sections designed to support thermal and epithermal irradiations. The sample capsule is conveyed to a sender-receiver station via pressure differences in the tubing system. An optional transfer box permits the sample to be sent and received to three different sender-receiver stations. One station is in the reactor confinement, one is in a fume hood in a laboratory room, and the third operates in conjunction with an automatic sample changer and counting system.

5.5 Beam Port Facilities

Five neutron beam ports penetrate the concrete biological shield and reactor water tank at core level. Specimens may be placed inside a beam port or outside the beam port in a neutron beam from the beam port. The beam ports were designed with different characteristics to accommodate a wide variety of experiments.

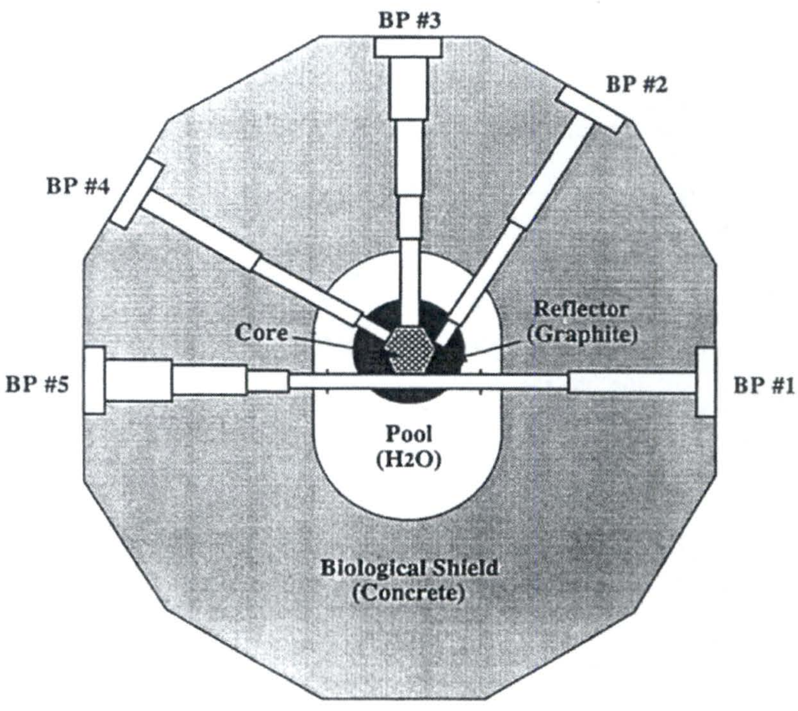


Figure 5-2, Beam Ports

Shielding reduces radiation levels outside the concrete biological shield to safe values when beam ports are not in use. Beam port shielding is configured with an inner shield plug, outer shield plug, lead-filled shutter, and circular steel cover plate. A neutron beam coming from a beam port may be modified by using collimators, moderators and/or neutron filters. Collimators are used to limit beam size and beam divergence. Moderators and filters are used to change the energy distribution of neutrons in beams (e.g., cold moderator).

Table 5.2, Dimensions of Standard Beam Ports

	BP#1, BP#2, BP#4	
At Core	6 in.	15.24 cm
At Exit	8 in.	20.32 cm
	BP #3, BP#5	
At Core	6 in.	15.24 cm
8 in.	20.32 cm	
10 in.	25.40 cm	
At Exit:	16 in.	40.64 cm

5.5.1 Beam Port 1 (BP1)

BP1 is connected to BP5, forming a through port. The through port penetrates the graphite reflector tangential to the reactor core, as seen in Figure 5-2. This configuration allows introduction of specimens adjacent to the reactor core to gain access to a high neutron flux from either side of the concrete biological shield, and can provide beams of thermal neutrons with relatively low fast-neutron and gamma-ray contamination.

5.5.2 Beam Port 2 (BP2)

BP2 is a tangential beam port, terminating at the outer edge of the reflector. A void in the graphite reflector extends the effective source of neutrons into the reflector for a thermal neutron beam with minimum fast-neutron and gamma-ray backgrounds. Tangential beams result in a "softer" (or lower average-) energy neutron beam because the beam consists of scattered reactor neutrons. BP2 is configured to support neutron depth profiling applications.

Neutron Depth Profiling (NDP) Some elements produce charged particles with characteristic energy in neutron interactions. When these elements are distributed near a surface, the particle energy spectrum is modulated by the distance the particle traveled through the surface. NDP uses this information to determine the distribution of the elements as a function of distance to the surface.

5.5.3 Beam Port 3 (BP3)

BP3 is a radial beam port. BP3 pierces the graphite reflector and terminates at the inner edge of the reflector. This beam port permits access to a position adjacent to the reactor core, and can provide a neutron beam with relatively high fast-neutron and gamma-ray fluxes. BP3 contains the Texas Cold Neutron Source Facility, a cold source and neutron guide system.

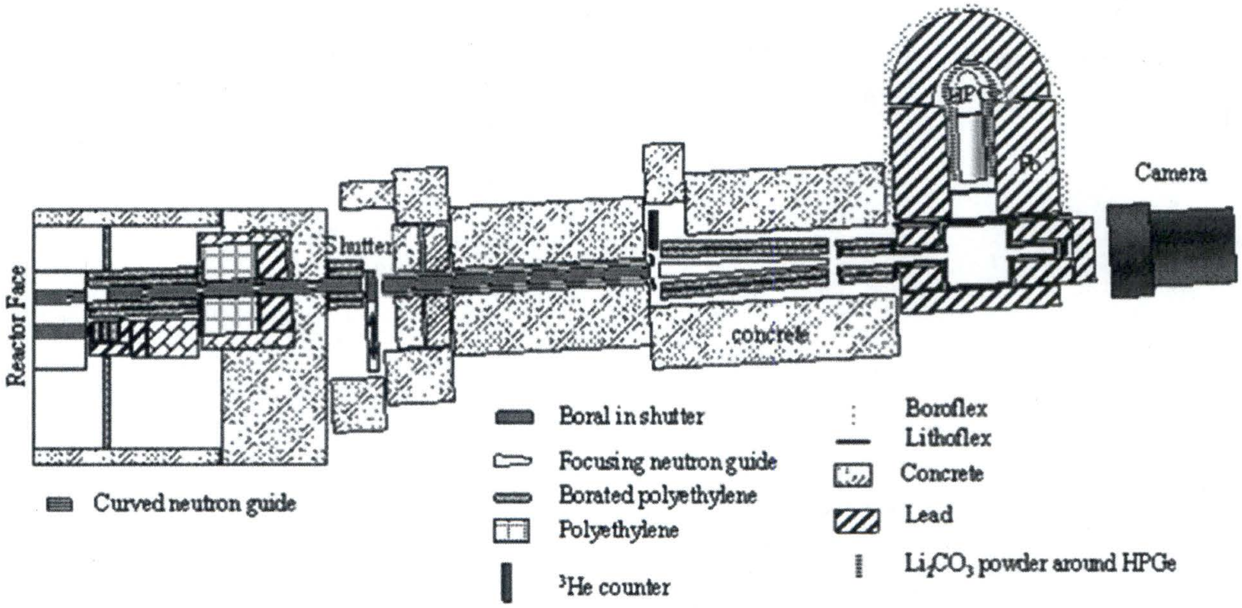


Figure 5-4, Prompt Gamma Focused-Neutron Activation Analysis Facility

Texas Cold Neutron Source. The TCNS provides a low background subthermal neutron beam for neutron reaction and scattering research. The TCNS consists of a cooled moderator, a heat pipe, a cryogenic refrigerator, a vacuum jacket, and connecting lines. The TCNS uses eighty milliliters of mesitylene moderator, maintained by the cold source system at ~36 K in a chamber within the reactor graphite reflector. A three-meter aluminum neon heat pipe, or thermosyphon, is used to cool the moderator chamber. The heat pipe working fluid evaporates at the moderator chamber and condenses at the cold head.

Cold neutrons from the moderator chamber are transported by a 2-m-long neutron guide inside the beam port to a 4-m-long neutron guide (two 2-m sections) outside the beam port. Both neutron guides have a radius of curvature equal to 300 m. All reflecting surfaces are coated with Ni-58. The guide cross-sectional areas are separated into three channels by 1-mm-thick vertical walls that block line-of-sight radiation streaming.

Prompt-Gamma Neutron Activation Analysis (PGNAA) Characteristic gamma radiation is produced when a neutron is absorbed in a material. PGNAA analyzes gamma radiation to identify the material and concentration in a sample. PGNAA applications include: i) determination of B and Gd concentration in biological samples which are used for Neutron Capture Therapy studies, ii) determination of H and B impurity levels in metals, alloys, and semiconductor, iii) multi-element analysis of geological, archeological, and environmental samples for determination of major components such as Al, S, K, Ca, Ti, and Fe, and minor or trace elements such as H, B, V, Mn, Co, Cd, Nd, Sm, and Gd, and iv) multi-element analysis of biological samples for the major and minor elements H, C, N, Na, P, S, Cl, and K, and trace elements like B and Cd.

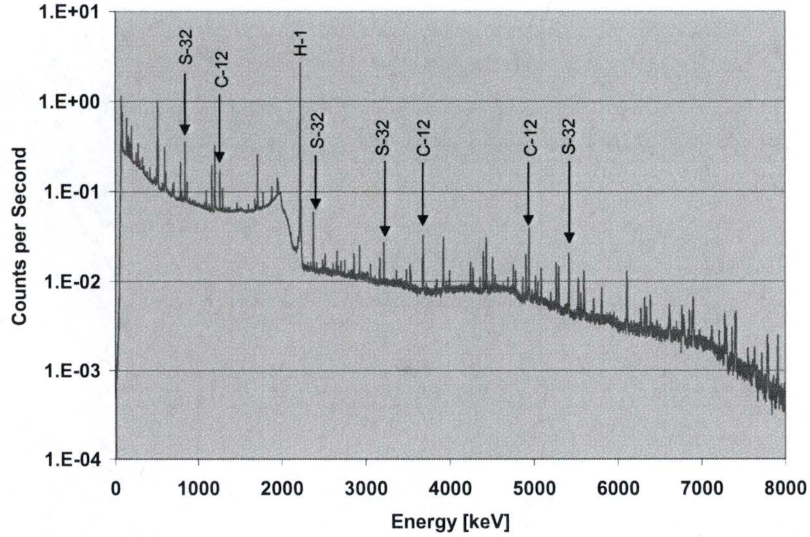


Figure 5-3, PGAA Spectra of Carbon Composite Flywheel

Prompt Gamma Focused-Neutron Activation Analysis Facility The UT-PGAA facility utilizes the focused cold-neutron beam from the Texas Cold Neutron Source. The PGAA sample is located at the focal point of the converging guide focusing system to provide an enhanced reaction rate with lower background at the sample-detector area as compared to other facilities using filtered thermal neutron beams. The sample handling system design permits the study of a wide range of samples and quick, reproducible sample-positioning.

5.5.4 Beam Port 4 (BP4)

BP4 is a radial beam port that terminates at the outer edge of the reflector. A void in the graphite reflector extends the effective source of neutrons to the reactor core. This configuration is useful for neutron-beam experiments which require neutron energies higher than thermal energies. BP4 is currently not used due to space limitations created by shielding for BP5.

5.5.5 Beam Port 5 (BP5)

A Neutron Radiography Facility is installed at BP5 (Figure 5-5). Neutrons from BP5 illuminate a sample. The intensity of the exiting neutron field varies according to absorption and scattering characteristics of the sample. A conversion material generates light proportional to the intensity of the neutron field as modified by the sample.

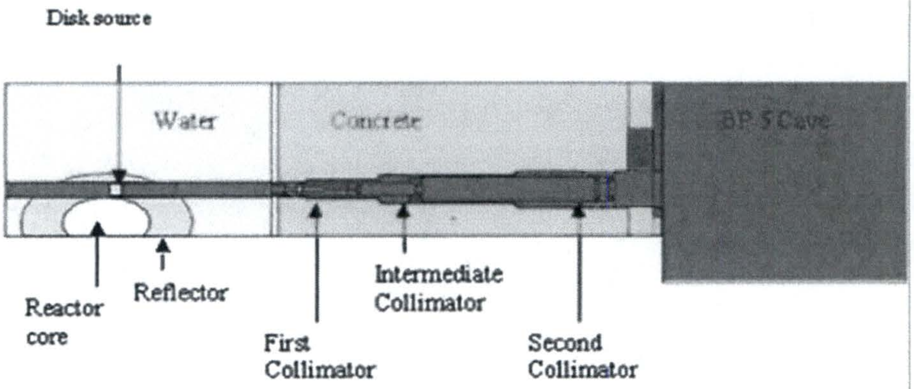


Figure 5-5, Neutron Radiography System

The conversion material is integral in one imaging system at the NETL; there are two independent conversion devices available at the NETL. A Micro-Channel Plate image intensifying technology system (NOVA Scientific) is characterized by high resolution (up to 30 μm) over a small (approximately ½ in.) field of view. A larger image can be obtained using a more conventional 7X7 in.^{2} ^{6}LiF/ZnS scintillation screen.

A conversion screen mounted on a video tube provides a direct single in one neutron radiography camera at the NETL. The image produced by the independent conversion apparatuses can be recorded in one of three available digital cameras. Cameras include a charge injection device (CID) camera, a cryogenically cooled charge coupled device (CCD) camera, and an electronically cooled CCD camera. The digital image is captured in a computer, where image analysis software produces the final product.

5.6 Other Experiment and Research Facilities

The NETL facility makes available several types of radiation facilities and an array of radiation detection equipment. In addition to the reactor, facilities include a subcritical assembly, various radioisotope sources, machine produced radiation fields, and a series of laboratories for spectroscopy and radiochemistry.

5.6.1 Subcritical Assembly

A subcritical assembly of 20% enriched uranium in a polyethylene moderated cylinder provides an experimental device for laboratory demonstrations of neutron multiplication and neutron flux measurements.

A full critical loading of fuel previously at the Manhattan College Zero Power Reactor is currently at the facility.

5.6.2 Radioisotopes

Radioisotopes are available in a variety of quantities. Alpha, beta, and gamma sources generally in microcurie to millicurie quantities are available for calibration and testing of radiation detection equipment. Neutron sources of plutonium-beryllium are available. Laboratories provide locations to setup radiation experiments, test instrumentation, prepare materials for irradiation, process radioactive samples and experiment with radiochemical reactions.

5.6.3 Radiation Producing Machines

The NETL houses a 14-MeV neutron generator. The generator is available for high-energy neutron activation analysis and various other applications.

5.6.4 Support Laboratories

There are several laboratories adjacent to the reactor. One laboratory supports sample and standards preparation. Labs are also used for various types of radio assay, with one dedicated to a receiving station for rabbit system operations and sample counting. A control system permits automated operations.

The DOE is anticipating a loss of nuclear workforce with limited prospects for replacement of radio chemists in the national laboratory system. Therefore, a graduate-level radiochemistry laboratory was developed with support from the Department of Energy (DOE). The laboratory consists of state-of-the-art Alpha Spectroscopy Systems, Liquid Scintillation Counting System and several High Resolution Gamma Counting Systems. Students are encouraged to develop skills and interests that make them viable replacements for the nuclear workforce.

5.7 Experiment Facility Utilization

Table 5-3 provides the number of days of reactor operation an experiment was supported in the applicable facility. There were 750 hours utilized for experiments and training in 2017. The number of operating hours allocated to experiments includes the "console key on" time.

6.0 FACILITY OPERATING SUMMARY

6.1 Operating Experience

The UT-TRIGA reactor operated for 750 hours on 192 days in 2017, producing a total energy output of 305 MW-hrs. Operations metrics for the past 5 years is provided in below. As illustrated, operating time has shown a marked increase from the first several years and has been relatively stable for the past decade. Varying research and maintenance requirements over the past few years have led to a decrease in total energy generation.

Table 6.1: NETL Cumulative Yearly Totals

Year	**Number of Operations**	**Mw-days (cumulative)**
2013	**3127**	**284**
2014	**3276**	**290**
2015	**3410**	**299**
2016	**3599**	**327**
2017	**3791**	**340**

Table 6.2: Days Operated

Year	***Days Operated***
2013	***195***
2014	***149***
2015	***134***
2016	***189***
2017	***192***

Table 6.3: Energy Generation

Year	**Mw-days**
2013	**12.74**
2014	**5.56**
2015	**9.5**
2016	**24**
2017	**12.7**

6.2 Unscheduled Shutdowns

Reactor safety system protective actions are classified as limiting safety system (LSSS) trip, a limiting condition for operation (LCO) trip or a trip of the SCRAM manual switch. The use of the manual scram switch in normal reactor shutdowns is not a protective action.

Table 6.2 lists 6 unscheduled shutdowns that occurred in 2017, all of which were initiated by the reactor safety system.

SCRAM Log for 2017

Date	Time	Type	Comments
2/10/2017	15:46	PWR HI	NM1000 spurious power level scram
02/15/2017	11:27	PWR HI	NM1000, Operator error, balancing rods
03/24/2017	16:20	PWR HI	NP, Spurious, Playback 85% power
04/04/2017	11:14	PWR HI	NP, operator error, shifted to manual S/D
04/20/2017	12:18	FT1	FT1 spurious
04/21/2017	15:15	PWR HI	FT1, Spurious, playback 200C
05/08/2017	14:28	PWR HI	NP, Operator error, adjusting pwr
05/26/2017	11:24	FT1	FT1, Spurious, Playback 423C
06/08/2017	11:30	FT1	FT1, Spurious, Playback 315C
06/21/2017	13:06	--	Database Timeout
07/06/2017	16:38	PWR HI	NPP, Spurious, Playback max power 100%
07/27/2017	09:21	PWR HI	Spurious, Spike, PWR Calibration
07/27/2017	09:35	PWR HI	Spurious, Spike, PWR Calibration
07/28/2017	15:24	FT1	FT1, Spurious, Playback 402C
08/01/2017	15:55	PWR HI	NP, Spurious, Playback max power 100%
09/01/2017	16:02	PWR HI	NPP, Spurious, Playback no power indication
10/04/2017	1523	Pool Lo	Due to monthly maint, Student RO
11/13/2017	1652	PWR HI	NP, Spurious, Playback less than 100%
11/14/2017	1543	PWR HI	NM, Spurious, Playback showed 92%

There were four temperature channel trips in 2017 related to thermocouple intermittent signal failure. In all cases, time dependent data indicates fuel temperatures were normal and the trips occurred because of signal transients not indicative of actual fuel temperature. Attempts to isolate the trip to a specific component or recreate the failure have not been successful. The failure mode is conservative and acceptable until either the channel fails in a more consistent mode or the characteristics leading to the actuations can be identified.

There were four errors by operators: two during power adjustment/rod balancing, one when member shifted to manual for shutdown and delayed rod insertion and one when monthly maintenance was performed on the pool low level scram while at power. Two occurred during Power calibration and 6 were spurious scrams where playback showed no violations of technical specifications.

6.3 Utilization

Utilization of the NETL reactor facility is near the maximum possible under a 5-day per week schedule. The main categories of facility utilization include education, undergraduate research, graduate research, and external research collaborations. Table 6.3 lists the external research collaborations at NETL since 2009. Facility usage is largely dominated by the use of nuclear analytical techniques for sample analysis. These techniques include neutron activation analysis, neutron radiography, neutron depth profiling, and prompt gamma activation analysis.

Table 6.3, NETL External Research Collaborations since 2009

External Collaborator	Location	Facility Utilization
Trinitek Services, Inc.	Sandia Park, NM	Soil sample analysis
Environment Canada	Gatineau, Quebec, Canada	Arctic air filter analysis
Bridgeport Instruments	Austin, TX	Radiation detector development
Carollo Engineering	Austin, TX	Radiation damage studies
Evergreen Solar	Marlboro, MA	Silicon wafer trace element analysis
Kaizen Innovations	Georgetown, TX	Soil sample analysis
Idaho National Laboratory	Idaho Falls, ID	Isotope production
Illinois State Geological Survey	Champaign, IL	Water sample analysis
UT Biology	Austin, TX	Soil sample analysis
Department of Geological Sciences	Austin, TX	Geological sample irradiation
Los Alamos National Laboratory	Los Alamos, NM	Sample irradiations
LoIodine, LLC	Jersey City, NJ	Nut Analysis
UT Health Science Center	Houston, TX	Nanoparticle analysis
Pacific Northwest National Laboratory	Richland, WA	Isotope Production
RMT, Inc.	Madison, WI	Water sample analysis
Signature Science	Austin, TX	Material irradiations and shrapnel analysis
Biomedical Engineering Department	Austin, TX	Tissue sample analysis
Southwestern University	Georgetown, TX	Plant sample analysis and student laboratories
Comprehensive Nuclear-Test-Ban Treaty Organization	Vienna, Austria	Radioxenon production
Clarkson University	Potsdam, NY	Air filter analysis
JWK Corporation	Annandale, VA	Sample irradiations
Civil and Environmental Engineering Department	Austin, TX	Fly ash sample analysis
National Center for Energy, Science and Nuclear Technologies	Rabat, Morocco	Soil sample analysis
Nanospectra Biosciences, Inc.	Houston, TX	Tissue sample analysis
U.S. Nuclear Regulatory Commission	Rockville, MD	Reactor operations training
NTS	Albuquerque, NM	Isotope production
Omaha Public Power District	Blair, NE	Boral coupon analysis
TEKLAB	Collinsville, IL	Water sample analysis
XIA	Hayward, CA	Radioxenon production

Table 6.3, NETL External Research Collaborations since 2009

External Collaborator	Location	Facility Utilization
Lawrence Livermore National Laboratory	Livermore, CA	Isotope production
Angelo State University	San Angelo, TX	Motor oil sample analysis
UT Bureau of Economic Geology	Austin, TX	NORM analysis
Duracell	Bethel, CT	Material analysis
Eckert & Ziegler Analytics	Atlanta, GA	Isotope production
Freescale Semiconductor	Austin, TX	Detector development
International Atomic Energy Agency	Vienna, Austria	Nuclear security training
Atom Consulting	Austin, TX	Detector development
Frank Roberts	Austin, TX	Ore analysis
Texas State Technical College	Waco, TX	Reactor operations and health physics training
Yooshin Engineering	Seoul, Korea	Water sample analysis

Various activation and analysis services were carried out in support of the overall UT mission and for public service. Analytical service work was performed for outside agencies. There were 1784 samples irradiated during 2017 as illustrated in Figure 6-4. Nearly 55 percent of these were pneumatic tube system, a quarter of the total samples were RSR facility and the rest were mostly BP-3 PGAA irradiations and 3L irradiations

6.4 Routine Scheduled Maintenance

All surveillances and scheduled maintenance activities were completed during the reporting year at the required frequencies. All results met or exceeded the requirements of the Technical Specifications.

6.5 Corrective Maintenance

Activities this reporting period predominately consisted of replacement of the NPP 1000 assembly drawer, adjustments on the NM 1000, replacement of DAC power supply and a CSC computer power supply and motherboard, replacement of Shim 2 drive motor, Regulator rod up light switch, Transient rod auto opto coupler and periodic maintenance due to wear. All replacements were done in accordance with 10 CFR 50.59. Corrective maintenance activities included the replacement of individual components or assemblies with like or similar replacement parts. The following list is a summary of the corrective maintenance activities accomplished by facility staff:

- Replacement of Shim rod 2 rod drive motor
- Replacement of CSC computer power supply and motherboard
- Replacement of NPP 1000 assembly drawer
- Replacement of DAC power supply
- Replacement of Transient rod auto opto coupler

- Replacement of Regulating rod up light indicator switch

6.6 Facility Changes

During the 2017 calendar year, changes in the facility and staffing are included below. These include a number of operator changes.

6.6.1 Staff changes:

During the 2017 calendar year, changes in the facility staffing included the hiring of a new Reactor Manager, the loss and subsequent hire of the Electronics Technician. In July the Director accepted a job at Georgia Tech. Dr Klein served as Interim Director for the remainder of the year. At the beginning of 2018, Dr William Charlton will become Director. 1 Senior Reactor Operator and 4 Reactor Operators successfully completed license examination.

6.6.2 Facility changes

Facility changes in in 2017 principally included replacement of obsolete parts as indicated above. During 2017 facility modifications included the upgrading and addition of security systems for the reactor facility. One modification was accomplished to the pool cover to support power for new area monitors, completed under 10CFR50.59.

Future upgrades include the creation of a new lab space by incorporating rooms 3.104 and 3.106, the reuse of the current metal shop to an electronics lab, new boiler installation, new fire sprinkler system and new reactor bay lighting. A bid is in for a reactor operation console.

6.6.3 Procedure revision/updates

There were neither procedure revisions nor updates made in 2017

6.6.4 Facility Changes Accomplished in Accordance with Other Regulatory Requirements:

There were no changes the license, or Technical Specifications.

Proposed or Pending Changes:

In 2011, a request for renewal of the facility operating license was made, with notification by the USNRC that the UT facility meets requirements for operation under "timely renewal." Work to address requests for additional information is in progress.

6.7 Oversight & Inspections:

Inspections of laboratory operations are conducted by university and licensing agency personnel. NRC conducted an inspection from 18-22 September 2017. Two committees, a Radiation Safety Committee and a Reactor Oversight Committee review operations of the NETL facility. The Reactor Oversight Committee convened on the dates listed in Table 6.4.

Table 6.4, Reactor Oversight Committee Reviews

First Quarter	None
Second Quarter	12 April 2017
Third Quarter	None
Fourth Quarter	27 October 2017

Inspections by licensing agencies include federal license activities by the U. S. Nuclear Regulatory Commission (NRC), Nuclear Reactor Regulation Branch (NRR), and state license activities by the Texas Department of State Health Services (TDSHS) Radiation Control Program. Licensing agency inspections conducted in calendar year 2017 are indicated in Table 6.5. No findings of significance were identified.

Table 6.5, License Inspections

License	Dates
R-129	18 to 21 September 2017
SNM-180	None
L00485 (89)	06 April 2017

Routine inspections by the Office of Environmental Health and Safety (OEHS) for compliance with university safety rules and procedures are conducted at varying intervals throughout the year. Inspections cover fire, chemical, and radiological hazards. No significant safety problems were found at NETL, which reflects favorably on the positive safety culture for all hazard classes at the NETL.

7.0 RADIOLOGICAL SUMMARY

7.1 Summary of Radiological Exposures

The Radiation Protection Program for the NETL facility provides monitoring for personnel radiation exposure, surveys of radiation areas and contamination areas, and measurements of radioactive effluents as indicated in Table 7.1. Site area measurements include exterior points adjacent to and distant from the building.

Table 7.1, Radiation Protection Program Requirements and Frequencies

Frequency	Radiation Protection Requirement
Weekly	Gamma survey of all Restricted Areas. Swipe survey of all Restricted Areas. Response check of the continuous air monitor. Response checks of the area radiation monitors.
Monthly	Gamma surveys of exterior walls and roof. Exchange personnel dosimeters & interior area monitoring dosimeters. Review dosimetry reports. Response check emergency locker portable rad. measuring equipment. Review Radiation Work Permits. Response check of the argon monitor. Response check hand and foot monitor.
As Required	Process and record solid wastes and liquid effluent discharges. Prepare and record radioactive material shipments. Survey and record incoming radioactive materials. Perform and record special radiation surveys. Issue radiation work permits, provide HP coverage for maintenance operations. Conduct orientations and training. Neutron surveys following shielding changes
Quarterly	Exchange environmental monitoring dosimeters. Gamma and swipe surveys of all non-restricted areas. Collect and analyze TRIGA pool water Swipe survey of building exterior areas.
Semi-Annual	Calibrate continuous air monitor, argon monitor, area rad. monitors. Leak test and inventory sealed sources.
Annual	Inventory emergency lockers Conduct ALARA Committee meeting. Calibrate portable radiation monitoring instruments. Calibrate personnel pocket dosimeters. Calibrate emergency locker portable radiation detection equipment

7.2 Summary of Radioactive Effluents

The radioactive effluent paths are ventilation for air-borne radionuclides, and the sanitary sewer system for liquid radionuclides. The most significant airborne radionuclide effluent is argon-41. Two other airborne radionuclides, nitrogen-16 and oxygen-19, decay rapidly and do not contribute to effluent releases. Argon-41, with a half-life of 109 minutes, is the only airborne radionuclide emitted by the facility during normal operations.

7.2.1 Released

Solid radioactive waste transferred from the facility in 2017 consisted primarily of used ion exchange resin (~125 pounds containing primarily Co-60 (~20 mCi)). Additional solid waste was in the form of ~2 pounds of thorium compounds and ~60g of uranium compounds. Liquid radioactive waste transferred from the facility in 2017 consisted primarily of aqueous uranium solutions (~5 liters containing ~500ppm U). Additional liquid waste was in the form of 38 LSC quench standards and ~500 ml of U and Th standard solutions.

7.2.2 Discharged

Airborne Releases. A differential pressure control system in the facility assures airborne radioactive releases are controlled. The reactor room is ventilated by a general area system, and a sub-system to collect and discharge argon-41 generated from routine reactor operations. There were 2.2×10^6 μCi of argon-41 discharged during calendar year 2017 which is approximately 2% of the value permitted by Technical Specifications.

Liquid Discharges. There are no routine releases from the facility associated with reactor operation. Large liquid-volume radioactive waste may be captured in holding tanks, where liquid radioactive waste may be held for decay or processed to remove the radioactive contaminants as appropriate. Small quantities of liquid scintillation cocktail or dilute concentrations below the limits of 10 CFR 20 in the NETL laboratories may be disposed directly to the sanitary sewer. Liquid disposals are infrequent.

Liquid radioactive waste disposed via sanitary sewer in 2017 consisted of 200 ml of water contaminated with 0.1 μCi tritium from pool water samples. The tritium concentration in this water was 5 x 10-4 μCi/ml, which is well below the 10 CFR 20 sanitary sewer release concentration limit of 1 x 10-2 μCi/ml.

7.4 Environmental Surveys Performed Outside the Facility

NETL monitors exterior locations indicated as positions 1 through 6 on the exterior dosimeter map. For 2017 "minimal" doses (< 1 mrem) were reported for all positions. This is well below the 100 mrem annual limit for dose to the general public.

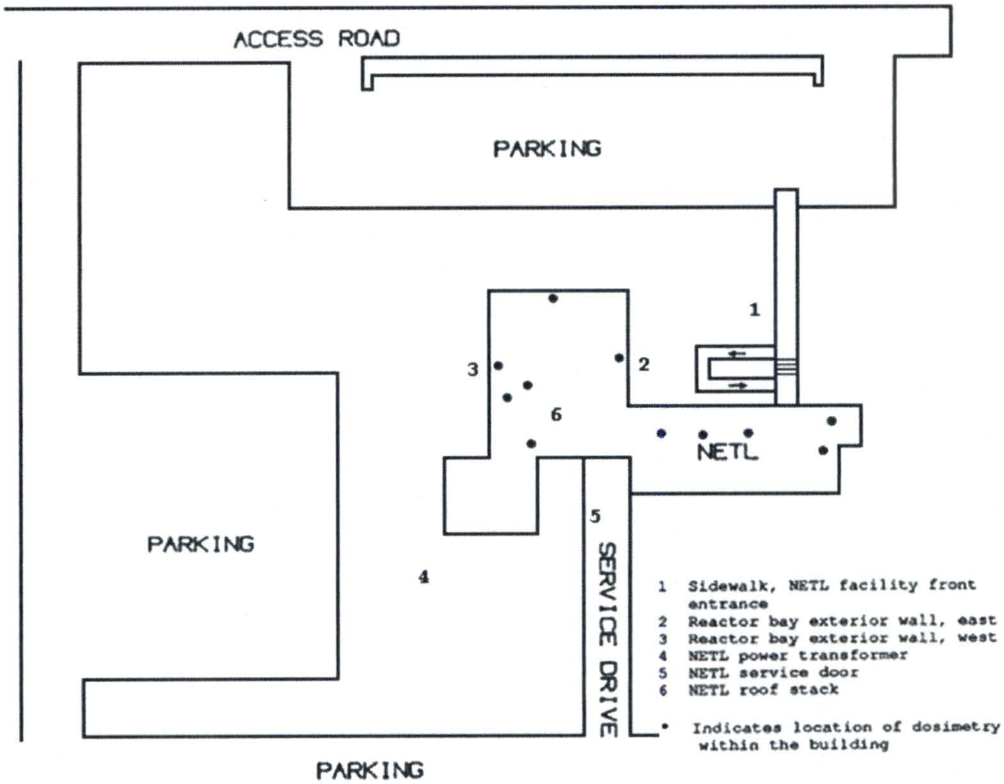
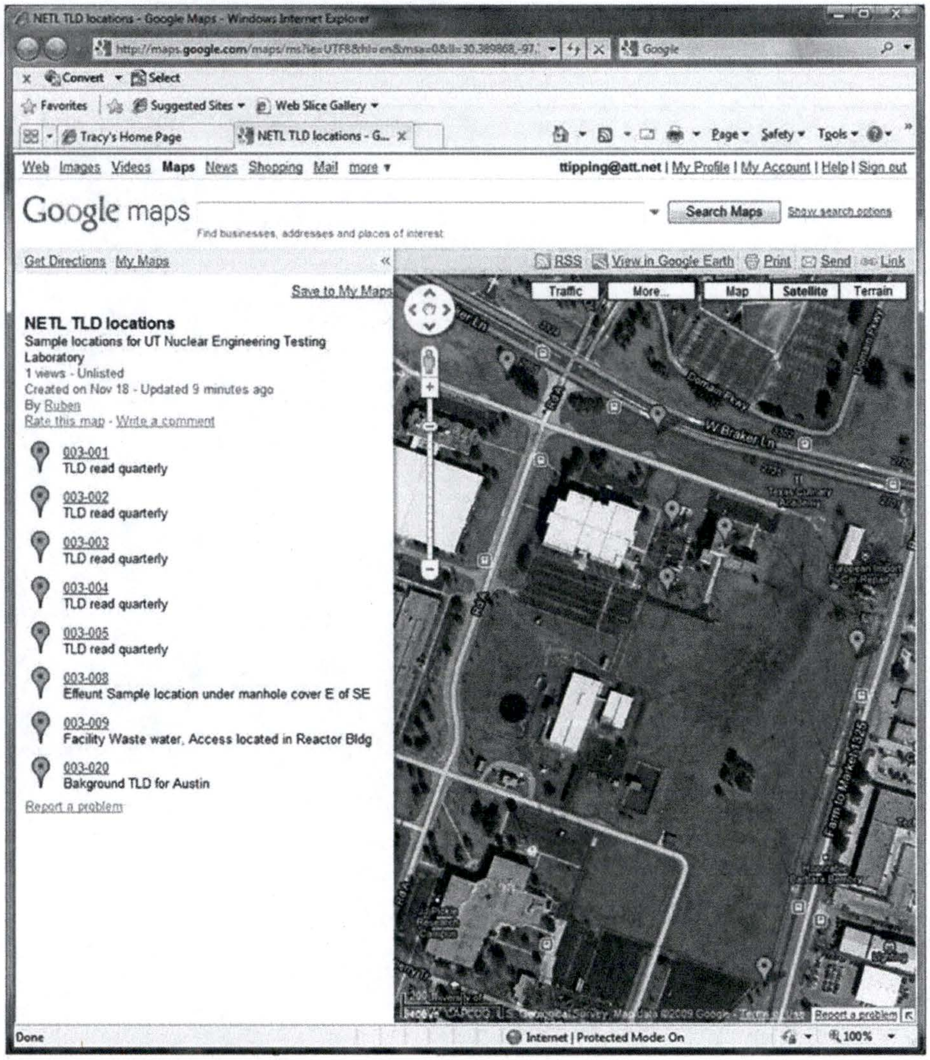


Figure 7-1, NETL Environmental Monitor Locations

In addition to the NETL monitors, the Texas Department of State Health Services monitors exterior locations near NETL indicated as positions 1 through 5 on the TDSHS TLD map. As yet, TDSHS has only reported doses through the second quarter of 2017. The reported doses were:

- Position 1 – 0 mrem
- Position 2 – 0 mrem
- Position 3 – 2 mrem
- Position 4 – 6 mrem
- Position 5 – 6 mrem


NETL TLD locations - Google Maps - Windows Internet Explorer
Google maps
Search Maps
NETL TLD locations
Sample locations for UT Nuclear Engineering Testing Laboratory
1 views - Unlisted
Created on Nov 18 - Updated 9 minutes ago
By Ruben
Rate this map - Write a comment
003-001
TLD read quarterly
003-002
TLD read quarterly
003-003
TLD read quarterly
003-004
TLD read quarterly
003-005
TLD read quarterly
003-008
Effeunt Sample location under manhole cover E of SE
003-009
Facility Waste water, Access located in Reactor Bldg
003-020
Bakground TLD for Austin
Report a problem
W Braker Ln
Farm to Market 1825
Traffic
More...
Map
Satellite
Terrain