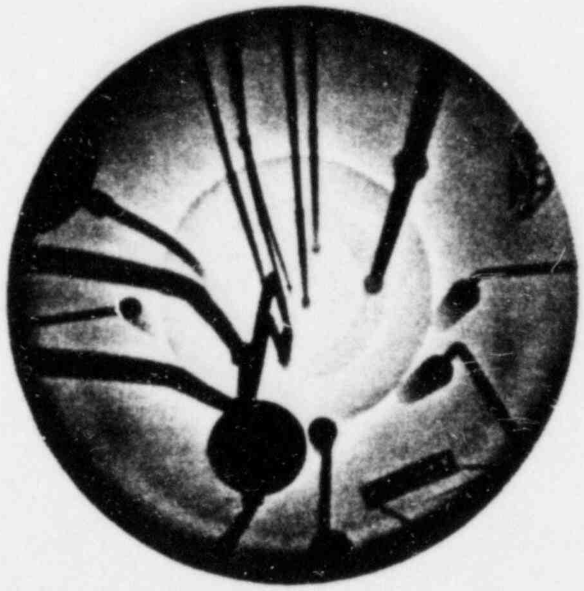

NUCLEAR REACTOR LABORATORY

TECHNICAL REPORT

THE UNIVERSITY OF TEXAS

COLLEGE OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

1983 ANNUAL REPORT

of

The University of Texas at Austin
Nuclear Engineering Teaching Laboratory

January 1, 1983 - December 31, 1983

D. E. Klein, Director
T. L. Bauer, Supervisor

Taylor Hall 104
512/471-5136

January 1984

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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, 1983 to December 31, 1983.

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. The program's 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 most significant event was the renewal of operation license R-92 for the period February 9, 1980 to February 9, 1990. A request is pending for an extension of the license period for an additional ten (10) years.

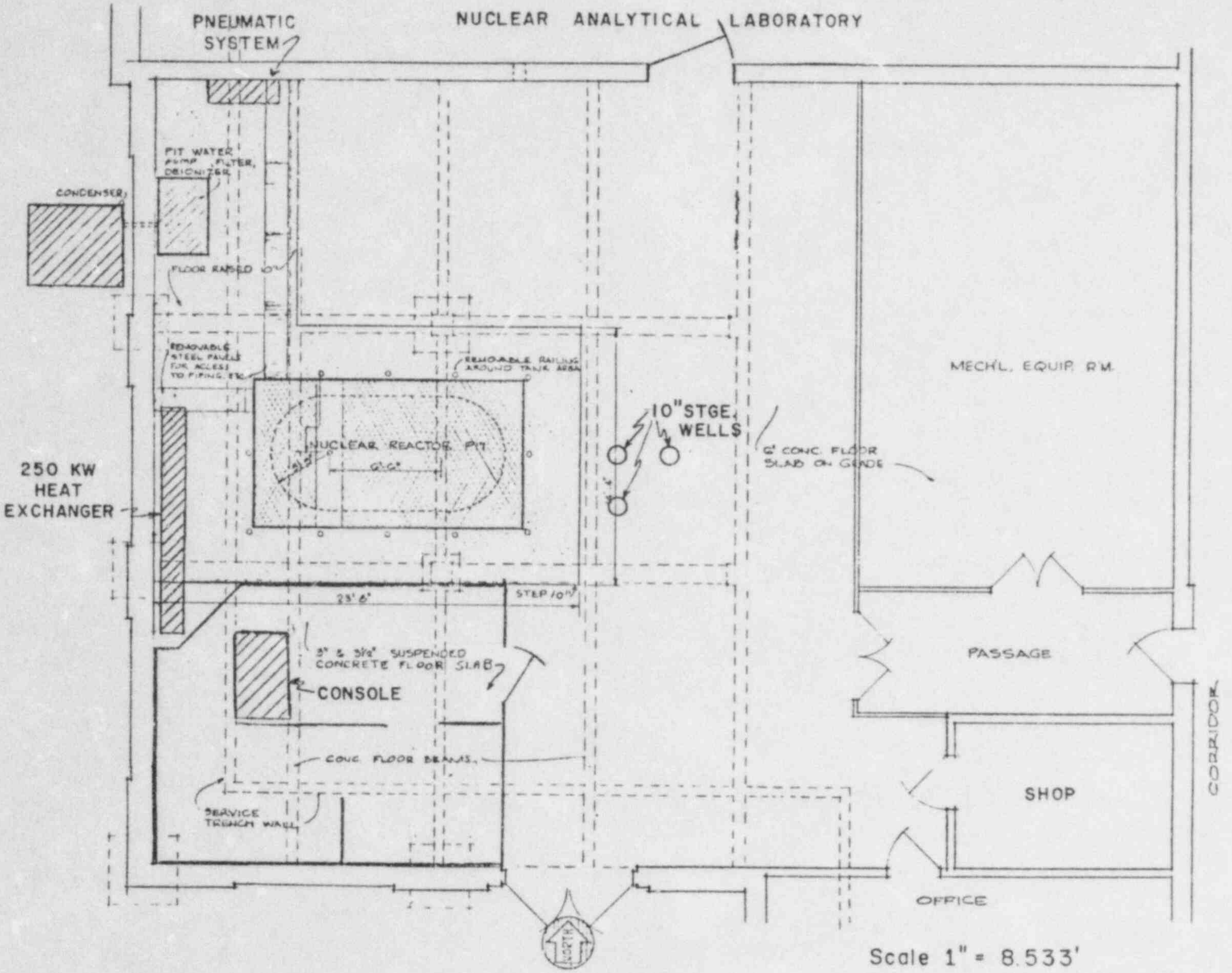

Fig. 1 TAYLOR HALL 131 FLOOR PLAN

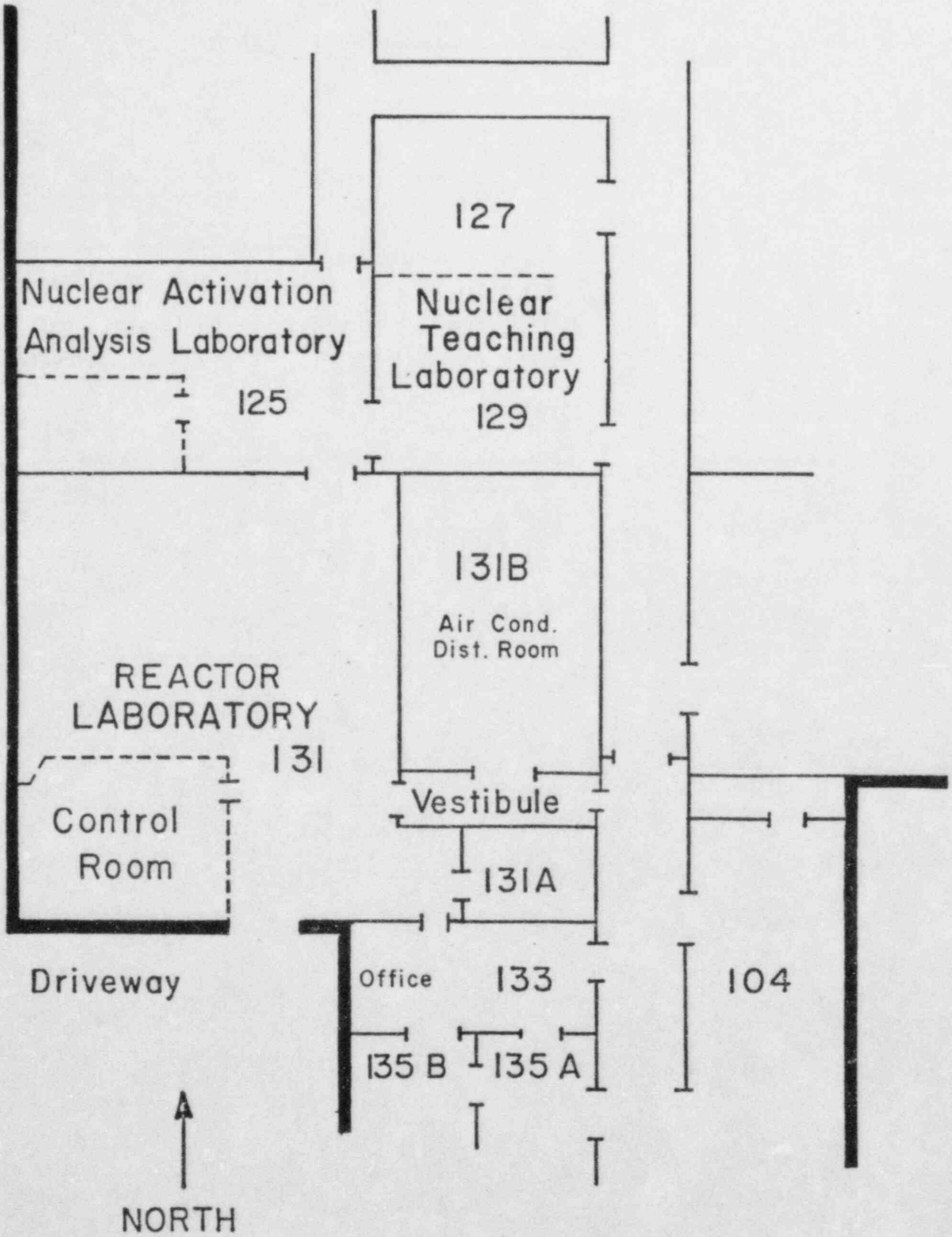

Fig. 2 TAYLOR HALL FLOOR PLAN
ADJACENT ROOMS TO 131

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. Budget support is divided into full time positions for supervisor, technician and radiochemist; half time for an operator; and quarter time for a secretary.

B. Personnel

Personnel associated with the laboratory consist of NETL staff, faculty, students, and certain other university personnel. The personnel involved in the NETL program during the past year are summarized in Table I.

C. Standing Committees

1. Reactor Committee

The Reactor Committee convened and reviewed the activities occurring at the facility during each calendar quarter of this reporting period. Committee meeting dates were April 12, July 13, October 11 and January 17. Committee composition is shown in Table 2.

2. Radiation Safety Committee

The Radiation Safety Committee convened and reviewed radiological safety priorities at the university during this reporting period. Committee meeting dates were April 18 and November 16. Committee composition is shown in Table 2.

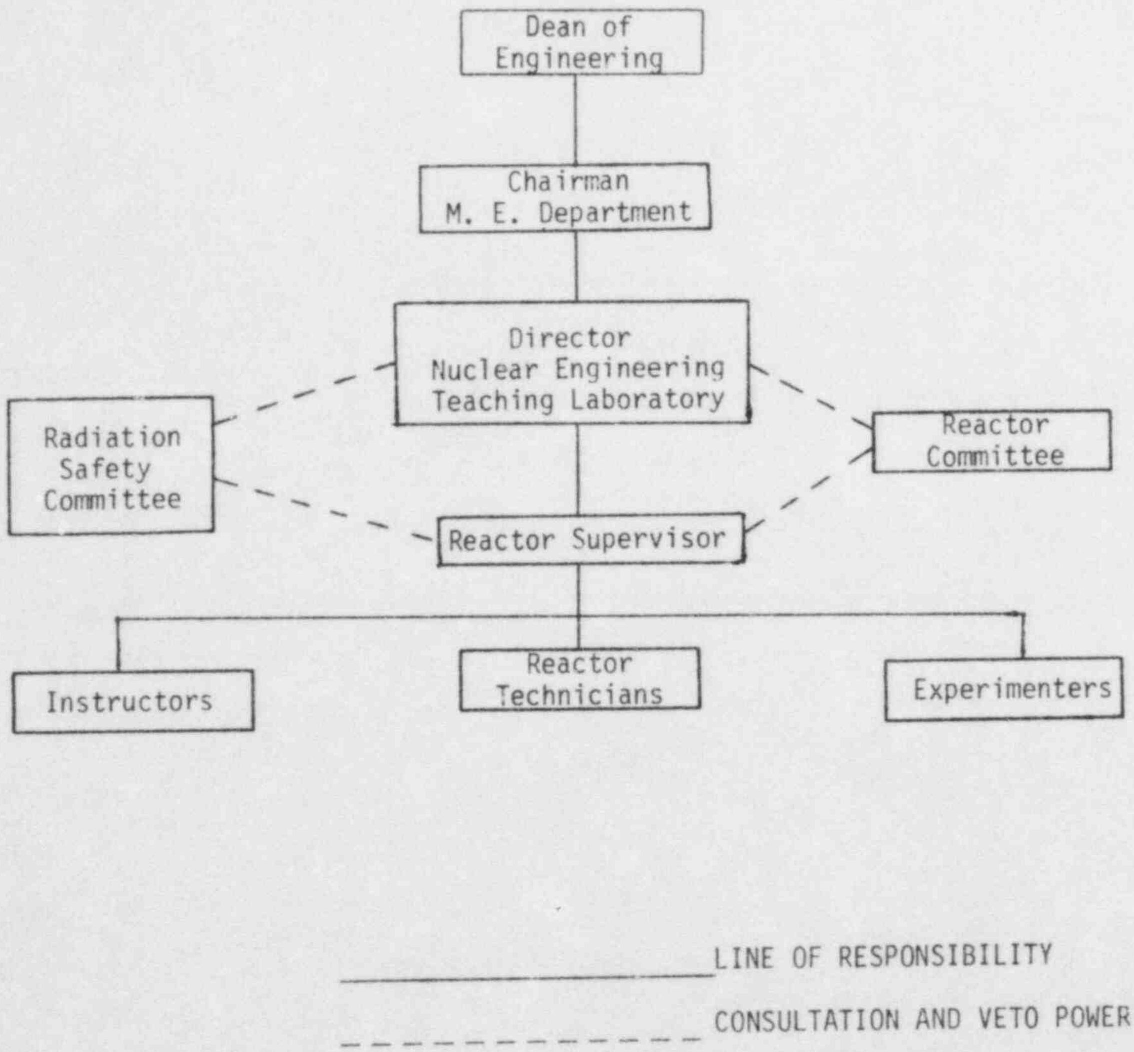

Fig. 3 ORGANIZATIONAL CHART

Table I

Facility Personnel

Staff and Faculty

Director	D.E. Klein
Assistant Director/Supervisor	T.L. Bauer
Nuclear Technical Specialist	M.G. Krause
Nuclear Technical Specialist	N.A. Povio
Radiochemist	F.Y. Iskander
Assistant Professor	N.E. Hertel
Administrative Secretary	M.G. Morrison

Support Personnel

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

Graduate Assistants

M. Ally
A. Gaines
A. Patterson-Hine
T. Sanders
B. Kolda
R. Savage
E. Ibrahim
G. Polansky
L. Grater
Y. Kunimoto

Student Assistants

J. Evans
T. Tran

Table 2
Standing Committees

Reactor Committee

Chairperson:	B. L. Marcus
Member:	N. E. Hertel
Member:	D. E. Klein
Member:	J. O. Ledbetter
Student Member:	R. D. Manteufel
Ex officio member:	T. L. Bauer
Ex officio member:	H. W. Bryant
Ex officio member:	E. F. Gloyna

Radiation Safety Committee

Chairperson:	P. J. Riley
Member:	F. H. Bronson
Member:	L. O. Morgan
Member:	D. E. Klein
Member:	R. L. Shipman
Member:	K. J. Caskey
Ex officio member:	H. W. Bryant
Ex officio member:	P. T. Flawn

D. 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. Harris Marcus, Reactor Committee Chairman, summarized the activities during this period saying, "The past year again has been an active year for the Nuclear Reactor Teaching Laboratory, a continuing conscientious effort to improve the facility has been effectively carried out."

III. LABORATORY DEVELOPMENT

A. Organization

Dr. Dale E. Klein continued as the Director and Dr. Thomas L. Bauer continued as Reactor Supervisor during the past year. Technical and secretarial personnel also remained unchanged. Dr. Felib Iskander filled the vacant radiochemist position. Key faculty and university support personnel remained unchanged.

B. Nuclear Engineering Teaching Laboratory

The Nuclear Engineering Teaching Laboratory is part of the Nuclear Engienering 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 which increased experimental capabilities.

Other radiation producing devices maintained by the Laboratory are a 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. Courses utilizing the reactor and associated facilities are listed in Table 3. Approximately 1,700 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.

Table 3

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 361G	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 sutdies 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	Advanced 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.

C. 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 - 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.

D. Nuclear Radiation Laboratory

The Nuclear Radiation Laboratory is utilized by the students and staff of the Nuclear Engineering Program at The University of Texas at Austin. The laboratory was moved to the Engineering Science Building in the summer of 1983 since the building housing the laboratory at Balcones Research Center is to be demolished as part of the Balcones Research Center development program. The main feature of the laboratory is a 14 MeV Texas Nuclear neutron generator. Three californium-252 neutron sources are also available for use. The facility, with installed neutron shielding, provides an area where 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. Facility Operations Summary

A. Operating Experience

Renewal of operating license R-92 was received effective for the period July 29, 1983 through February 9, 1990. A request for license term extension is pending. During the fall of 1983, the University Broad Radioactive Material License issued by the Texas Department of Health was renewed, with expiration date June 30, 1988. The facility emergency plan was rewritten and resubmitted to the NRC for review. Established operating procedures and other required procedures remained unchanged. A study has been initiated to determine economic and license feasibility of continued operation of the NETL facility in response to possible reallocation of current site functions for alternate university program plans.

Licensed activities were performed by three persons with Senior Operator Permits, T.L. Bauer, M.G. Krause and N.A. Povio. Most operating activities were in support of nuclear engineering and reactor operations, research and education or demonstrations. No new experiments were proposed or approved. Excluding operation for demonstration, instruction or routine surveillance, the major experiment performed was neutron activation to support various research activities. Some operation occurred for radioisotope production. Most maintenance was routine with two conditions assessed as unacceptable and subsequently modified. The first modification was the installation of new fuel temperature measurement channels. The second condition was inconsistent performance of the uncompensated ionization chamber.

B. Reactor Shutdowns

Reactor shutdowns (scrams) occuring during the reporting period are summarized in Table 4, categorized according to the type of initiating event. Table 5 compares the number of inadvertent shutdowns during this reporting period to previous reporting periods.

C. Utilization

Reactor utilization data for this reporting period is summarized in Table 6. A summary of reactor utilization since initial criticality is shown in Table 7. Bar graphs comparing annual burnup and quantities of samples irradiated since initial criticality are shown in Figures 4 and 5.

TABLE 4

REACTOR SCRAMS

Intentional	--	6
Operator Error	--	1
Instrument Error	--	5
Power Outage	--	0
Safety	--	0
Total	--	12

TABLE 5

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	'83
4	7	5	9	11	12	7	7	8	6

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

TABLE 6

NUCLEAR ENGINEERING TEACHING LABORATORY

PERFORMANCE DATA, 1983

	Total Hours Reactor In Operation*	Total Burn-up (kW-hrs)	Number of Samples Irradiated
First Quarter 1983	40.4	1126	37
Second Quarter 1983	56.0	5399	52
Third Quarter 1983	70.0	8143	184
Fourth Quarter 1983	93.8	9360	204
TOTAL	260.2	24028 (1.0 MWD)	477

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

TABLE 7

COMPARISON OF PREVIOUS UTILIZATION DATA

Year	Hours Reactor In Operation*	Burn-up (kW-hrs)	Number of Samples Irradiated
1965-66**	104.5	251	63
1966-67	150.0	595	202
1967-68***	342.6	28,168	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	48,389	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
1983	260.2	24,028	477
TOTAL	4025.6	48,084 (20. MWD)	16,859

*Includes experimental setup time, maintenance, etc.

**1965 was the first year the utilization data was maintained.

***Reactor upgraded from 10 to 250 kW during this academic year.

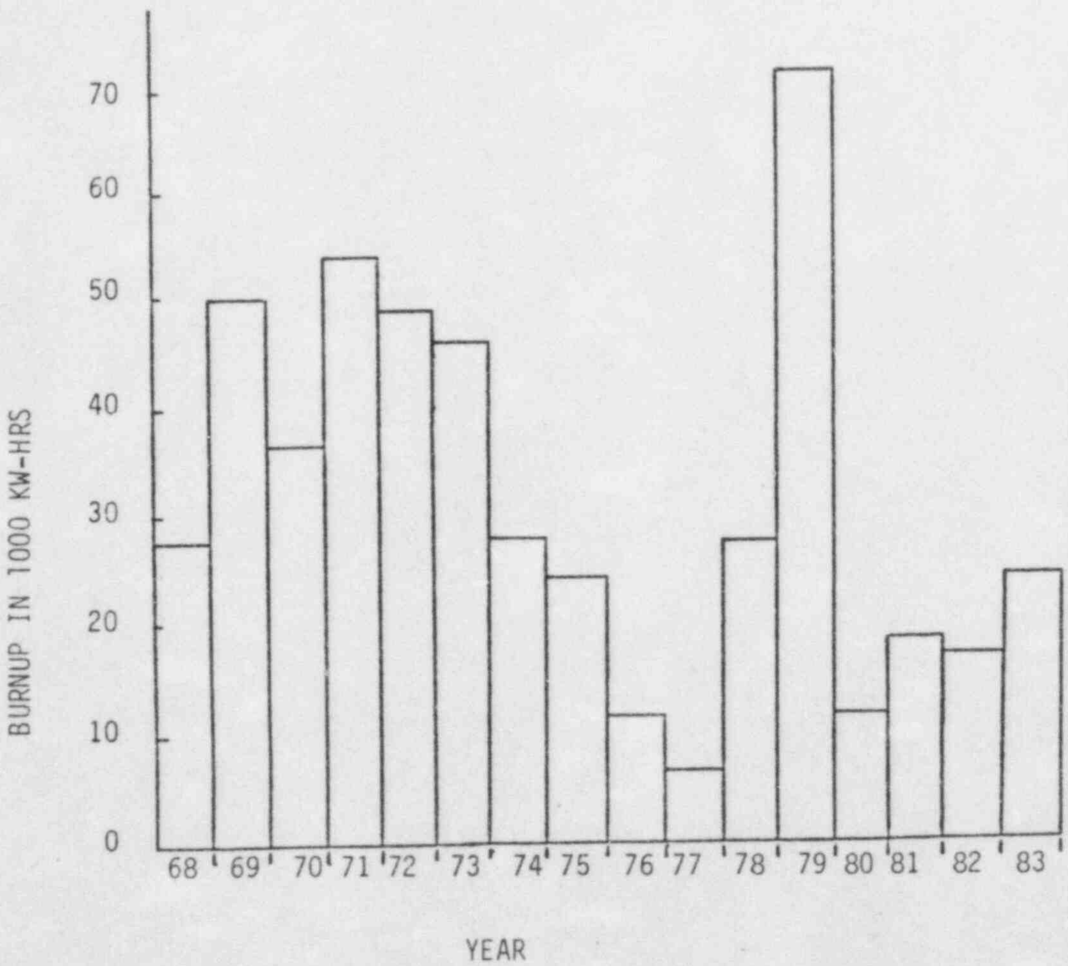

Fig. 4 TOTAL BURNUP PER YEAR

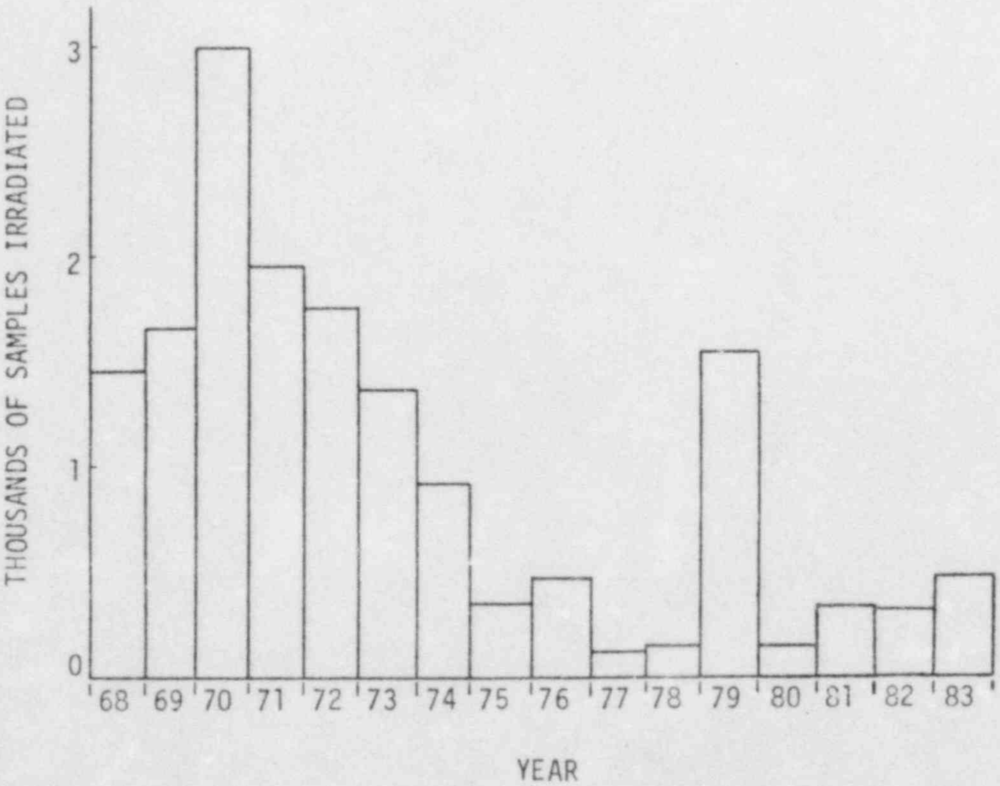

Fig. 5 NUMBER OF SAMPLES IRRADIATED

D. Maintenance

During this reporting period maintenance consisted primarily of routine repair and adjustment. The only non-routine maintenance performed was the replacement of both fuel temperature measuring channels described in the facility changes section.

E. Facility Changes

1. The wooden structure used to separate the area inside the reactor laboratory designated the radiochemical room was removed. The benefits of this action included the generation of more open work space, the removal of an aesthetically unpleasant structure, and a substantial decrease in the amount of combustible material in the laboratory.

No unreviewed safety questions are presented by removal of the structure.

2. Relay and loop resistance problems with fuel temperature measurement channels initiated redesign and replacement of the channels. Solid-state temperature controllers (0-800°C) replaced the loop resistance meter (0-600°C). Designed for Cr-Al thermocouples, the channels provided more reliable measurements and failure indication despite the additional circuit complexity.

No unreviewed safety questions are presented by the temperature channel modifications. Substantial improvement of temperature measurement accuracy and indication of failure conditions are possible with the modifications.

F. Radiation Exposures

A summary of radiation exposures during this reporting period to facility personnel, students, and visitors is shown in Table 8. The average exposure per individual and the greatest exposure per individual for each group is summarized in Table 9. No exposures in excess of the limits of 10CFR20 occurred during this period.

G. Area Radiation Surveys

An annual summary of the normal radiation levels measured in the laboratory is shown in Table 10. The results of routine surface and pool water contamination surveys are summarized in Table 11. Environmental surveys performed outside the laboratory are summarized in Table 12.

TABLE 8

SUMMARY OF RADIATION EXPOSURE

Range of Exposure in REM	Number of Individuals		
	Staff	Students	Visitors
Non-measurable exposure*	10	32	1700
0.0 - 0.1	1	0	0
0.1 - 0.25	0	0	0
0.25 - 0.5	0	0	0
0.5 - 0.75	0	0	0
0.75 - 1.0	0	0	0
1.0 - 2.0	0	0	0
2.0 - 3.0	0	0	0
Greater than 3.0	0	0	0

*Staff and Students: Film measured exposures below 10 mrem x or γ, 40 mrem hard β; 20 mrem fast n, or 10 mrem thermal n during each reporting period. Visitors: Pocket dosimeter exposures at or below 10 mrem.

TABLE 9

RADIATION EXPOSURE ANALYSIS

Group	Average Radiation Exposure Per Individual (mrem)	Greatest Radiation Exposure Per Individual (mrem)
Staff	$\leq 10^{(1)}$	20
Students	$\leq 10^{(1)}$	$\leq 10^{(1)}$
Visitors	≤ 10	≤ 10

(1) Exposures less than minimum detectable level (10 mrem x-γ) during each film badge reporting period.

Table 10

LABORATORY RADIATION LEVELS

Location	Average (mR/hr) (1)	Maximum (mR/hr) (2)
Wall Near Control Panel	-- (3)	-- (3)
Wall Near Water Purification System	1×10^{-2}	0.8
Ceiling Directly Above Reactor Pool	8×10^{-2}	7.0

(1) Determined using results of fixed film badge monitors averaged over one year.

(2) Annual film measured exposure divided by effective annual reactor full power hours.

(3) Non-measurable as defined in Table 8.

TABLE 11

LABORATORY CONTAMINATION LEVELS

Location	Average	Maximum
Floor	≤ 50 dpm	≤ 100 dpm
Work Surfaces	≤ 50 dpm	≤ 200 dpm
Pool Water (1)	-- (2)	≤ 650 pCi/l

(1) Measured when reactor not operating

(2) Not distinguishable from background

TABLE 12

ENVIRONMENTAL SURVEYS

Location (1)	Average (mrem/hr)	Maximum (mrem/hr)
1	0.01	0.01
2	0.01	0.01
3	0.01	0.03
4	0.01	0.01
5	0.01	0.01
6	0.01	0.01
Waller Creek (2)	-- (3)	135 pCi/l

(1) Monitoring locations shown in Figure 6.

(2) Water sample from stream flowing through campus approximately 0.25 miles from reactor facility.

(3) Measurements at or below background.

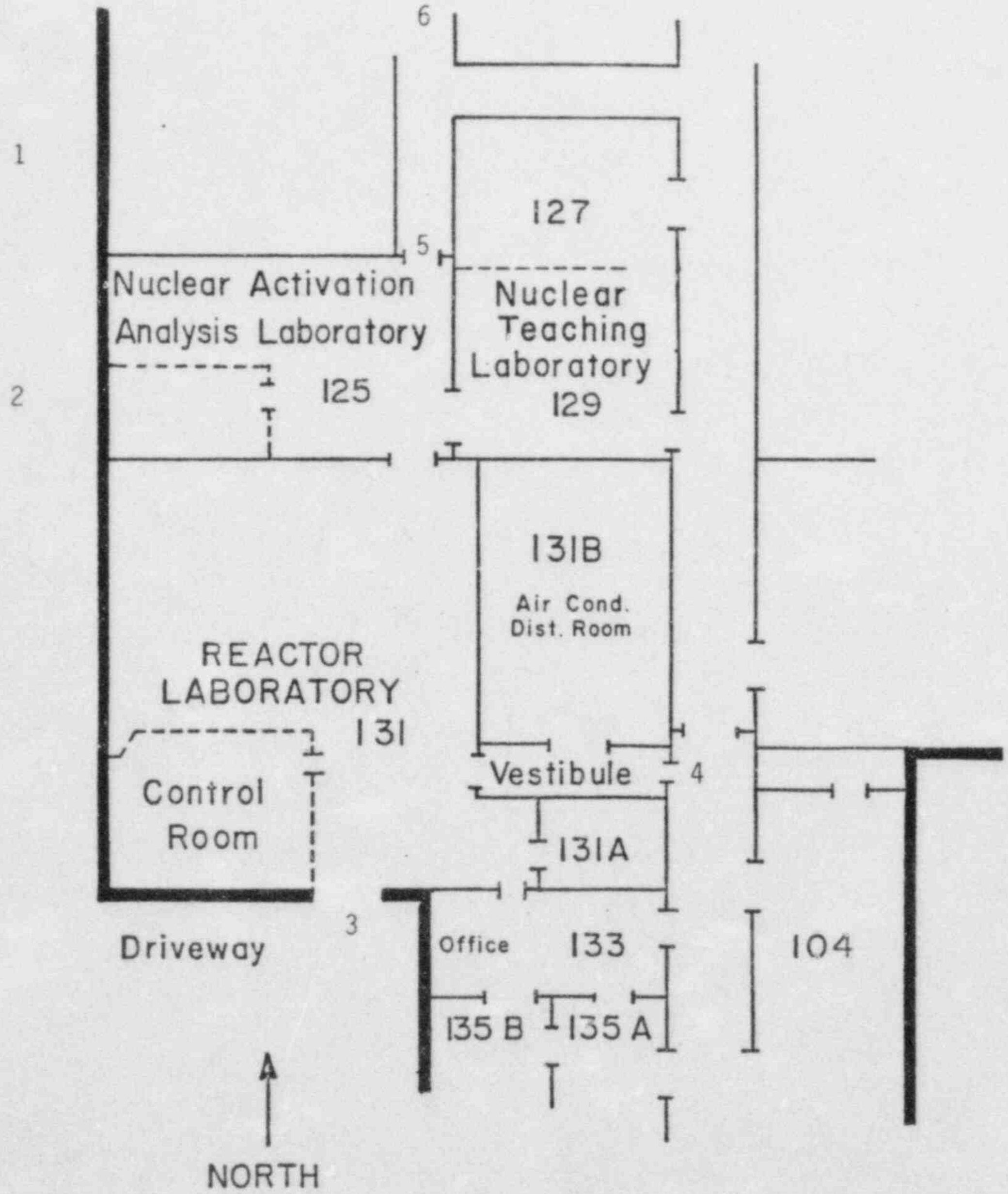

Fig. 6 TAYLOR HALL ENVIRONMENTAL SURVEY LOCATIONS

H. Radioactive Effluents

1. Liquid Waste

No liquid radioactive waste was discharged during the reporting period.

2. Gaseous Wastes

Gaseous discharge during the reporting period is limited to leakage of Ar^{41} from the reactor laboratory. The total estimated amount of radioactivity released was calculated based on experimental equilibrium Ar^{41} concentration measurements (4×10^{-8} Ci/m^3) adjusted by the number of full power hours operated during the period. Although air leakage from the laboratory is restricted on effective air change rate of two per hour (.37 m^3/sec) is assumed with dilution at the release point (.14 sec/m^3). A summary of the calculated radioactive gaseous discharges during the reporting period is presented in Table 13.

3. Solid Waste

The activity and amounts of solid waste discharged during the reporting period are summarized in Table 14. All solid waste materials were packaged and shipped, along with radioactive waste generated in other departments, by the University Safety Office.

TABLE 13

MONTHLY SUMMARY OF GASEOUS WASTE DISCHARGES

Date of Discharge (Month & Year)	Total Estimated Radioactivity Released µCi	Total Estimated Quantity of Argon-41 Released(1) µCi	Estimated Average Atmospheric Diluted Concentration of Argon-41 at Point of Release (µCi/cc)	Percent of the Applicable MPC for Diluted Concentration of Argon-41 at Point of Release (%)	Total Estimated Quantity of Radioactivity in Particulate Form with Half-Life >8 Days(2) (Curies)	Average Concentration of Radioactive Particulates Released With Half-Life >8 Days (Curies)	Estimated Average Concentration of Other Significant Radionuclides in Discharge if >20% of the Applicable MPC (µCi/cc)	Percent of MPC if the Estimated Release was >20% of the Applicable MPC
Jan	0	0	0	0	None	Not Applicable	Not Applicable	Not Applicable
Feb	87	87	4.7×10^{-12}	1.1×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
Mar	158	158	8.5×10^{-12}	2.1×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
Apr	757	757	4.1×10^{-11}	1.0×10^{-1}	None	Not Applicable	Not Applicable	Not Applicable
May	163	163	8.7×10^{-12}	2.1×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
June	256	256	1.4×10^{-11}	3.4×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
July	430	430	2.3×10^{-11}	5.8×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
Aug	267	267	1.4×10^{-11}	3.6×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
Sept	1072	1072	5.7×10^{-11}	1.4×10^{-1}	None	Not Applicable	Not Applicable	Not Applicable
Oct	419	419	2.2×10^{-11}	5.6×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
Nov	985	985	5.3×10^{-11}	1.3×10^{-1}	None	Not Applicable	Not Applicable	Not Applicable
Dec	631	631	3.4×10^{-11}	8.5×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
ANNUAL VALUE	5225	5225	2.3×10^{-11}	5.8×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable

TABLE 14

ANNUAL SUMMARY OF SOLID WASTE DISPOSAL

Activity	Volume	Shipment Date (1)
83µCi	8.5 ft^3	April 26, 1983
8Ci (2)	10.1 ft^3	May 31, 1983
17µCi	7.0 ft^3	December 21, 1983

(1) All shipments made to Isotex in Friendswood, Texas.

(2) Majority of activity ^3H target for neutron generator.

V. Laboratory Inspections

A. NRC Inspection February 28 - March 4, 1983

The inspection reviewed program and activities designed to protect against industrial sabotage and to safeguard special nuclear material as required by NRC Licenses R-92 and SNM-180. The inspection consisted of selective examination of procedures and representative records, interviews with personnel, and observations by the inspector. Within the scope of the inspection, no violations or deviations were identified.

B. NRC Inspection March 10-11, 1983

The inspection consisted of a review of activities authorized by NRC Operating License R-92. Principal areas examined during the inspection included: 1) organization, logs, records, and personnel changes; 2) audit and review; (3) procedures; 4) surveillance; 5) experiments; (6) environmental protection; 7) emergency planning; (8) radiation control; (9) operation requalification; (10) cobalt 60 irradiator storage; and (11) proposed building modification. Within these areas, the inspection consisted of selective examination of procedures and represenatative records, interviews with personnel, and observations by the inspectors. Within the scope of the inspection, no violations or devations were identified.

C. TDH Inspection February 7-8, 1983

The inspection consisted of a review of activities and radioactive materials used at the University of Texas as authorized by TDH License.

VI. Public Service Activities

A. Summer High School Science Teacher Symposium

The NETL staff organizes and supervises an annual two week symposium designed to familiarize high school science teachers with the theory and technology associated with energy resources today. Graduate college course credit is given to all participants who successfully complete the course. The program is funded by various electric utility companies in Texas. Approximately thirty (30) teachers attend the symposium every year.

B. Lectures and Presentations

On numerous occasions during 1983 the NETL staff talked to various organizations about subjects including but not limited to: "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. Reactor Facility Tours

During 1983, 1700 persons visited the laboratory. The two largest groups visiting the laboratory were 268 persons attending the Texas Energy Science Symposium and 258 persons attending the University of Texas Centennial Celebration activities. Numerous high school students also toured the facility during an event called The World of Engineering, designed to recruit students into the field of Engineering. Students from seven local high schools and students from six non-engineering related college courses visited the facility. Numerous college engineering related classes and several student engineering organizations also toured the facility. Safety personnel with Austin Fire Department, UT Police Department, UT Safety Office and the Texas Department of Health also visited the laboratory to familiarize themselves with the laboratory and emergency response procedures unique to the facility.

VII. Research Activities

The Nuclear Engineering Teaching Laboratory prusues research of both sponsored and unsponsored projects in several different areas. The following section lists research projects in which the laboratory has participated. Major research funding or grants are presented in Table 15.

A. The U.S. Department of Energy has provided research support by providing reactor fuel cycle assistance for the currently operating reactor core at 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 sources.

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

Personnel: Dale Klein, NETL
Tom Bauer, 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. The project was concluded with the measurement of Se, V, Cu, Mo, Zn, U and Th. An organic reagent (APDC) was successfully applied to obtain ng/g measurements of preconcentrated water samples.

TABLE 15

RESEARCH FUNDING

Texas Atomic Energy Research Foundation	$ 28,400
5/1/83 - 4/30/84	
Department of Energy -- Fuel Program	----
Center for Energy Studies	25,000
9/1/82 - 12/31/83	
National Science Foundation	76,376
2/81 - 7/84	
University of Texas	
College of Engineering Equipment Fund 9/81	26,400
Center for Fusion Engineering	21,000
DOE Fellowship Program	
(Institutional Allowance)	6,000
TOTAL	$183,176

D. <u>Heat Transfer and Friction Factor Analysis for Artificially Roughened Surfaces</u>

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 artificially 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.

E. Measurement of Vanadium in Egg White Diets

Personnel: T.L. Bauer, NETL
M. Ally, NETL

Sponsored by: J.H. Freeland, Home Economics Department, UT at Austin

Description:

Nutritional studies on takeup and retention of some trace elements in the human diet include the elements of V and Mn. Measurements were performed to determine the vanadium content of a test diet prepared primarily from egg whites.

F. Interlaboratory Comparison of Element Analysis of Coal

Personnel: T.L. Bauer, NETL
F.Y. Iskander, NETL

Sponsored by: C. Ho, Bureau of Economic Geology

Description:

Several core samples containing coal materials and other rock material from Texas sites were analyzed by INAA. Thirty-eight (38) elements were determined in the samples and compared to analysis performed by alternate analytical laboratory methods.

G. Analysis of Elements in Cigarette Tobacco, Filter, Ash and Paper

Personnel: F.Y. Iskander, NETL
T.L. Bauer, NETL

Sponsored by: NETL

Description:

Cigarettes from several countries and various domestic brands, including different brand types, were analyzed by INAA methods. Results were examined and compared to values reported in the literature. Approximately thirty elements were identified. Measurement determined the element content in the unsmoked tobacco, the

residual ash after smoking, the residue in the filter and the paper from which the tobacco was removed. Presence of some elements indicative of additives at either the processing or production stage were noted although evidence was not direct.

H. Calcium Content in Cereal Matter

Personnel: F.Y. Iskander

Sponsored by: Texas A&M University

Description:

Investigations to decrease production times of some cereal compounds require the measurement of Ca as indications of the elemental cereal content. Samples were activated and decay of Ca^{48} activity provided data for the calcium content.

I. Cadmium and Calcium Uptake Studies

Personnel: E. Sorenson, Pharmacy Dept. UT
D. Acosta, Pharmacy Dept. UT
T.L. Bauer, NETL

Sponsored by: John Hopkins Center for Alternatives to Animal Testing

Description:

Radioactive tracers of Cd^{104}, Ca^{45}, and Cd^{115} were employed in studies of binding and transport related to cell uptake mechanisms. Several experiments with cell cultures of rat hepatocyte cells were performed to determine the effect of calcium presence on the intake of the toxic element cadmium.

J. Interlaboratory Comparison of Air Particulate Filters

Personnel: F.Y. Iskander, NETL
T.L. Bauer, NETL
J. Rhodes, Columbia Scientific Industries

Sponsored by: CSI/NETL

Description:

Air particulates spiked with elements of interest were examined by several laboratories. Two sets of samples were analyzed each intended to be applied for XRF analysis types of measurements. The samples are intended to be used as standards and for quality assurance samples. INAA analysis was performed for elements V, Mn, As, Br, Ba, Co, Ni, Fe, Sb, Cr, Zn and Se in one set of samples. The second set of samples was analyzed for Al, Cl and Ca.

K. 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
Center for Fusion Engineering

Description:

The effect on blanket performance of fission product absorption in 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.

L. Pressure Drop and Heat Transfer Measurements of Liquid Metal Flowing in a Packed Bed Under the Influence of a Magnetic Field

Personnel: Dale Klein, NETL
Tom Sanders, NETL
Larry Grater, Mechanical Engineering
Mike Crawford, Mechanical Engineering

Sponsored by: Center for Fusion Engineering
Texas Atomic Energy Research Foundation

Description:

The flow of electrically conducting fluids through porous media in the presence of a magnetic field has recently begun to generate significant interest due to potential applications for fusion reactors. This study is designed to examine the pressure drop and heat transfer from a liquid metal (NaK) flowing through a packed bed of stainless steel spheres under the influence of a transverse magnetic field. Results of this investigation should have direct applications on the design of fusion breeder blankets using liquid metal flowing around spheres of fertile material.

M. CO_2 Production for Enhanced Oil Recovery Using Texas Lignite and Nuclear Process Heat

Personnel: B. Kolda, NETL
Dale Klein, NETL

Sponsored by: Center for Energy Studies

Description:

Carbon dioxide miscible displacement is one method of enhanced oil recovery which can increase ultimate production beyond that obtained from primary and secondary methods. Current sources of CO_2 for this application are obtained from natural CO_2 wells, by-product CO_2 and on-site generation of CO_2. This project is to examine the feasibility of obtaining CO_2 and other valuable by-products from Texas lignite using a high temperature gas-cooled nuclear reactor for process heat. An integrated concept will be developed to include the nuclear process heat and the valuable by-products converted from the Texas lignite.

N. Examination of Reversed-Field Pinch Reactor using a Homopolar Generator as a Power Supply

Personnel: Herbert Woodson, Electrical Engineering
Dale Klein, NETL
Erfan Ibrahim, NETL

Sponsored by: Center for Fusion Engineering
Texas Atomic Energy Research Foundation

Description:

The Reversed-Field Pinch (RFP) reactor is one of the conceptual designs under study for the production of electrical energy from fusion. Several reactor design evaluations have been undertaken at the Los Alamos National Laboratory. The RFP is a toroidal shaped device that holds a plasma by the simultaneous presence of a toroidal field and a poloidal field. A homopolar generator power supply has been developed by the Center for Electromechanics (CEM) at The University of Texas at Austin. The goal of this study is to examine the RFP and the homopolar power supply developed by CEM as a conceptual design. Parameters to be investigated include the physical size of the RFP, the power supply required and the fundamental plasma requirements for ignition.

O. 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 2MeV. 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 to 10 keV. The two detection systems will then be employed in fusion energy related neutronics studies.

P. 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.

Q. Neutron Transport Studies: Neutron Multiplication by Beryllium

Personnel: Nolan E. Hertel, CFE

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 re-evalutions 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.

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Department of Mechanical Engineering
Nuclear Engineering Program
512—471-5136

April 13, 1984

Director of Inspection and Enforcement
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

Enclosed are twelve (12) copies of the calendar year 1983 annual report required according to CFR 10 Section 50.59.

Sincerely yours,

T. L. Bauer

T. L. Bauer
Reactor Supervisor
SOP #3664

Dale Klein /hgb

Dale Klein, Director
Nuclear Engineering
Teaching Laboratory

TLB:DK:bb
Enclosures

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