1982 Annual Report

of

The University of Texas at Austin
Nuclear Engineering Teaching Laboratory

January 1, 1982 - December 31, 1982

D. E. Klein, Director
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I. INTRODUCTION

This report has been prepared by the staff of the Nuclear Engineering Teaching Laboratory (NETL), The University of Texas at Austin, to satisfy the reporting requirements of the U.S. Department of Energy Contract Number At-(40-1)-3919 and 10 CFR 50.59. The report covers the period from January 1, 1982 to December 31, 1982.

The Nuclear Engineering Teaching Laboratory (NETL) is a part of the Mechanical Engineering Department in the College of Engineering at The University of Texas at Austin, Austin, Texas. The programs major equipment consists of a 250 kW TRIGA Mark I reactor operated in pulsing and steady-state modes. The reactor laboratory and adjacent laboratory areas are shown in Figures 1 and 2. Other equipment maintained by the NETL program includes two Cockcroft-Walton 14 MeV neutron generators, a Lockheed Aerojet subcritical assembly, and a 1150 curie Co-60 irradiator. Isotopic neutron sources available include three californium-252 sources and six plutonium-beryllium sources. A wide array of detectors and electronic equipment are available to provide measurement and analysis capability of laboratory produced or maintained radiation sources.

Changes in the NETL program occur as a continuing response to achieve effective operation of various NETL projects and program development. During the past year the following events that represent a significant impact on the NETL program occurred:

a. Radiochemist position (half time) was vacated. A replacement was found temporarily but later resigned.

b. Three new Senior Operator licenses were issued and one Senior Operator license renewed.

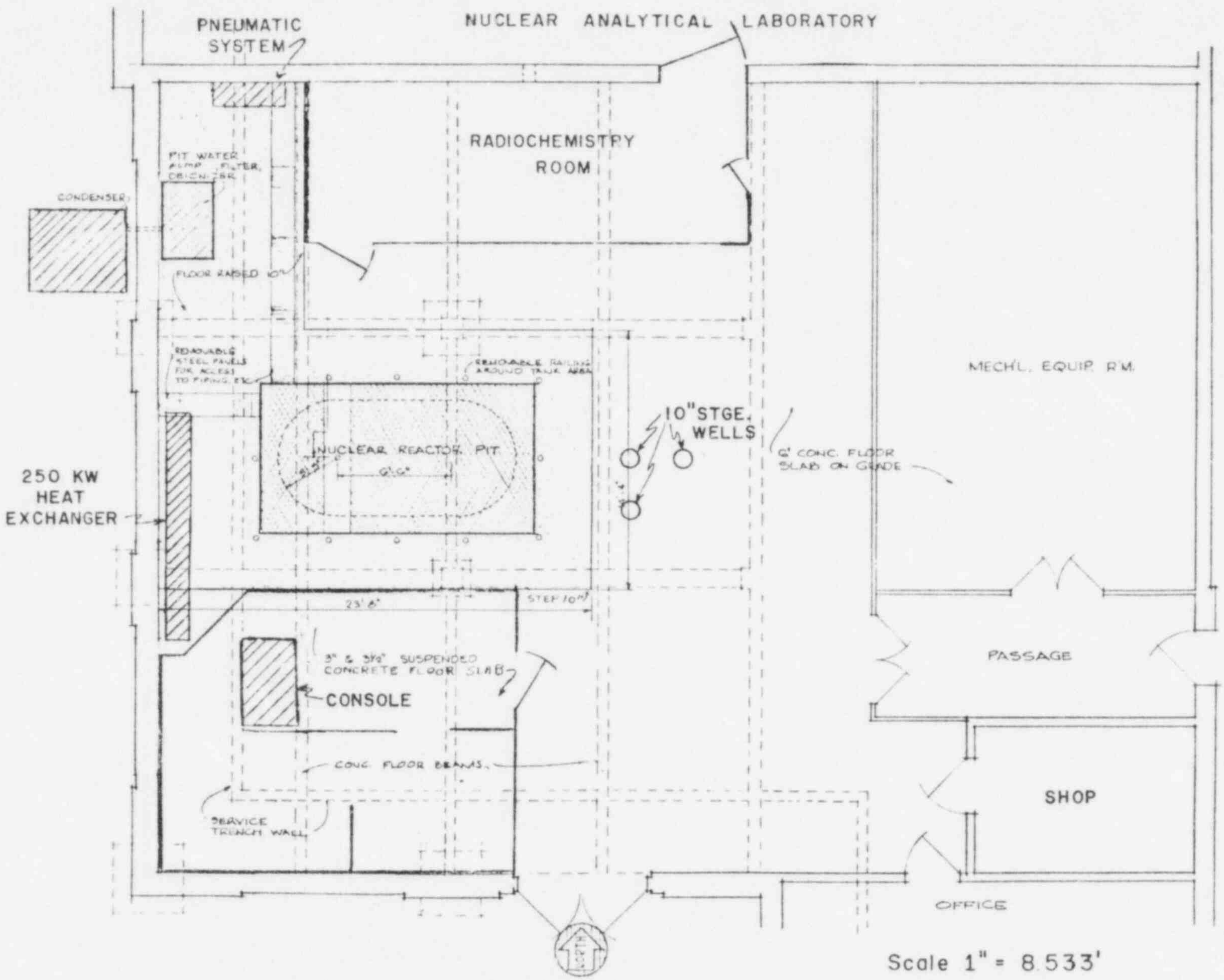


Fig. 1 TAYLOR HALL 131 FLOOR PLAN

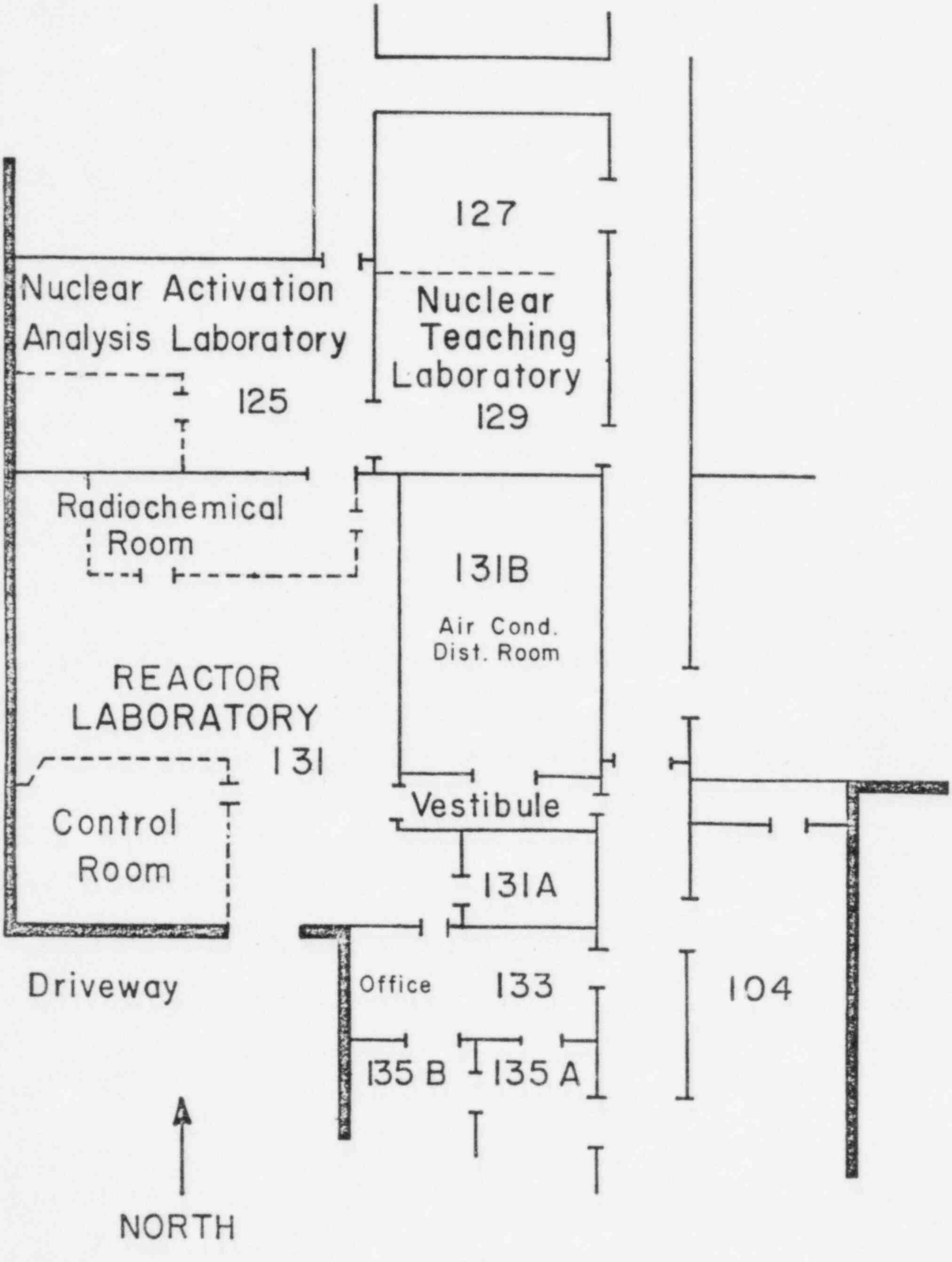


Fig. 2 TAYLOR HALL FLOOR PLAN
ADJACENT ROOMS TO 131

c. Operation license R-92 is still effected by timely renewal pending completion of the license renewal processes scheduled for NRC fiscal year 1983.

d. A new emergency plan has been submitted for NRC review and approval.

e. Completion of the review and revision of all laboratory procedures was completed.

f. The startup and log power channels of the reactor console have been replaced by a newer wide range channel manufactured by General Atomic.

g. A new data acquisition and analysis system for neutron activation analysis was installed.

h. An order for three new undergraduate counting stations to supplement teaching of radiation detection and measurement was completed.

i. University plans for complete renovation of Taylor Hall and construction of an adjacent building were scheduled for 1983 or later.

II. LABORATORY ADMINISTRATION

A. Organization

The present organizational chart of the NETL program is presented in Figure 3. Budgeted NETL staff funding is provided for a Supervisor/ Assistant Director, technician/operator, radiochemist, operator, and secretary.

B. Personnel

Personnel associated with the laboratory consist of NETL staff, faculty, students, and certain other university personnel. The following lists reflects personnel involved in the NETL program during the past year.

1. Staff and Faculty Personnel

Director	D.E. Klein
Assistant Director/Supervisor	T.L. Bauer+
Nuclear Technical Specialist	N. Povio+
Nuclear Technical Specialist	M. Krause+
Radiochemist	S. Piorek
Assistant Professor	N.E. Hertel
Administrative Secretary	M.G. Morrison

2. Support Personnel

Adjunct Associate Professor	D.G. Anderson+
Safety Officer	H.W. Bryant
Research Scientist	J.W. Davidson

3. Graduate Assistants

M. Ally
A. Gaines
B. Gantt
M. Krause+
R. Laucius
F. Patterson
M. Razzaque
T. Sanders

4. Student Assistants

G. Anderson
A. Chapa
S. Reichert
S. Sherwood

+--Licensed Senior Operator

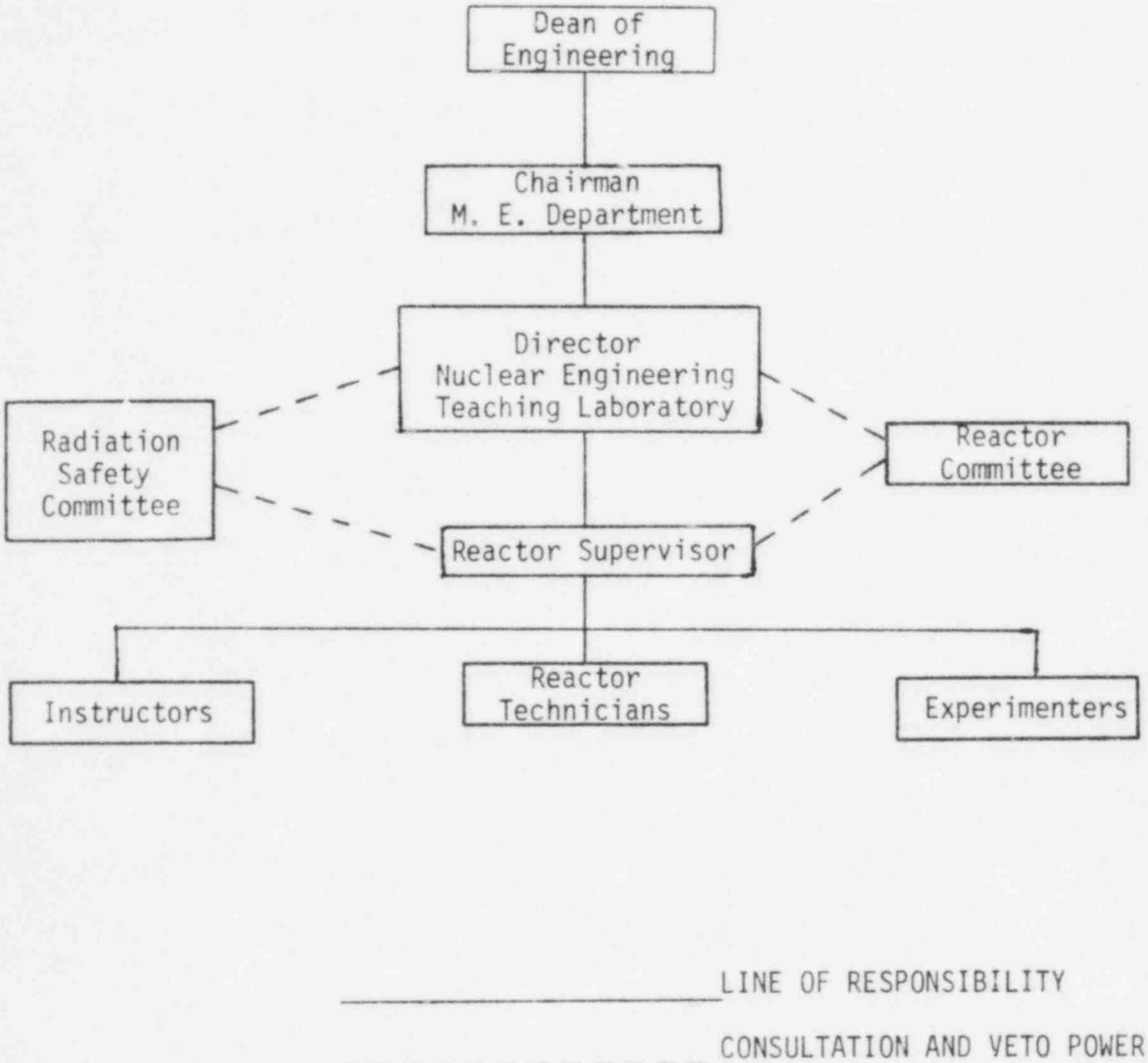


FIGURE 3 - ORGANIZATIONAL CHART

C. Reactor Committee

1. Committee Composition

Regular Members: (9/1/82)

Dr. Dale Klein
Dr. Joe Ledbetter
Dr. Harris Marcus (Chairman)
Dr. Nolan E. Hertel
Mr. J. Gluck (student)

Ex Officio Members:

Dr. H. G. Rylander, Chairman, Department of Mechanical Engineering
Mr. H. W. Bryant, University Radiation Safety Officer
Dr. T. L. Bauer, Supervisor, Nuclear Engineering Teaching Laboratory

2. Meeting Frequency

The Reactor Committee met four times for the calendar year of 1982 (March 31, July 29, October 14, and January 7)

D. Radiation Safety Committee

1. Committee Composition

Dr. P. Riley, Chairman
Dr. L. O. Morgan
Dr. C. Desjardins
Mr. H. W. Bryant, Ex Officio

2. Meeting Frequency

The Radiation Safety Committee met twice during the calendar year of 1982 (April 14 and November 11).

E. Report to the College of Engineering

Each year the Reactor Committee provides a report to the Dean of the College of Engineering describing activities of the committee and a review or assessment of the operation of specific portions of the NETL program concerning the reactor and other radiation producing equipment.

III. LABORATORY DEVELOPMENT

A. Organization

Dr. Dale E. Klein continued as the Director and Dr. Tom L. Bauer continued as Reactor Supervisor during the past year. Technical and secretarial personnel also remained unchanged. Stanislaw Piorek filled the vacant radiochemist position.

The radiochemist position was increased from half to full time by decreasing one technical position to half time. Unfortunately, Stanislaw Piorek resigned and a new search was initiated for a full time successor. Key faculty and university support personnel remained unchanged.

B. Nuclear Engineering Teaching Laboratory

The Nuclear Engineering Teaching Laboratory is part of the Nuclear Engineering Program at The University of Texas.

The Nuclear Engineering Teaching Laboratory's central feature is a Mark I TRIGA thermal fission reactor. Originally licensed by the Atomic Energy Commission to operate at 10 KW in 1963, the nuclear reactor and the associated laboratory equipment have been updated over the past years and the research capabilities of the Laboratory are now more diverse. In 1968, the facility license was amended to allow the TRIGA reactor to operate at a steady state power level of 250 KW and pulsed power of 250 MW which increased experimental capabilities.

Other radiation producing devices maintained by the Laboratory are a several thousand curie Co-60 irradiator, vertical neutron beam tube, subcritical assembly, industrial x-ray source, 14 MeV neutron generator, and several isotopic neutron sources. Different types of radiation detection devices provide the capacity to monitor or analyze the various radiation sources.

One of the functions of the nuclear reactor and its associated equipment has been to teach and demonstrate the fundamentals of reactor operation. Several organized classes routinely utilize the reactor facility. Numerous other classes, organizations and groups schedule tours or demonstrations of the reactor facility. Approximately 1,150 persons were admitted into the reactor facility during the past year.

The use, operation, regulation, security, and monitoring of the Nuclear Engineering Teaching Laboratory is controlled by the United States Nuclear Regulatory Commission, the Nuclear Reactor Committee of The University of Texas, the Director of the Nuclear Engineering Teaching Laboratory, the Radiation Safety Committee and the Texas Department of Health Radiation Control Board.

B. Neutron Activation Analysis Facilities

The Nuclear Analytical Laboratory has provided support for individual projects ranging from student laboratory support for advanced classes in chemistry, zoology, physics, and engineering to investigative projects in environmental monitoring. Scientific articles based upon the results of sponsored and unsponsored research by this laboratory have been published or accepted for publication in several journals and proceedings, and have been presented at conferences at the state, national and international level.

Radiation detection systems available include gamma ray spectroscopy HpGe detection acquisition and analysis system, multi sample α-β proportional counter, NaI detectors, Si(Li) detector, neutron detectors and associated electronic modules to accomplish several types of standard nuclear measurements. An important function of the laboratory is to support various research projects with the neutron activation analysis method and other related nuclear radiation research techniques.

C. Nuclear Radiation Laboratory

The Nuclear Radiation Laboratory at Balcones Research Center has been utilized by the students and staff of the Nuclear Engineering Program at The University of Texas at Austin for the past several years.

The primary use of the building was to house and operate a 14 MeV Texas Nuclear neutron generator. When the Nuclear Engineering Teaching Laboratory acquired three (3) Californium-252 sources from Louisiana State University in 1973, the Nuclear Radiation Laboratory became the logical place for their storage and use due to the space and availability of the already installed neutron shielding around the neutron generator. Thus, with the acquisition of Cf^{252}, students and staff can perform experiments utilizing not only the high energy neutrons from the neutron generator but fission spectrum neutrons from Cf^{252}. In addition to the neutron generator and the Californium sources, other smaller radioactive sources are also used within the confines of the Nuclear Radiation Laboratory.

IV. LABORATORY OPERATION AND UTILIZATION

A. Reactor

1. Operation

During this reporting period the reactor operated for a total of 247.6 hours while supporting numerous nuclear engineering and operation courses, research, and other related activities. Fuel burnup was approximately two-thirds grams from 16,150 kW-hrs of operation.

2. Maintenance

During 1982 maintenance consisted of routine repair and adjustments, plus a reactor console improvement project. Both minor improvements, a physical rearrangement of console functions, and a major channel replacement were effected.

3. Safety

Inadvertant reactor shutdowns ("scrams") occurred 8 times during 1982 compared to 7 times the previous year. The scrams are categorized according to the type of initiating event and the total number compared to previous years in Tables 1 and 2.

4. Utilization

Reactor utilization is measured by the number of operation hours (magnet power on), amount of energy produced (kW-hrs), and number of samples irradiated in reactor experiment facilities. The data is presented in Tables 3 and 4 and Figures 4 and 5. The effect of reactor operation on personnel radiation exposures are included in Table 5.

TABLE 1

REACTOR SCRAMS

Intentional	--	10
Operator	--	0
Instrument Error	--	8
Power Outage	--	0
Safety	--	0
Total	--	19

TABLE 2

COMPARISON OF YEARLY INADVERTANT SCRAMS*

'63	'64	'65	'66	'67	'68**	'69	'70	'71	'72	'73
10	9	3	4	3	11	15	11	13	6	10

'74	'75	'76	'77	'78	'79	'80	'81	'82
4	7	5	9	11	12	7	7	8

*Inadvertant scrams are defined as all scrams that were not intentionally initiated.

**Corrected to reflect log book data

TABLE 3

NUCLEAR ENGINEERING TEACHING LABORATORY

PERFORMANCE DATA, 1982

	Total Hours Reactor In Operation*	Total Burn-up (kW-hrs)	Number of Samples Irradiated
First Quarter 1982	54.7	725	25
Second Quarter 1982	74.7	4943	53
Third Quarter 1982	78.4	5883	142
Fourth Quarter 1982	39.8	4599	74
TOTAL	247.6	16150	294

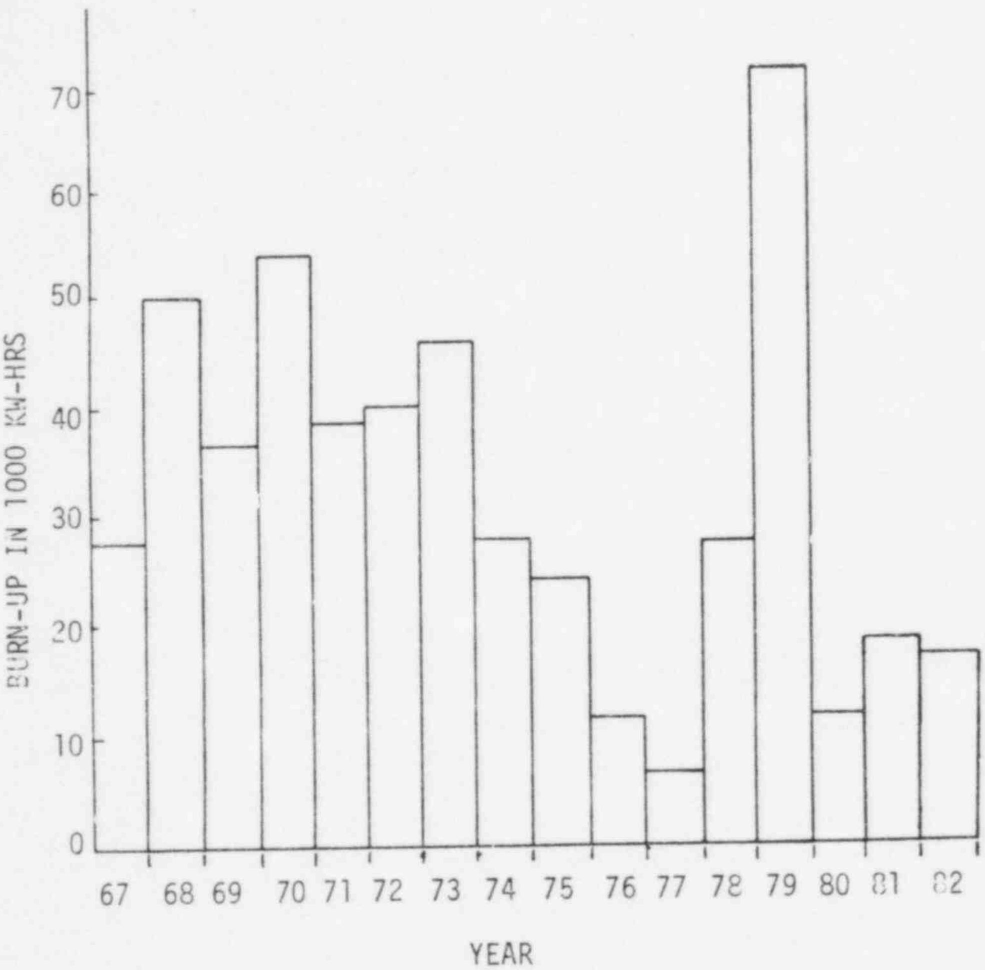
*Time Reactor Key on; includes certain experimental setup time, maintenance, etc.

TABLE 4

COMPARISON OF PREVIOUS UTILIZATION DATA

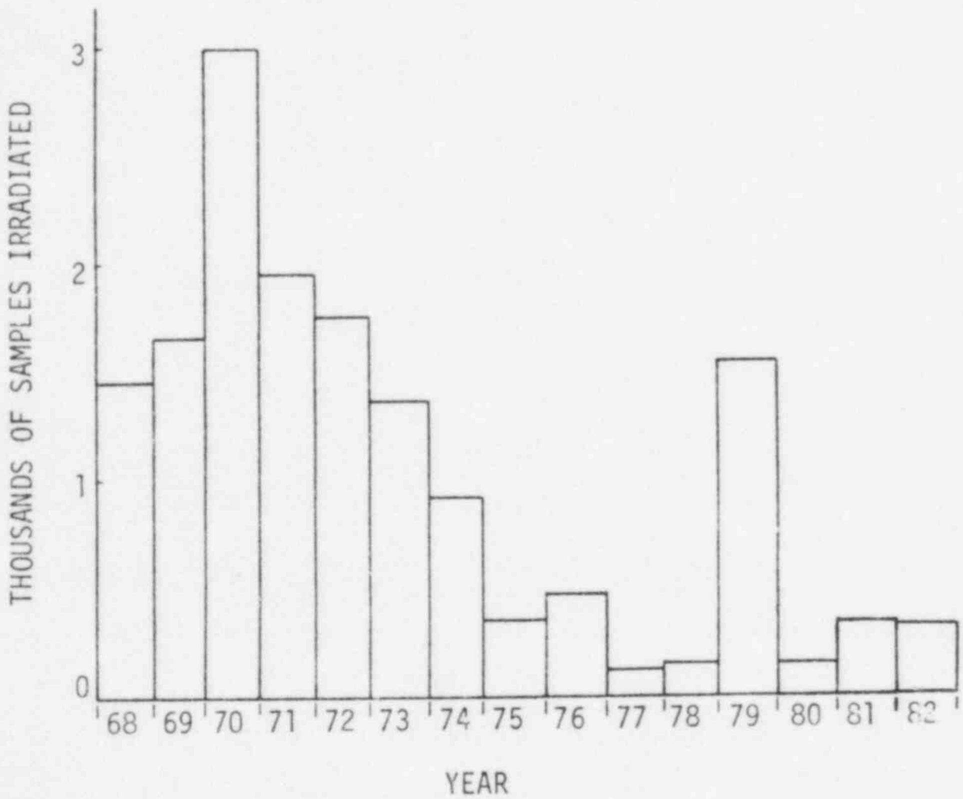
Year	Total Hours Reactor In Operation*	Total Burn-up (kW-hrs)	Number of Samples Irradiated
1965-66**	104.5	251	63
1966-67	150.0	595	202
1967-68***	342.6	23,168	2449
1968-69	260.8	49,985	1452
1969-70	222.0	36,477	1640
1970-71	262.5	53,912	2990
1971-72	222.8	38,624	1946
1973	318.6	45,794	1347
1974	226.1	27,641	778
1975	207.0	20,450	363
1976	135.7	11,312	468
1977	139.3	7,509	164
1978	171.9	26,870	178
1979	311.6	72,616	1568
1980	184.1	11,760	150
1981	258.5	18,165	330
1982	247.6	16,150	294

* Includes experimental setup time, maintenance, etc.
** 1965 was the first year the utilization data were maintained.
*** Reactor upgraded from 10 to 250 kW during this academic year.



TOTAL BURN UP PER YEAR

Figure 4



NUMBER OF SAMPLES IRRADIATED
PER YEAR

Figure 5

TABLE 5

STATISTICAL SUMMARY OF RADIATION EXPOSURE

1982

Range of Exposure in REM	Number of Individuals
Non-measurable exposure	13
0.0 - 0.1	7
0.1 - 0.25	0
0.25 - 0.5	0
0.5 - 0.75	0
0.75 - 1.0	0
1.0 - 2.0	0
2.0 - 3.0	0

5. Courses

Table 6 lists the courses at The University of Texas at Austin that make some use of the reactor and its functions during the course of student instruction.

TABLE 6

Courses Utilizing the Reactor and Associated Facilities

Mechanical Engineering Department

Course Number	Course Description
ME 361F	Introductory Nuclear Laboratory - studies in radioactive decay, activation, detection and measurement.
ME 379M	Reactor Operations - studies in nuclear reactor parameters, instrumentation characteristics and regulation.
ME 389R	Nuclear Engineering Laboratory - studies for graduate students in nuclear methods in measurement and analysis.
ME S389R	Special projects course for nuclear engineering laboratory studies as a summer course for foreign students.
ME 377K	Projects in Mechanical Engineering - individual study and experiment projects for undergraduates.
ME 397	Current Studies in Engineering - special projects course for graduate study of selected topics.

Additional Courses in Other Departments

GEO 388L	Isotope Geology - graduate course
CH 376K	Advance Analytical Chemistry - senior level course in instrumental and analytical methods.
CE 390L	Environmental Analysis - graduate course
PHR 370K	Nuclear Pharmacy - senior level course in measurement and analysis methods with nuclear pharmaceuticals.

B. Facility Changes

1. Wide Range Channel

Original equipment startup channel and log power channel were removed and replaced by a new wide range channel with percent power measurement capability. Scram signals for low source count, high voltage, period, and percent power were added to the original scram bus. The only scram removed from the original bus was the period scram. A scram on high log power was not implemented. The solid state channel with calibration circuits, power supplies and single detector replaces two separate non-overlapping detectors and channels. For pulse mode operation the extended scram bus is shorted to remove the wide range channel operation.

2. Console Improvements

To obtain greatest advantage of the new wide range channel a physical rearrangement of the original console instrumentation configuration was made. Several minor physical changes in the water system alarms were also made to provide all alarm indication in a common area on the console. The replaced channels are maintained for additional instrumentation to experimenters, students, or operators.

3. Plans for renovation of Taylor Hall and future construction that will impinge on the reactor facility revised the requirements for operation of an exhaust ventilation system. The ventilation requirements are being reevaluated and the ventilation exhaust system maintained in a secured condition until future requirements are firmly established.

4. A new gamma-ray spectroscopy detection, acquisition, and analysis system has been obtained to support research activities with neutron activation analysis. The system uses a high purity germanium detector and microcomputer processing system.

V. LABORATORY INSPECTIONS

No laboratory inspections by NRC or TDH personnel occurred during the calendar year 1982. Routine inspections by university radiation safety personnel, fire safety personnel, and reactor committee representatives were conducted at periodic intervals.

VI. PUBLIC SERVICE ACTIVITIES

These activities include those other than research projects or assistance provided in the pursuit of research which are covered in Section VII of this report. In this section the subjects are symposiums, lectures, presentations, and tours.

A. Summer High School Science Teachers Symposium

Funded by the Electric Utility Companies of Texas, this program was designed to familiarize high school science teachers with the theory and technology of energy resources. During the summer of 1982, 26 teachers participated in the program.

B. Lectures and Presentations

On numerous occasions during 1982 the NETL staff gave talks on subjects including: "Nuclear Reactor Safety," "Nuclear Engineering and Society," "Research and Development of Energy Resources," "Energy and the Environment," and "What Happened at Three Mile Island."

C. Tours and Radiation Monitoring

During the calendar year of 1982 over 1,150 persons visited the lab. Most of these persons represented educational, civic, or industrial organizations, while others were part of formal engineering laboratory groups. All persons working in or around the laboratory are provided with personal radiation monitoring devices while tour group members are randomly monitored. Measurable exposure to tour group members was in the non-measurable exposure range as indicated by pocket dosimeters.

VII. RESEARCH ACTIVITIES

The Nuclear Engineering Teaching Laboratory is pursuing research in numerous areas which are sponsored by the organizations listed below. Major research funding is shown in Table 7.

A. The U.S. Department of Energy has provided research support by providing reactor fuel for the operation of The University of Texas at Austin TRIGA reactor.

B. The Electric Utility Companies of Texas have sponsored Summer High School Science Teachers Symposium, a program designed to familiarize these teachers with the theory and technology of energy resources.

C. Development of a Preconcentration Method for Field Sampling of Uranium

Personnel: Dale Klein, NETL
Mohammed Ally, NETL

Sponsored by: Nuclear Engineering Teaching Laboratory

Description:

Two basic techniques are used presently at the Nuclear Engineering Teaching Laboratory at The University of Texas at Austin for the determination of trace elements (e.g. uranium). These include neutron activation analysis and x-ray fluorescence. When the elements to be examined are present in trace quantities, either a large sample must be measured or the sample must be preconcentrated. There are several advantages of a preconcentration method and the objective of this project is to develop a suitable method for the analysis of trace elements, including uranium, in water. In previous years a method was developed for transition elements in water. Experiments were extended to Cr, Mn, Th and U.

TABLE 7

RESEARCH FUNDING

Texas Atomic Energy Research Foundation (5/1/81 - 4/30/82)	$37,000
Department of Energy -- Fuel Program	----
Center for Energy Studies (9/1/81 - 8/31/82)	15,000
National Science Foundation	
(5/15/80 - 10/31/82)	39,975
(2/81 - 2/83)	76,373
University of Texas (5/81)	
Safety Related Purchases	26,510
College of Engineering Equipment Fund 9/81	53,000
Institute of Nuclear Power Operations (9/1/80 - 5/31/82)	8,000
TOTAL	$255,858

D. Modification of COBRA-4

Personnel: Dale Klein, NETL
Tom Sanders, NETL

Sponsored by: General Atomic Company
Center for Energy Studies

Description:

The transient version of the thermal-hydraulic computer code COBRA-4 was modified. Considerable modifications were made to COBRA-4 to enhance its application for analyzing Gas Cooled Fast Breeder Reactor (GCFR) transients. This includes new numerical techniques to speed up calculations. The completed model is capable of analyzing transient events for reactor safety studies.

E. Thermal Analysis of a Spent Fuel Shipping Cask in an Engulfing Fire

Personnel: Dale Klein, NETL
James E. Hamann, NETL

Sponsored by: Sandia Laboratories

Description:

A thermal analysis using the computer code HEATING5 was completed to predict the temperature distribution in a nuclear fuel shipping cask. Results from this detailed model are compared with data from a full scale thermal test conducted by Sandia. The Sandia test involved a full-scale shipping container in an engulfing fire for more than 120 minutes. The HEATING5 model enables thermal analysis for a 3-dimensional transient system where a change in phase occurs. Although this project is directly applicable for a spent-fuel shipping cask, other heat transfer systems can be examined.

F. Heat Transfer and Friction Factor Analysis for Artifically Roughened Surfaces

Personnel: Dale Klein, NETL
J. Parker Lamb, Mechanical Engineering
Mike Krause, NETL
Gary Polansky, Mechanical Engineering

Sponsored by: Center for Energy Studies
National Science Foundation

Description:

The proposed research is to determine the heat transfer and friction characteristics for surfaces with discrete roughness geometry. Two major aspects are to be examined in that this is both an experimental and an analytical investigation. Values of $R(h^+)$ and $G(h^+)$ in the universal velocity and temperature profiles will be examined. New experimental techniques have been developed at The University of Texas at Austin to measure local heat transfer values surrounding discrete roughness elements. A test assembly to examine artifically roughened surfaces is being designed. In addition, a new analytical method has also been developed to determine $R(h^+)$ and $G(h^+)$ values without making detailed velocity and temperature profile measurements. Analytical predictions will be made utilizing fundamental parameters in boundary layer theory coupled with the latest information on rough surfaces using integral techniques. Results from the experimental and analytical methods will be compared in order to gain insight as to the dominant mechanism involved for the use of discrete rough surfaces. This research has fundamental application for heat transfer augmentation. Primary application includes heat exchangers and the Gas Cooled Fast Breeder Reactor (GCFR). The modeling will be directed towards the GCFR design conditions. This is the fifth year of a seven year study.

G. Finite Elements in Radiative Heat Transfer in Asboring/Emitting Medium

Personnel: Dale Klein, NETL
Muhammad Razzaque, NETL

Sponsored by: Texas Atomic Energy Research Foundation

Description:

An exact analysis of radiative heat transfer coupled with conductive and/or convective modes was performed to predict the temperature distribution inside a medium and the heat flux distribution at all bounding surfaces of an enclosure with a medium having absorbing-emitting properties. The Galerkin finite element technique was employed to solve numerically the resulting highly nonlinear partial integro-differential energy equation utilizing isoparametric, quadrilateral elements with Lagrangian tensor product biquadratic shape functions. The walls were assumed to be either gray or black with any given temperature distributions and the medium was assumed to be gray. Internal heat generation within the medium can also be included. One often encounters such physical situations in practical engineering problems, particularly in a high temperature system where radiation plays an important role in the heat transfer process such as fusion reactors. The work has been concluded.

H. Fission Product Absorption in Continuously Processed Fission Suppressed Fusion Hybrid Reactor Blankets

Personnel: Dale Klein, NETL
J.W. Davidson, NETL
Ann Patterson, NETL

Sponsored by: Department of Energy Fellowship

Description:

The effects on blanket performance of fission product absorpt' 'n lithium/molten salt hybrid reactor blankets is being investigated. Neutron flux spectra in blankets of varying fuel and fission product compositions are being determined using the discrete ordinates codes, ANISN, and DOT-IV with multigroup cross section data from VITAMIN-C. Flux levels and spectrally weighted cross section libraries for the blanket materials, fuel, and fission products will be established for use in the depletion analyses. Generation and depletion of the various isotopes in the blanket will be calculated using ORIGEN. A lumped fission product model will be used in the transport calculations; however, detailed information concerning the constituents of the lump will be included in the depletion analysis.

In addition to full and partial reprocessing of the molten salt, alternative processing concepts will be investigated. A parametric study of the effects of processing performance will be carried out. This study will result in the characterization of the fission product concentration in the molten salt with respect to isotopics, neutron absorption, and the effects on blanket parameters such as the tritium and fissile breeding ratios.

I. Construction of a Large Benjamin Counter

Personnel: Nolan E. Hertel, NETL
Richard Savage, NETL

Sponsored by: Texas Atomic Energy Research Foundation

Description:

A large spherical proton-recoil proportional counter is being constructed for use in measuring neutron energy spectra below 2 MeV. By differentiating proton-recoil spectra obtained with the detector filling gas (methane or hydrogen) at various pressures, an unknown neutron energy spectrum can be reconstructed. This detector will be used with an existing NE-213 spectrometry system to make possible neutron spectral measurements from 20 MeV down to approximately 10 keV. The two detection systems will then be employed in fusion energy related neutronics studies.

J. Measurement of Gamma-Ray Spectra Resulting in Tissue from Bombardment with Neutron Radiotherapy Beams

Personnel: Nolan E. Hertel, NETL
James B. Smathers, UCLA
Robert G. Graves, University of Rochester

Sponsored by: National Institutes of Health: Public Health Service Grant CA12542 from the National Cancer Institute

Description:

Measurements of gamma-ray spectra produced in tissue-equivalent liquid when bombarded by 50-MeV d^+-Be and 42 MeV p^+-Be neutron beams have been performed. These measurements were done at the Texas A&M University Variable Energy Cyclotron using an NE-213 spectrometer. Analysis of the measurements will help to determine gamma-ray spectral distribution in tissue during radiotherapy treatment. These spectral distributions are currently being used to calculate the average gamma-ray energy as well as the average gamma-ray mass-energy absorption coefficient.

K. High-Energy Neutron Transport Studies

Personnel: Nolan E. Hertel, NETL
Regina Laucius, NETL

Sponsored by: National Science Foundation

Description:

The principal thrust of this project is to develop the capability to routinely and accurately measure high-energy neutron spectra from 1 to 50 million electron volts (MeV). An effective means of performing such measurements is to utilize the recoil pulse-height data from an organic scintillation detector. The reconstruction of the unknown neutron spectrum from the recoil data requires the use of a matrix describing the detector's response to monoenergetic neutrons over the energy range of interest. To meet this need, a neutron response matrix from 1 to 50 MeV is being constructed from recent neutron time-of-flight data. The resulting unnormalized experimental pulse-height distribution data will be used in conjunction with various computer codes to form the matrix. This matrix can then be applied with existing unfolding codes to reconstruct unknown energy spectra. High-energy spectral measurements could be made using this technique at neutron radiotherapy facilities and intense neutron source facilities such as fusion materials radiation damage facilities.

L. Transient Analysis of Fissile and Fusile Fuel Trajectories for Hybrid and Convertor Reactor Symbioses

Personnel: Nolan E. Hertel, NETL
J. Wiley Davidson, NETL
Yukitaka Kunimoto, NETL

Sponsored by: Texas Atomic Energy Research Foundation

Description:

Fissile fuel bred in a hybrid fusion reactor blanket may be used to expand the fission convertor reactor economy. Similarly, fusile fuel (tritium) produced in the convertor reactors may be used to expand the fusion economy. A model has been developed to predict the rate at which such a symbiotic economy could grow. The model allows the determination of time dependent fissile and fusile inventories for stockpiles, as well as for both hybrid and convertor reactor cores and blankets. This transient analysis is being performed for a variety of fission convertor and anticipated fusion hybrid reactor concepts and fuel cycles. Such an analysis will allow the prediction of initial stockpile requirements in addition to providing a more accurate assessment of short term symbiotic system doubling times.

M. Neutron Transport Studies: Neutron Multiplication by Beryllium

Personnel: Nolan E. Hertel, NETL
J. Wiley Davidson, NETL

Sponsored by: Pending, National Science Foundation

Description:

The use of beryllium as a neutron multiplier is central to the current fusion breeder design. Recent measurements of beryllium neutron multiplication and reevaluations of beryllium nuclear data indicate that the multiplying performance of beryllium previously has been overestimated, possibly by as much as 25%. If beryllium's performance as a neutron multiplier has indeed been overestimated even by as much as 10%, the direction of the fusion breeder program in the United States might well change. It is tantamount to the current fusion breeder concepts that the issue of beryllium neutron multiplication be resolved. Therefore, an experiment using a spherical shell of beryllium is being proposed.

The beryllium experiment has been designed to measure multiplication resulting from DT, DD, PuBe, and ^{252}Cf neutron sources being placed in a spherical shell. By doing so the sensitivity of the multiplication to spectral shape can be observed. In addition, the use of these four sources helps to simulate the effect of neutron source degradation in a fusion reactor. The neutron multiplication will be obtained directly from summing weighted Bonner ball measurements of the neutron leakage.

The neutron multiplication obtained in this manner will provide a number which tests the capability of the current beryllium nuclear data to calculate total neutron multiplication.

N. Determination of Selenium in Fish

Personnel: Elsie Sorensen, Memphis State University
A. H. Pradzynski, NETL
Thomas L. Bauer, NETL

Sponsored by: Nuclear Engineering Teaching Laboratory

Description:

Additional measurements and evaluation of selenium levels in fish to environmental contamination were performed. Part per million levels of fish hepatapancreas and muscle were observed and correlated with various other physical observations. Data from two separate lakes, one in Texas and one in North Carolina, were examined. A report to the State of Texas Attorney General was completed and several papers prepared.

O. Au and Cu Content of Athenian Coins

Personnel: Tom Bauer, NETL
Stanislaw Piorek, NETL

Sponsored by: J. Kroll

Description:

Fifteen silver coins with owl insignias minted by Athens were examined for Au and Cu content. Correlation of the coins dates with previous studies was attempted by comparing ratios of the impurities. The coins were property of the American Numismatics Museum.

VIII. Publications From the Nuclear Engineering Teaching Laboratory

1. K.L. Gilbert, "Neutron Flux Mapping of a Subcritical Reactor Core with a Polyethylene Reflector", Masters Thesis, Physics Department, The University of Texas, 61 pp., June 1961.

2. T.T. Doss, "Neutron Density Distribution in and Unreflected Subcritical Reactor Core", Masters Thesis, Physics Department, The University of Texas 63 pp., June 1961.

3. J.M. Norwood, "The Point Source Transport Solution for the Position and Velocity Dependent Neutron Distribution in a Spherical Body of Non-Multiplying Material", Masters Thesis, Physics Department, The University of Texas, 75 pp. June, 1962.

4. R.W. Reed, "Effect of a Cadmium Control Rod on the Neutron Density in a Subcritical Reactor", Masters Thesis, Physics Department, The University of Texas, 85 pp., August 1962.

5. P. Berananda, "Neutron Flux Distribution of a Subcritical Reactor Core with a Graphite Reflector", Masters Thesis, Physics Department, The University of texas, 40 pp., January 1962.

6. T.A. Fredericks, "Thermal Neutron Flux Distribution Due to a Plane Wave Source in and Unreflected Reactor Assembly", Masters Thesis, Physics Department, The University of Texas, 107 pp., August 1963.

7. D.G. Martin, "Film Detector for a Neutron Spectrometer", Masters Thesis, Physics Department, The University of Texas, June 1963.

8. M.L. West II, "Flux Decay Rate in a Reflected Subcritical Reactor", Masters Thesis, Physics Department, The University of Texas, 55 pp., August 1963.

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