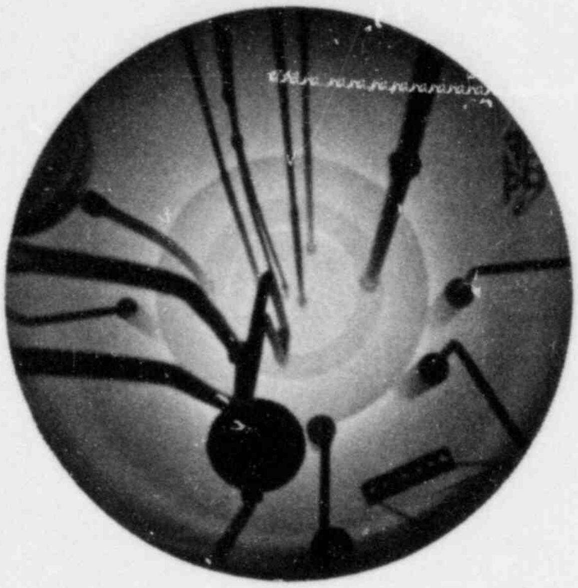
50-192



NUCLEAR REACTOR LABORATORY

TECHNICAL REPORT

THE UNIVERSITY OF TEXAS

COLLEGE OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

IE24 1/12

1984 ANNUAL REPORT

of

The University of Texas at Austin
Nuclear Engineering Teaching Laboratory

January 1, 1984 - December 31, 1984

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

Taylor Hall 104
512/471-5136

January 1985

TABLE OF CONTENTS

List of Figures

List of Tables

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, 1984 to December 31, 1984.

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 925 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. A major planning effort was initiated during the 1984 calendar year to move the facility location from The University of Texas at Austin Main Campus to the Balcones Research Center. The proposed move is in response to needs for expansion of other educational programs and facilities on the Main Campus and the development of the research center as a major research and engineering site. A submittal was made to the Nuclear Regulatory Commission in November for the approval of a combined Construction Permit and Operating License to be applied to the proposed facility. Completion of final plans and issuance of the requested permits is expected in 1985 with construction scheduled for 1986. Facility completion and acceptance of the new facility is projected for the spring of 1987.

Decommission and dismantling of the current facility is being studied with plans to be submitted in early 1985. Actual decommission and dismantling work is scheduled for the first months of 1987.

The proposed facility will provide laboratories for the TRIGA reactor, neutron generator, radiation measurement, preparation and processing of radioactive samples, and office space. Although the facility move consists primarily of moving the current TRIGA facility and other program activites into a single building at the Research Center, several improvements to the reactor facility are planned to extend facility capability. These include above ground shield structure for access to horizontal beam tubes, and increased power and pulse parameters. Plans are to utilize the current fuel and move some other components from the old to the new facility. Many of the components such as reactor structure, and instrumentation and control system are to be replaced for the proposed facility. A few components such as the rod drives will be reconditioned.

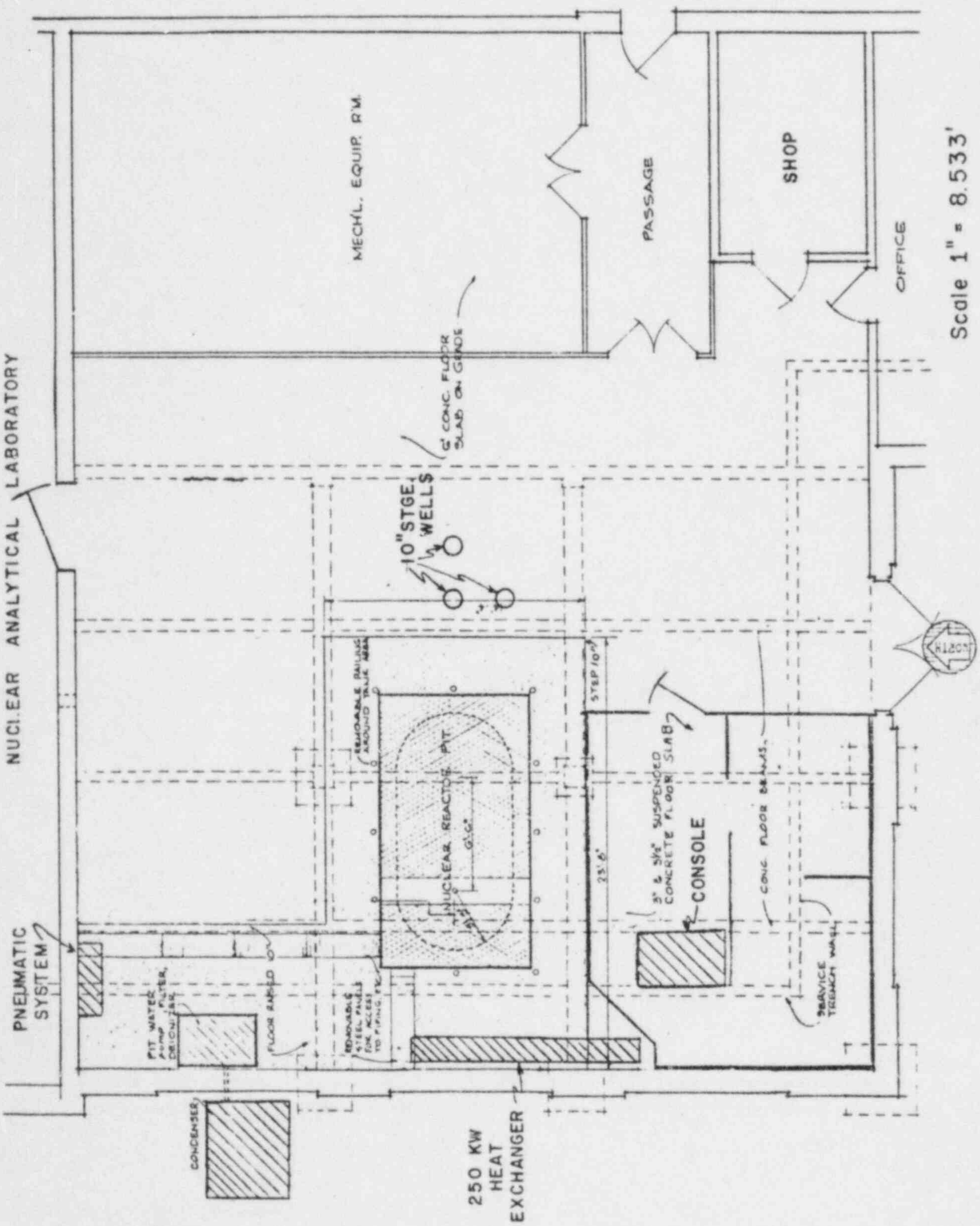


Fig. 1 TAYLOR HALL 131 FLOOR PLAN

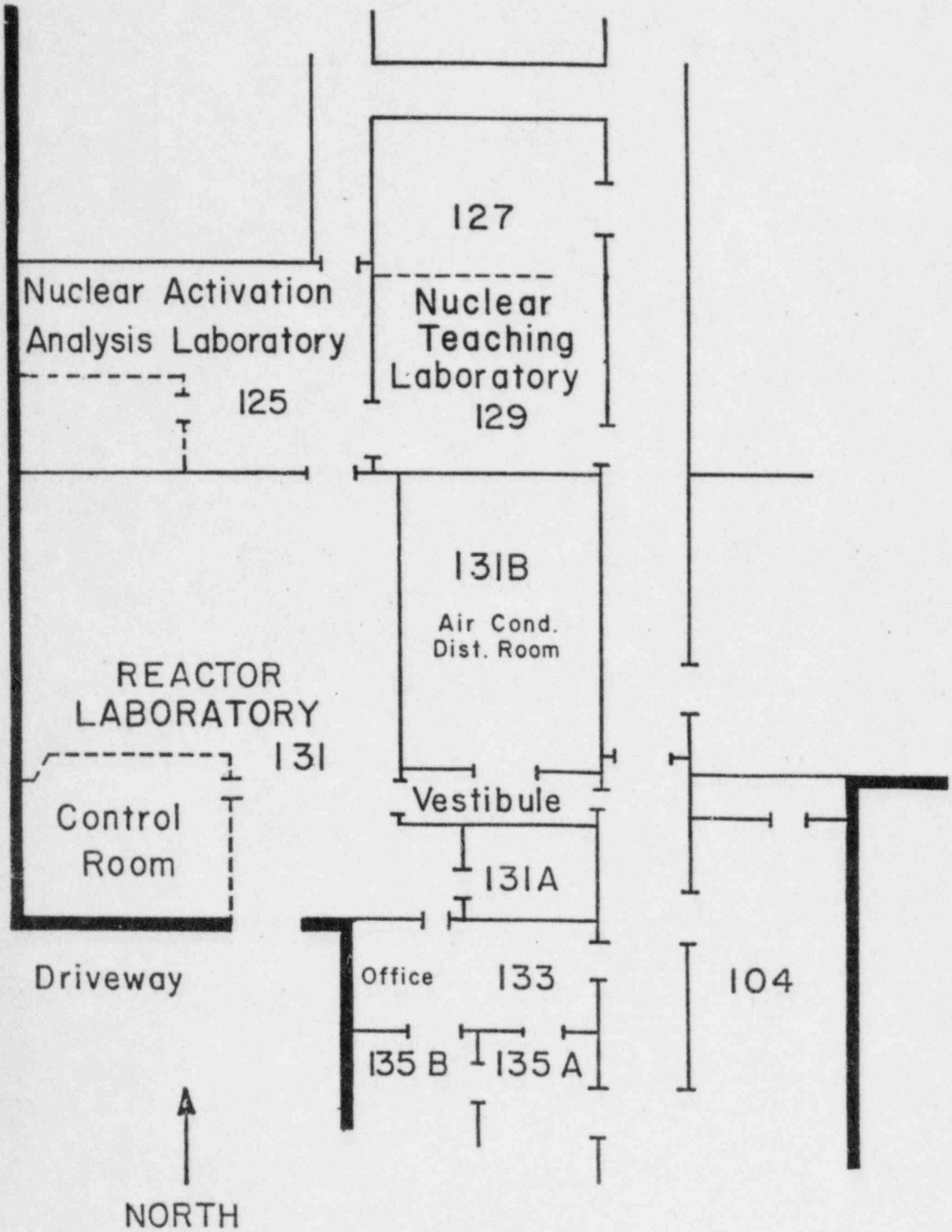


Fig. 2 TAYLOR HALL FLOOR PLAN
ADJACENT ROOMS TO 131

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 30, July 2, October 26 and January 29. 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 10 and November 26. Committee composition is shown in Table 2.

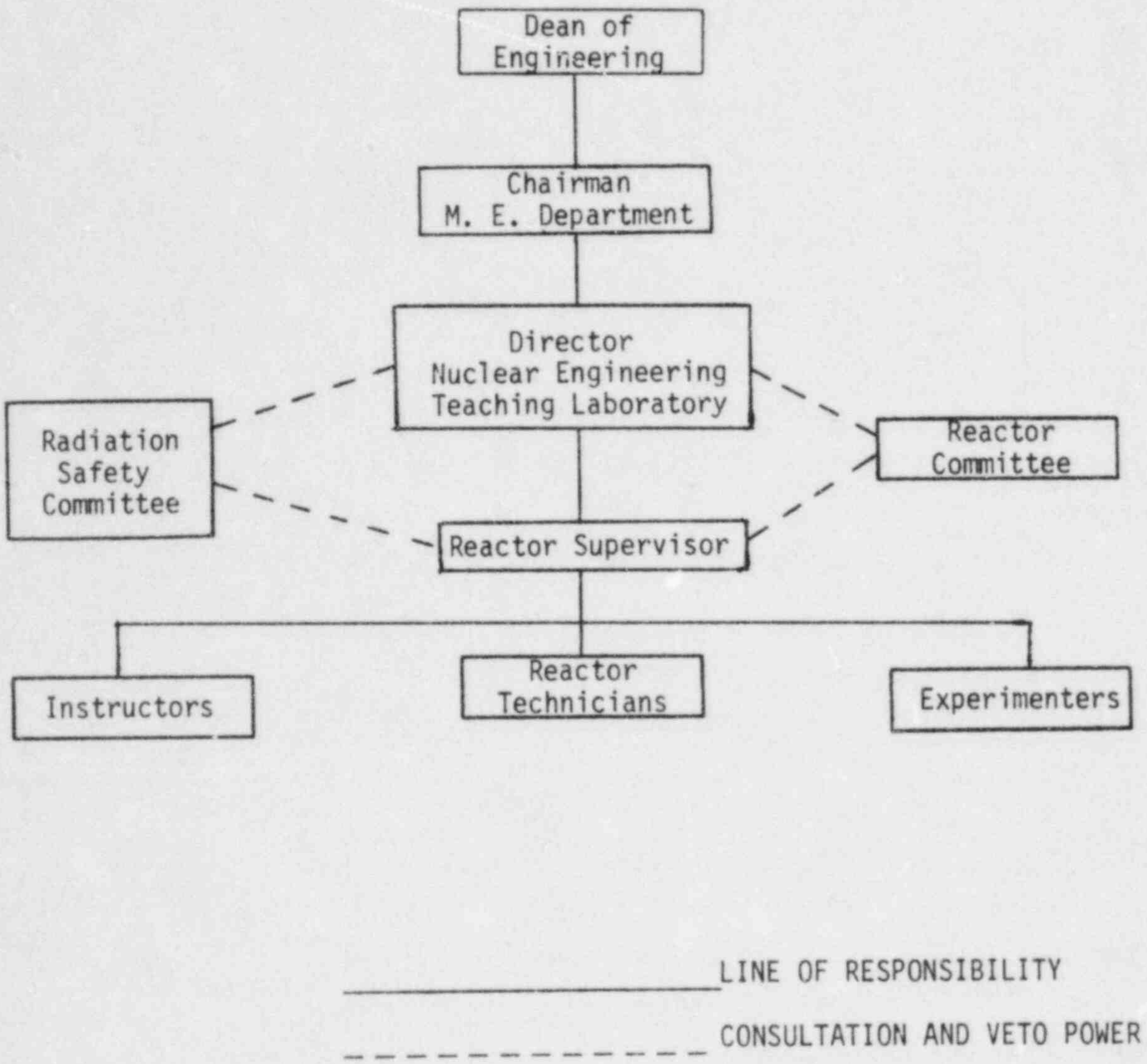


Fig. 3 ORGANIZATIONAL CHART

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	D.H. Eppes
Radiochemist	F.Y. Iskander
Assistant Professor	N.E. Hertel
Administrative Secretary	B.J. Babich

Support Personnel

Safety Officer	H.W. Bryant

Graduate Assistants

M. Ally
A. Gaines
A. Patterson-Hine
T. Sanders
B. Kolda
R. Savage
E. Ibrahim
G. Polansky
L. Grater
N. Poor
D. Smith
R. Hartley

Student Assistants

J. Evans
T. Tran

Table 2
Standing Committees

Reactor Committee

Chairperson:	H. L. Marcus
Member:	N. E. Hertel
Member:	D. E. Klein
Member:	J. O. Ledbetter
Student Member:	R. D. Manteufel (Thru 8/31/84)
Student Member:	N.D. Poor (After 9/1/84)
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 (Thru 8/31/84)
Chairperson:	E. L. Sutton (After 9/1/84)
Member:	F. H. Bronson (Thru 8/31/84)
Member:	L. O. Morgan
Member:	D. E. Klein
Member:	R. L. Shipman
Member:	K. J. Caskey
Member:	G. Hoffman (After 9/1/84)
Ex officio member:	H. W. Bryant
Ex officio member:	P. T. Flawn

D. <u>Report to the College of Engineering</u>

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. Dr. Harris Marcus, Reactor Committee Chairman, summarized the activities during this period saying, "The program has again completed a busy, successful year. With the prospect of an upgraded facility at BRC, a great deal of enthusiasm exists within the Nuclear Engineering Teaching Laboratory."

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. B. J. Babich filled the Administrative Secretary position vacated by M. G. Morrison and D. H. Eppes filled the Nuclear Technical Specialist position vacated by N. Povio. The remaining technical personnel remained unchanged. Key faculty and university support personnel also 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 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 700 persons were admitted into the reactor facility during the past year.

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.

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.

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 is located in the Engineering Science Building. 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

During the period no significant deviations from normal operating conditions were observed aside from the apparent failure and subsequent replacement of the Percent Power UCIC (uncompensated ionization chamber) described in the facility changes section. The facility emergency plan was approved by the Nuclear Regulatory Commission and implemented. Established operating procedures and other required procedures remained unchanged.

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 also occurred for radioisotope production. Maintenance during the period consisted primarily of routine equipment repair and adjustments.

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.

D. Maintenance

During this reporting period maintenance consisted primarily of routine repair and adjustment.

TABLE 4

REACTOR SCRAMS

Intentional	--	6
Operator Error	--	2
Instrument Error	--	3
Power Outage	--	0
Safety	--	0
Total	--	11

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	'84
4	7	5	9	11	12	7	7	8	6	5

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

TABLE 6

NUCLEAR ENGINEERING TEACHING LABORATORY

PERFORMANCE DATA, 1984

	Total Hours Reactor In Operation*	Total Burn-up (kW-hrs)	Number of Samples Irradiated
First Quarter 1984	54.4	6576	157
Second Quarter 1984	46.4	5776	141
Third Quarter 1984	43.5	6504	185
Fourth Quarter 1984	35.3	5950	184
TOTAL	179.6	24806 (1.03 MWD)	667

---

*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
1984	179.6	24,806	667
TOTAL	4,205.2	524,878	17,526
		(21.9 MWD)	

---

*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.

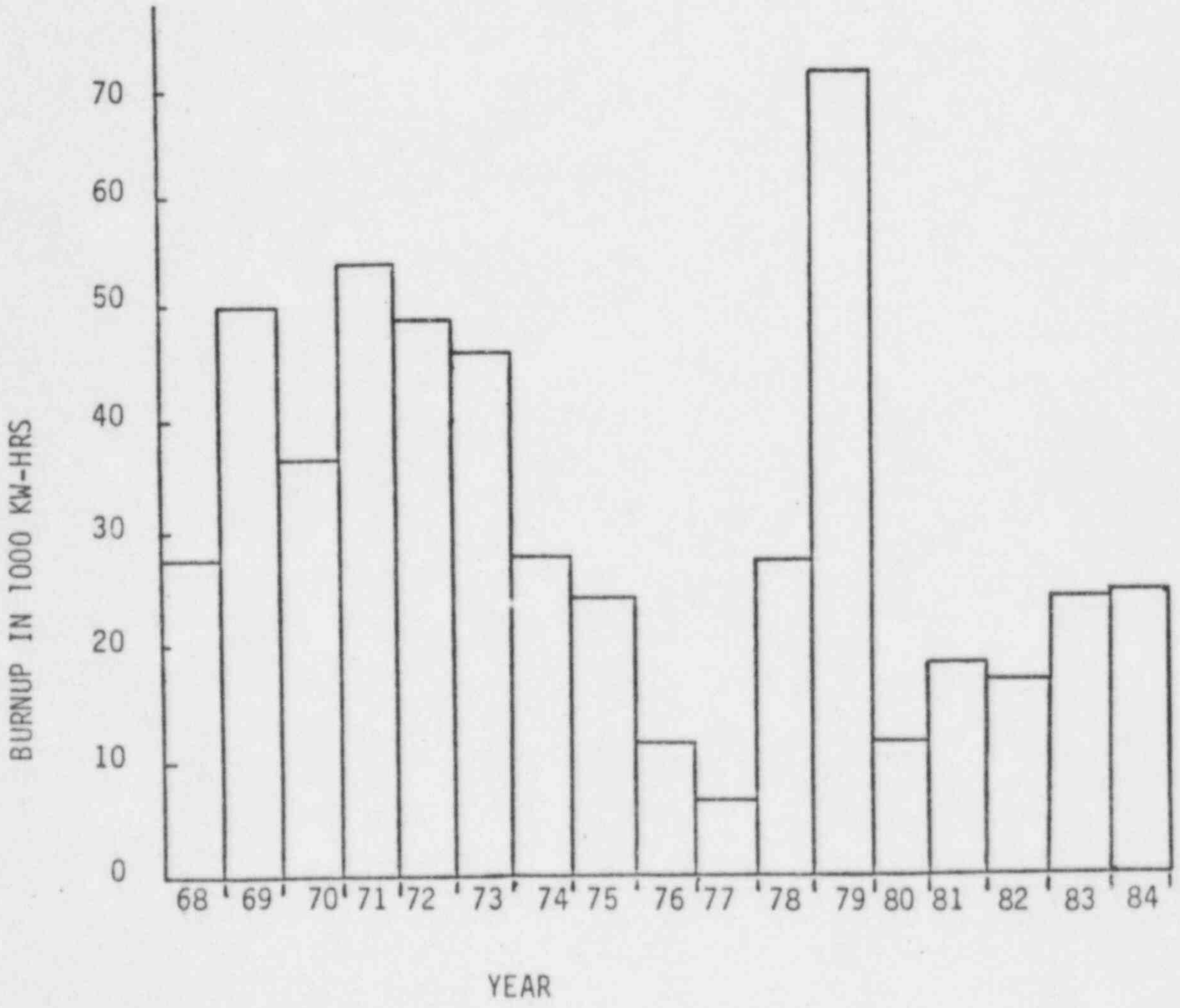


Fig. 4 TOTAL BURNUP PER YEAR

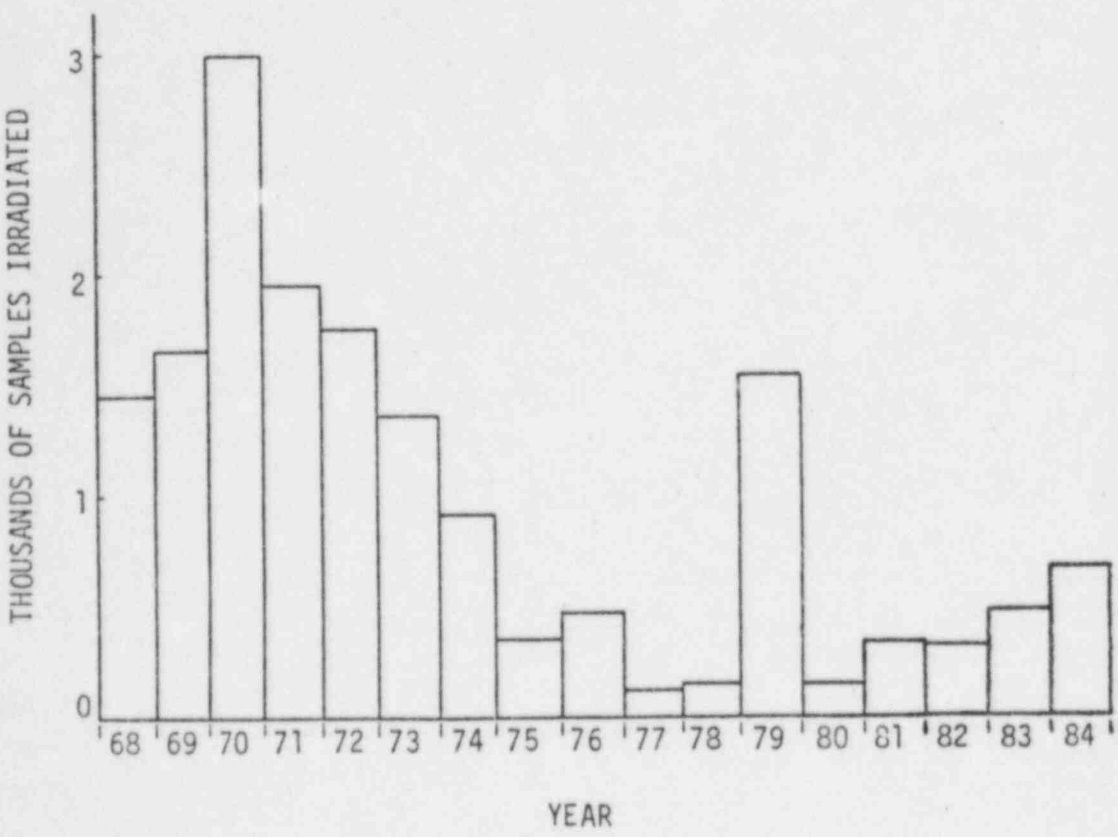


Fig. 5 NUMBER OF SAMPLES IRRADIATED

E. Facility Changes

The uncompensated ionization chamber in the percent power channel was replaced with a compensated ionization chamber. The replacement chamber had previously operated as the log power channel before installation of the wide range fission chamber. Replacement of the uncompensated ionization chamber was indicated by several sporadic decreased readings of power level (~5% low) and subsequent measurement of chamber impedance. Resistance measurements supported the indication that an insulation, connector, or chamber condition may have caused the observed loss of sensitivity. No unreviewed safety questions are presented by replacement of the defective chamber.

Operation of the reactor in the pulse mode has been discontinued until the operation characteristics of the compensated chamber as related to pulsing is established. This evaluation is a low priority since current activities of the facility do not require pulsing and future facility operation will be re-evaluated in relation to the new facility proposal.

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.

H. Radioactive Effluents

1. Liquid Waste

No liquid radioactive waste was discharged during the reporting period.

TABLE 8

SUMMARY OF RADIATION EXPOSURE

Range of Exposure in REM	Number of Individuals		
	Staff	Students	Visitors
Non-measurable exposure	13	21	720
0.0 - 0.1	0	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	$\leq 10^{(1)}$	$\leq 10^{(1)}$
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	1×10^{-3}	1×10^{-1}
Wall Near Water Purification System	7×10^{-3}	6×10^{-1}
Ceiling Directly Above Reactor Pool	6×10^{-2}	5×10^{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.

TABLE 11

LABORATORY CONTAMINATION LEVELS

Location	Average	Maximum
Floor	$\leq$ 25 dpm	$\leq$ 50 dpm
Work Surfaces	$\leq$ 25 dpm	$\leq$ 50 dpm
Pool Water (1)	$\leq$ 112 pCi/ℓ	$\leq$ 500 pCi/ℓ

(1) Measured when reactor not operating.

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	0.04
4	0.01	0.01
5	0.01	0.01
6	0.01	0.01
Waller Creek (2)	8 pCi/ℓ	32 pCi/ℓ

(1) Monitoring locations shown in Figure 6.

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

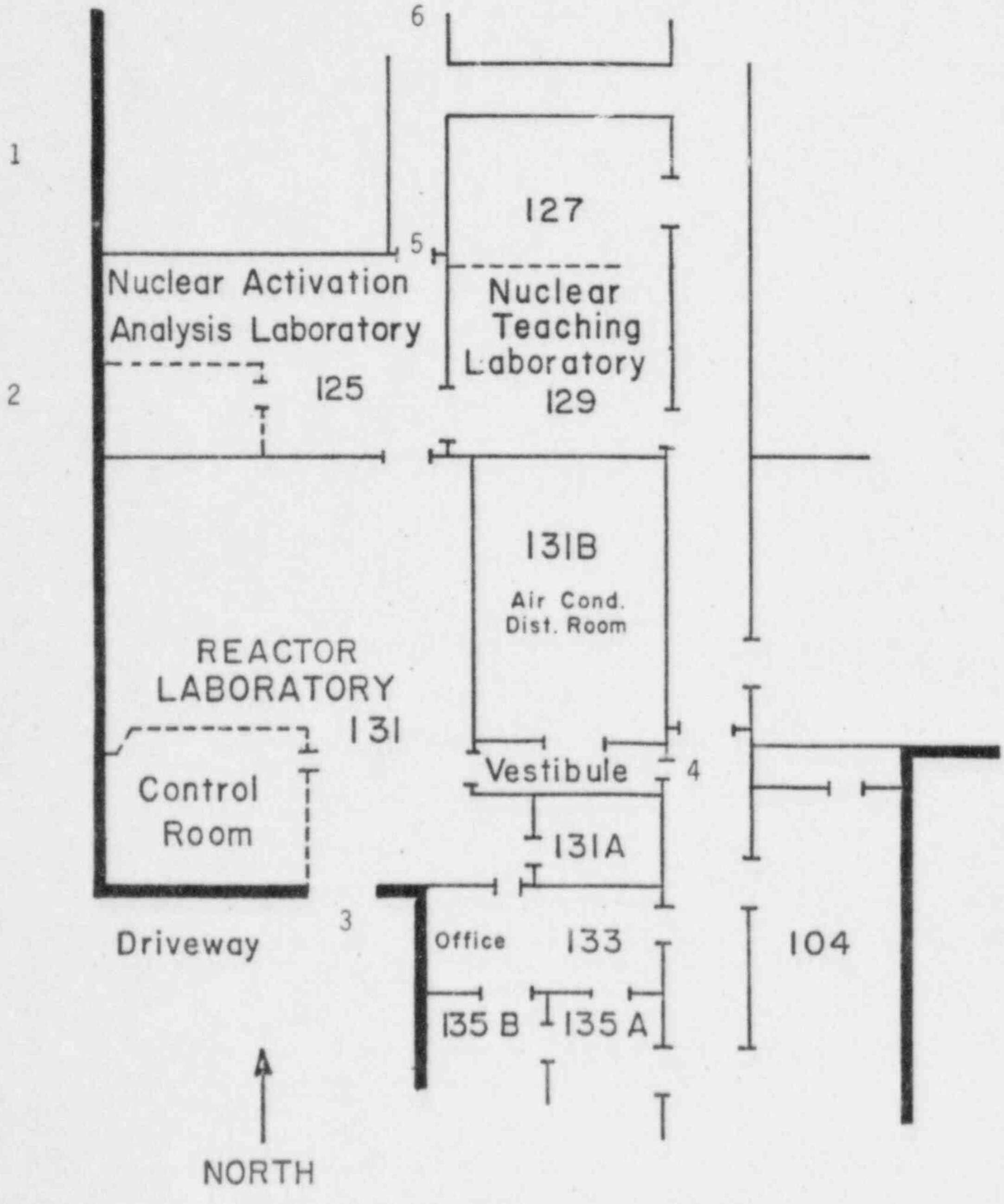


Fig. 6 TAYLOR HALL ENVIRONMENTAL SURVEY LOCATIONS

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, an effective air change rate of two per hour (0.37 m^3/sec) is assumed with dilution at the release point (0.14 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	Total Estimated Radioactivity Released (Curies) (μCi)	Total Estimated Quantity of Argon-41 Released (Curies) (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 (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.	258	258	1.4×10^{-11}	3.4×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
Feb.	1176	1176	6.3×10^{-11}	1.6×10^{-1}	None	Not Applicable	Not Applicable	Not Applicable
March	4	4	2.5×10^{-13}	6.2×10^{-4}	None	Not Applicable	Not Applicable	Not Applicable
April	345	345	1.8×10^{-11}	4.6×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
May	213	213	1.1×10^{-11}	2.8×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
June	706	706	3.8×10^{-11}	9.4×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
July	11	11	6.1×10^{-13}	1.5×10^{-3}	None	Not Applicable	Not Applicable	Not Applicable
August	761	761	4.1×10^{-11}	1.0×10^{-1}	None	Not Applicable	Not Applicable	Not Applicable
Sept.	651	651	3.5×10^{-11}	8.7×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
Oct.	Ø	Ø	Ø	Ø	None	Not Applicable	Not Applicable	Not Applicable
Nov.	668	668	3.6×10^{-11}	8.9×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
Dec.	635	635	3.4×10^{-11}	8.5×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable
ANNUAL VALUE	5428	5428	2.9×10^{-11}	6.0×10^{-2}	None	Not Applicable	Not Applicable	Not Applicable

TABLE 14

ANNUAL SUMMARY OF SOLID WASTE DISPOSAL

Activity	Volume	Shipment Date [1]
45 µCi	2 ft^3	March 5, 1985

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

V. Laboratory Inspections

A. NRC Inspection February 27, 1984

The inspection examined the activities conducted under license SNM-180. The inspection consisted of selective examination of procedures and representative records, interviews with personnel and observations by the inspector. During the scope of the inspection, one violation was identified. The violation originated from difference in the frequency and allowable tolerance specified on calibrations of survey instruments as stated in License R-92 and License SNM 180. Until this difference is eliminated, calibrations shall be performed to meet the more stringent requirement as stated in license SNM 180.

B. TDH Inspection September 17-18, 1984

The inspection consisted of a review of activities and radioactive materials used at The University of Texas at Austin 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 1984 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 1984, 720 persons visited the laboratory. The largest group visiting the laboratory were persons attending the Texas Energy Science Symposium. 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 several local high schools and students from several 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 facility to remain familiar with the laboratory and emergency response procedures unique to the facility.

VII. Research Activities

The Nuclear Engineering Teaching Laboratory pursues 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. Heat Transfer and Friction Factor Analysis for Artificially 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
University Research Institute

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

TABLE 15

RESEARCH FUNDING

Texas Atomic Energy Research Foundation	
1/83 - 8/84	18,386
9/82 - 8/84	33,732
Department of Energy -- Fuel Program	------
Center for Energy Studies	
5/82 - 5/84	10,000
9/83 - 8/84	6,600
6/84 - 8/84	1,400
National Science Foundation	
2/81 - 7/84	76,376
Texas Low Level Radioactive Waste Disposal Authority	
9/84 - 8/85	9,736
University of Texas	
College of Engineering Equipment Fund 9/83 - 8/84	21,400
Center for Fusion Engineering	
5/83 - 5/84	38,094
DOE Fellowship Program	
(Institutional Allowance)	4,000
University Research Institute	
9/84 - 8/85	6,000
TOTAL	$225,724

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.

D. 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.

E. 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.

F. 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.

G. Calcium Content in Cereal Matter

Personnel: F.Y. Iskander, NETL
M.M. Morad, Texas A&M

Sponsored by: Texas A&M University

Description:

Traditional method for tortilla and most corn snack-based food involve cooking of corn with calcium hydroxide for 12 - 18 hours. A new method, pre-soaking technique, was introduced in which a 12 hour steeping step was followed by 80 minutes of cooking. By this method, up to 40% of energy expended during alkali cooking of corn can be achieved and produce a similar quality product. INAA was employed to evaluate Ca content of starting material, during cooking and in the final product.

H. 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.

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

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

J. 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.

K. 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.

L. 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.

M. 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.

N. 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.

O. Neutron Transport Studies: Neutron Multiplication by Beryllium

Personnel: Nolan E. Hertel, NETL
Center for Fusion Engineering

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.

P. Thermal Analysis of Nuclear Shipping Containers

Personnel: Randy Manteufel, NETL
Dale E. Klein, NETL

Sponsored by: Sandia National Laboratories

Description:

The thermal analysis of shipping containers to be used in the transport of spent nuclear fuel is an important safety issue. Sandia National Laboratories has been involved in safety issues for the transport of nuclear material for many years. The University of Texas at Austin (NETL) has been involved in the specific issues of thermal analysis of these containers for several years. The current project is intended to benchmark a thermal analysis code (Q/TRAN) and pre and post processing software PATRAN-G using four standard model problems. Comparisons will be made with other applicable codes currently available at UT (including HEATING 5). Sensitivity studies will be performed to further evaluate Q/TRAN's suitability for thermal analysis. Enhancements, if any, that will increase the current capabilities of the software will be suggested and developed if feasible.

Q. Determination of Trace Element Impurities in Aspirin Tablets

Personnel: Felib Y. Iskander, NETL
Dale E. Klein, NETL
Thomas L. Bauer, NETL

Sponsored by: Nuclear Engineering Teaching Laboratory

Description:

Twenty-five trace and minor elements in five differenc aspirin brands were determined. The results were compared to literature values.

R. Determination of 25 Elements in T xas Hard Red Winter Wheat and Its Milling Fractions.

Personnel: Felib Y. Iskander, NETL

Sponsored by: Nuclear Engineering Teaching Laboratory
Texas A&M University

Description:

Five varieties of hard red winter wheat (Scout 66, Coker 767, Vona, TAM101 and TAM105) grown in Texas, 1982 were milled and separated into six fractions using U.S. standard sieves. Twenty-five elements were determined in each fraction as well as in the whole wheat. Protein, in vitro protein digestibility and ash content of each fraction were also determined. Correlation between the results was studied.

S. Vanadium Sorption by Crude Oil

Personnel: Felib Y. Iskander, NETL
F.S. Jacobs, ODU

Sponsored by: Nuclear Engineering Teaching Laboratory
University of Old Dominion (Virginia)

Description:

Crude oil and ashphaltenes samples were equilibrated with vanadium salt solutions then separated into petroleum and aqueous phases. Each phase was analyzed for vanadium by INAA. Sorption of VO_2^+ occurs to a greater extent than the sorption of VO^+. The effect of pH, presence of other ions and oil-to-aqueous volume ratio was studied. Three crude oil samples were used (Jobo, Tia Juana and Bachaquero) and one asphaltene (Jobo).

T. Determination of Lanthanum in Soil Samples

Personnel: Felib Y. Iskander, NETL
Thomas L. Bauer, NETL
J. Rhodes, (CSI)

Sponsored by: Nuclear Engineering Teaching Laboratory
Columbia Scientific Industries

Description:

The use of rare earth elements (e.g., La) as an indicator in oil exploration was the prime target in this study. Several samples were activated and the activity of ^{141}La was measured.

U. Determination of Toxic and Other Elements in Rain Sediment Collected in Nigeria

Personnel: Felib Y. Iskander, NETL
Bode Asubiojo, U of Ife

Sponsored by: Nuclear Engineering Teaching Laboratory
University of IFE (Nigeria)

Description:

Rainfall, after drought season, washes out the suspended dust and air particulates. Twenty-seven (27) elements were determined in six samples collected at different locations.

V. <u>Analysis of Soil Samples from South America</u>

<u>Personnel</u>: Thomas L. Bauer, NETL
Felib Y. Iskander, NETL

<u>Sponsored by</u>: Center for Maximum Potential Building Systems

<u>Description</u>:

Clay samples in different locations were analyzed for Al, Mg, K, Na and Ca to determine suitable components of certain minerals. Study supported applications of two types of mineral deposits for building construction in areas of low economic income.

W. <u>Measurement of Gold</u>

<u>Personnel</u>: Felib Y. Iskander, NETL

<u>Sponsored by</u>: Nuclear Engineering Teaching Laboratory
H.S. Jackson Sand & Gravel, Inc.
Irving, Texas 75061

<u>Description</u>:

Different methods were used to extract gold and other precious metals. Several samples that represents the extraction steps were analyzed to identify the efficiency of these methods. The concentration of gold ranged from 15 ng g^{-} to 800 μg g^{-1}.

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.

9. R.D. O'Dell, "The Angular Thermal Neutron Spectrum in the Vicinity of the Interface Between Two Media", Ph.D. Dissertation, The University of Texas, 186 pp., January 1965.

10. B.E. Thompson, Sr., "Cryogenic Neutron Spectra Measurements Across a Discontinuity in Temperature and Properties", Ph.D. Dissertation, The University of Texas, 149 pp., January 1965.

11. R.S. Kolflat, "An Experimental Approach to the Study of Nucleonic Fundamentals", Masters Thesis, Mechanical Engineering Department, The University of Texas, 190 pp., May, 1965.

12. D.G. Anderson, "A Technique for Recoil Fission Fragment Range Measurements", Health Physics, Vol. 12, No. 4, 558, April 1966.

13. J.B. Whitworth, "A Cryogenic Irradiation Device for the TRIGA Mark I Nuclear Reactor", Masters Thesis, Mechanical Engineering Department, The University of Texas, 52 pp., January 1967.

14. D.A. Pullen, " A Rod Oscillator Design and Zero Power Transfer Function Measurement for a TRIGA Mark I Reactor," Masters Thesis, Mechanical Engineering (Nuclear Engineering), The University of Texas, January, 1967.

15. G.F. Malan, "Transfer Function Analysis of Temperature and Xenon Feedback in Coupled-Core Nuclear Reactor Systems", Masters Thesis, Mechanical Engineering Department, The University of Texas, 69 pp., August 1967.

16. M.G. Stevenson, "Investigations on the Macroscopic Nodal Approach to Space-dependent Nuclear Reactor Kinetics", Ph.D. Dissertation, The University of Texas, 203 pp., August 1968.

17. F.H. Antunez-Castillo, "Gamma Radiation Dosimetry Techniques and Application to Mapping of The University of Texas Cobalt-60 Irradiation Facility", Masters Thesis, Physics Department, The University of Texas, 60 pp., September 1968.

18. R. Valiente, "Neutron Radiography with the University of Texas TRIGA Nuclear Reactor", Masters Thesis, Physics (Nuclear Engineering), The University of Texas, August 1968.

19. P.J. Rodriguez and D.H. Nguyen, "Time Decay Constants in Pulsed Multiplying Media", Trans. Amer. Nucl. Soc. 11:1, 289 (June 1968).

20. P.J. Rodriguez and D.H. Nguyen, "The Maximum Eigenvalue in the Pulsed-Neutron Initial-Value Problem", Trans. Amer. Nucl. Soc. 11:2, 578 (November 1968).

21. P.J. Rodriguez and D.H. Nguyen, "Contribution of the Continuum to the Neutron Transient Behavior in a Pulsed Multiplying Cylinder", Trans. Amer. Nucl. Soc., 11:2, 582 (November 1968).

22. G.D. Bouchey and S.J. Gage, "Neutron Radiography with a Small Subcritical Reactor", Trans. Am. Nucl. Soc., 12, 462-463, 1969.

23. G.D. Atkinson, Jr., W. Coltharp, R. Cramatges, E. Oelkers, D.A. Roberts, K.R. Waid, S.H. Gage, and B.V. Koen, "Project Atlantis: A Design of the Nuclear Power Supply for an Undersea City", Proceedings of the Offshore Technology Conference, Dallas, Texas (1969).

24. J.A. Villalobos, "A Study of Gamma Radiation Dosimetry Techniques and Application to Radiation Field Mapping", Masters Thesis, Physics Department (Nuclear Engineering), The University of Texas, January 1969.

25. M.A. Zuniga, "Delayed Neutron Counting Technique for Uranium Determination", Masters Thesis, Physics Department (Nuclear Engineering), The University of Texas, January 1969.

26. V. Chanto, S.J. Gage, and D.F. Barker, "Chlorine and Bromine Concentrations in Some Haliburton-Bancroft Rocks and Minerals by Neutron Activation Analysis", 1969.

27. M. Gallardo, S.J. Gage, and D.F. Barker, "Trace Elements in Quartz by Nondestructive Neutron Activation Analysis", 1969.

28. G.D. Atkinson, Jr., "Investigation of the Dynamic Behavior of a Two-Region Subcritical Reactor", Masters Thesis, Mechanical Engineering (Nuclear Engineering), The University of Texas, January 1969.

29. M. Gallardo, "Trace Elements in Six Quartz Samples by Nondestructive Neutron Activation Analysis Technique," Masters Thesis, Physics Department (Nuclear Engineering), The University of Texas, January 1969.

30. F.A. Rodriguez, S.J. Gage, and K.M. Ralls, "Nondestructive Neutron Activation Analysis for Trace Impurities in Niobium", Seventh Symposium on Nondestructive Evaluation of Components and Materials in Aerospace, Weapon Systems, and Nuclear Applications, San Antonio, Texas (1969).

31. S.J. Gage and M. Zuniga, "Uranium Trace Analysis by Pulsed Reactor Irradiation", Radiation and Isotope Technology in Latin American Development, American Nuclear Society Topical Meeting, San Juan, Puerto Rico, May 4-6, 1969.

32. R.H. Richardson, "Migration, and Enzyme Polymorphisms in Natural Populations of Drosophila", Jap. J. Gen., (in press), 1969.

33. R.H. Richardson, R.J. Wallace, Jr., S.J. Gage, G.D. Bouchey, and Margaret Denell, "Neutron Activation Techniques for Drosphila in Natural Populations", Studies in Genetics, Marshall R. Wheeler Ed., The University of Texas Press, Austin, Texas 1969.

34. G.D. Bouchey and S.J. Gage, "Development and Potential Utilization of a Neutron Radiography Facility at The University of Texas NuclearReactor Laboratory", Seventh Symposium on Nondestructive Evaluation of Components and Materials in Aerospace, Weapons Systems, and Nuclear Applications, San Antonio, Texas (1969).

35. G.D. Bouchey and S.J. Gage, "Utilization of the University of Texas TRIGA Reactor for Neutron Activation Analysis Service", ANS/CNA Transactions (11) p. 287, 1968.

36. G.D. Bouchey and G. Gjerstad, "Chemical Studies of Aloe-Vera Juice -- II Inorganic Ingredients", Quarterly Journal of Crude Drug Research, Vol. 9, No. 4 (1969).

37. S.J. Gage, R.H. Richardson, and G.D. Bouchey, "Neutron Activation Techniques for Labeling of Insects with Stable Elements", Trans. Am. Nucl. Soc., 12, 495-496, (1969).

38. F.G. Pasos, "Nondispersive X-Ray Fluorescence Analysis Using a Lithium-Drifted Germanium Detector", Masters Thesis, Physics Department, The University of Texas, 54 pp., January 1969.

39. P.J. Rodriguez, "Time and Energy Dependent Neutron Distribution in a Pulsed Multiplying Medium", Ph.D. Dissertation, The University of Texas, 205 pp., January 1969.

40. G.D. Bouchey, B.V. Koen, C.S. Beightler, "The Optimal Allocation of Energy in Industrial and Agro-Industrial Complexes Using Dynamic Programming", Nucl. Sci. and Engr., Vol. 41, 70-78 (1970).

41. G.F. Malan and B.V. Koen, "A Nonlinear Programming Approach to Optimal Control of Nuclear Reactors", Trans. Am. Nucl. Soc., November 1970.

42. M.G. Stevenson and S.J. Gage, "Application of a Coupled Fission Mode Approach to Modular Reactor Kinetics", Journal of Nucl. Energy, Vol. 24, pp. 1-10. Pergamon Press 1970. Printed in Northern Ireland.

43. G.D. Bouchey and S.J. Gage, "Neutron Radiography at The University of Texas Nuclear Reactor Laboratory", Isotopes and Radiation Technology 1, 294-296 (Spring 1970).

44. D.G. Jopling, "The Politics of Nuclear Reactor Siting", Masters Thesis, Mechanical Engineering, The University of Texas, December 1970.

45. A.H. Urdaneta, "A Programmed Associative Analyzer", Masters Thesis, Mechanical Engineering (Nuclear Engineering), The University of Texas, December 1960.

46. G.D. Bouchey and S.J. Gage, "Detection and Location of Leaking TRIGA Reactor Fuel Elements", GA Publication T-117, Papers and Abstracts, TRIGA Reactor Owners' Seminar, February 19-20, 1970 (Denver, Colorado) p. 43.

47. G.D. Bouchey and S.J. Gage, "Neutron Radiography with a Small Subcritical Assembly", International Journal of Nondestructive Testing, (1970).

48. G.D. Atkinson, Jr., J.B. Whitworth, and S.J. Gage, "NAACOL--A Spectrum Analysis Routine for the Small Laboratory", 21st Mid-America Symposium on Spectroscopy, Chicago, Illinois (1970).

49. S.J. Gage, G.D. Atkinson, Jr., J.B. Whitworth, and A.H. Pradzynski, "Computer-Aided Multielement Gamma Ray Analysis with a Compton Suppressed Ge(Li) Radiation Source", Ninth National of the Society of Applied Spectroscopy, New Orleans, Louisiana, October 5-9, 1970.

50. K.R. Waid, "Solid State Radiation Detection Devices: Fabrication, Techniques and Application to Nuclear Engineering", Masters Thesis, Mechanical Engineering (Nuclear Engineering), The University of Texas, January 1970.

51. V.H. Chanto, "Neutron Activation Analysis of Chlorine and Bromine in Some Haliburton-Bancroft Rocks and Minerals", Masters Thesis, Physics (Nuclear Engineering), The University of Texas, January 1970.

52. J.J. Chromik and E.L. Draper, Jr., "Energy Integral Tests of Differential Fission Cross Section Data", Trans. Am. Nucl. Soc., Vol. 13, No. 2, p. 755 (1970).

53. R.J. Gramatges-Figueras, "Neutron Waves in Cylindrical Geometries for a Subcritical Reactor", Masters Thesis, Mechanical Engineering Department, The University of Texas, 98 pp., May 1970.

54. E. Oelkers, Jr., "A Learning Method for Identification of Nuclear Reactor Point Dynamics", Masters Thesis, Mechanical Engineering Department, The University of Texas, pp. 165, August 1970.

55. F.A. Rodriguez-Gonzalez, "Application of Neutron Activation Analysis to the Study of Interstitial Solid Solution of Oxygen in Niobium and in Niobium-Titanium Alloys", Ph.D. Dissertation, The University of Texas, 131 pp. August 1970.

56. J.R. Deen, "Calculation of Resonance Integrals Using the Intermediate Resonance Approximation", Masters Thesis, Mechanical Engineering Department, The University of Texas, 140 pp., January 1970.

57. C.T. Rombough, "Application of Queueing Theory to Closed-Loop Computer-Reactor Control Systems", Masters Thesis, Mechanical Engineering Department, The University of Texas, 78 pp., December 1970.

58. A.H.U. Bohorquez, "A Programmed Associative Analyzer", Masters Thesis, Mechanical Engineering Department, The University of Texas, 98 pp. December 1970.

59. S.J. Gage and D.G. Jopling, The Nuplex Concept: Potential for the SINB Region, Southern Interstate Nuclear Board, 250 pp., March 22, 1971.

60. G.F. Malan and B.V. Koen, "Application of Nonlinear Programming to the Optimal Control of a Point Model Nuclear Reactor", Nucl. Sci. and Engr., (1971).

61. G.D. Bouchey, B.V. Koen, and C.S. Beightler, "Optimization of Material Safeguards Sampling System", Trans. Am. Nucl. Soc., Winter Meeting, (1971).

62. A.H. Pradzynski and S.J. Gage, "Nondestructive Identification of Material by Nondispersive X-Ray Fluorescence Spectroscopy Using Si(Li) Detectors and Radioisotopic Sources", Proc. Eighth Symposium on Nondestructive Evaluation in Aerospace, Weapons Systems, and Nuclear Applications, San Antonio, Texas (1971).

63. G.D. Atkinson, Jr., and S.J. Gage,"Uranium Assay by Delayed Gamma Ray Analysis Following Cf-252 Neutron Interrogation", Proc. Twelfth Annual Meeting Institute of Nuclear Materials Management, Plam Springs, Florida (July 1971).

64. S.J. Gage, E. Linn Draper, Jr., G.D. Bouchey, and R.R. Day, "Design and Construction of a Versatile Cf-252 Source Shield and Experimental Facility", Neutron Sources and Applications, CONF-710402, Vol. 2, Proc. of ANS Topical Meeting, Augusta, Georgia, April 19-21, 1971.

65. D.G. Jopling and S.J. Gage, "Public Resistance to Nuclear Reactor Siting", Nuclear News, 14:3, 32-35 (March 1971).

66. J.B. Whitworth, G.D. Atkinson, and S.J. Gage, "Some Recent Applications of Nuclear Analysis Techniques to Typical Forensic Evidence" 23rd Annual Program American Academy for Forensic Sciences, Phoenix, Arizona (February 25, 1971).

67. G.D. Bouchey, E. Linn Draper, Jr., B.V. Koen, and C.S. Beightler, "Multiple Foil Activation Spectrum Determination Using a Numerical Direct Search Technique", Trans. Am. Nucl. Soc., Vol. 14:2, pp. 667-668, (October 1971).

68. G.D. Bouchey, B.V. Koen, and C.S. Beightler, "The Optimization of Nuclear Systems by Geometric Programming, Nucl. Sci. and Engr. 44, 267-272 (1971).

69. G.D. Bouchey, B.V. Koen, and C.S. Beightler, "Optimization of Nuclear Materials Safeguards Sampling Systems by Dynamic Programming", Nuclear Technology 12, 18-25 (1971).

70. S.J. Gage, G.D. Atkinson, Jr. and G.D. Bouchey, "Cyclic Neutron Activation Analysis with a Cf-252 Neutron Source", Trans. Am. Nucl. Soc., (October 1971).

71. E. Linn Draper, Jr., "Integral Reaction Rate Determination Part I: Tailored Reactor Spectrum Preparation and Measurement", Nuclear Science and Engineering, 46, 22, (1971).

72. E. Linn Draper, Jr., "Integral Reaction Rate Determinations Part II: Fission Rate Measurements", Nuclear Science and Engineering, 46, 31, (1971).

73. G.D. Bouchey and S.J. Gage, "Detection and Location of Leaking TRIGA Reactor Fuel Elements", Nuclear Technology, 10, 211-214 (1971).

74. G.D. Bouchey and S.J. Gage, "Neutron Radiography with a Small Subcritical Reactor", Int. J. of Nondestructive Testing, 2, 335-353, (1971).

75. G.D. Bouchey and S.J. Gage, "The Economics of Subcritical Radiography", Trans. Am. Nucl. Soc., 14, 123 (1971).

76. G.D. Bouchey, E. Linn Draper, Jr., and S.J. Gage, "Neutron Radiography with Cf-252: The Effect of Tailoring Neutron Energy Spectra on Photogrpahic Images", Neutron Sources and Applications, CONF-210402, Vol. 3, Proc. ANS Topical Meeting, Augusta, Georgia, April 19-21, 1971.

77. G.D. Atkinson, Jr., J.B. Whitworth, and S.J. Gage, "Computer-Assisted Analysis of Gamma-Ray Spectra", Computer Physics Communications, 2, 40-46 (1971).

78. S.J. Gage, E. Linn Draper, Jr., and G.D. Bouchey, "Recent Developments in Radioisotopic Source Neutron Radiography", Proc. Eighth Symposium on Nondestructive Evaluation in Aerospace, Weapon Systems, and Nuclear Applications, San Antonio, Texas (1971).

79. G.D. Atkinson, Jr., "Nondestructive Uranium Assay by Delayed Gamma Ray Analysis Following Californium-252 Neutron Interrogation", Ph.D. Dissertation, The University of Texas, 183 pp., August 1971.

80. G.D. Bouchey, "The Optimization of Nuclear Systems", Ph.D. Dissertation, The University of Texas, 231 pp., August 1971.

81. J.B. Whitworth, "The Development and Application of a Systematic Approach to Elemental Analysis in Forensic Investigations", Ph.D. Dissertation, The University of Texas, 223 pp., December 1971.

82. J.J. Chromik, "Experimental Determination of the Neutron Flux in the University of Texas Californium-252 Irradiation Facility", Masters Thesis, Mechanical Engineering Department, The University of Texas, 85 pp. December 1971.

83. E. Linn Draper, Jr., Mary Elizabeth Foster and G.D. Bouchey, "X-Ray Fluroescence Analysis and Neutron Activation Analysis in an Analytical Chemistry Laboratory", presented at the Combined Meeting of the Texas Association for Radiation Research and South Central Photobiology Group, Houston, Texas, November 5-6, 1971.

84. E. Linn Draper, Jr. and G.D. Bouchey, "Utilization of a Portable Californium-252 Source for Neutron Activation Analysis and Neutron Radiography", Presented at the Combined Meeting of the Texas Association for Radiation Research and South Central Photobiology Group, Houston, Texas, November 5-6, 1971.

85. E. Linn Draper, Jr. and J.J. Chromik, "Production and Measurement of a Reference Spectrum in a Versatile Experimental Facility", Trans. Am. Nucl. Soc., Volume 15:1, p. 157, 1972.

86. E. Linn Draper, Jr. and Andrzej H. Pradzynski, "Identification of Alloys by Energy Dispersive X-Ray Spectroscopy", Ninth Symposium on Nondestructive Evaluation (1972).

87. M.B. Owen, "Fuel Management Using Dynamic Programming", Masters Thesis Mechanical Engineering Department, The University of Texas, 59 pp. May 1972.

88. C.E. Brauer, "Thermal Neutron Radiography with a Lithium-Lead Collimator-Filter", Masters Thesis, Mechanical Engineering Department, The University of Texas, 64 pp., May 1972.

89. J.L. Macdonald, "Heuristic Learning Control for Nuclear Reactors", Masters Thesis, Mechanical Engineering Department, The University of Texas, 131 pp. August 1972.

90. J. Freim, "Theoretical and Experimental Evaluation of Nuclear Data and Calculation Techniques for Fusion Reactor Blanket Design", Ph.D. Dissertation, The University of Texas, 210 pp., December 1972.

91. S.G. Barbee, "Neutronic Calculations in a Simulated Fusion Reactor Blanket", Masters Thesis, Mechanical Engineering Department, The University of Texas, 259 pp., November 1972.

92. D.G. Anderson, "Fission Product Mass-Yield Measurements from Intermediate Energy Neutron Fission of Plutonium-239 and Plutonium-241", Ph.D. Dissertation, The University of Texas, 125 pp., December 1972.

93. D.M. Williams, "Identification of Thermal Feedback Parameters for a TRIGA Mark I Reactor", Masters Thesis, Electrical Engineering Department, The University of Texas, 53 pp., December 1972.

94. G.D. Atkinson, Jr. E. Linn Draper, Jr., and G.D. Bouchey, "Subcritical TRIGA Reactivity Measurements Using the Source Jerk Technique", TRIGA Owner's Conference II, College Station, Texas (1972).

95. G.D. Atkinson, Jr., and E. Linn Draper, Jr., "Transient Rod Failure in a Pulsing TRIGA Mark I Reactor", TRIGA Owner's Conference II, College Station, Texas (1972).

96. G.D. Atkinson, Jr., "A Safeguards Minicourse", 18th Annual Meeting of the American Nuclear Society, Las Vegas, Nevada (1972).

97. G.D. Atkinson, Jr., E. Linn Draper, Jr., G.D. Bouchey, and S.J. Gage, "Radioisotopic Source Amplification Using a Heterogeneous Subcritical Assembly", Proc. 18th Annual Meeting of the American Nuclear Society, Las Vegas, Nevada (1972).

98. E. Linn Draper, Jr., and G.D. Atkinson, Jr., "Transient Rod Failure in a Pulsing TRIGA Mark I Reactor", published in proceedings of 2nd TRIGA Owner's Conference, February 1972.

99. E. Linn Draper, Jr., John W. Davidson, S.J. Gage, G.D. Bouchey, "A System for Reduction of ^{41}A Release from a Research Reactor Facility", Trans. Am. Nucl. Soc., Vol. 15:1, p. 4-5, (1972).

100. E. Linn Draper, Jr., et.al., "Standard for the Development of Technical Specifications for Research Reactors", Trans. Am. Nucl. Soc., (1972).

101. E. Linn Draper, Jr., G.D. Atkinson, Jr., and B.B. Tomlin, "A Radiography and Capture Gamma Ray Facility for Californium-252" Proceedings of the American Nuclear Society "Applications of Californium-252" National Topical Meeting, September 11-13, 1972.

102. E. Linn Draper, Jr., G.D. Bouchey, G.D. Atkinson, Jr., and S.J. Gage, "A Versatile Subcritical Assembly for Undergraduate Nuclear Engineering Instruction", Proceedings of the American Nuclear Society "Applications of Californium-252" National Topical Meeting, September 11-13, 1972.

103. E. Linn Draper, Jr., and S.J. Gage, "The Fusion-Fission Breeder: Its Potential in a Fuel Starved Thermal Reactor Economy", 93rd Annual Meeting of the ASME, New York, New York (1972).

104. E. Linn Draper, Jr., "Technological Innovation and Assessment: A Novel Course for Nuclear Engineering", Winter Meeting of the American Nuclear Society, November 12-16, 1972.

105. D.T. Hall, E. Linn Draper, Jr., and P.S. Schmidt, "Management of the Transition to Nuclear Power Generation", Technical Report ESL-3, Energy Systems Laboratories, College of Engineering, The University of Texas at Austin, December 1972.

106. P.S. Schmidt and G.G. Park, "Heat Dissipation in a Power ylant Cooling Bay", ASME, Paper No. 72-WA/HT-61, November 1972.

107. P.S. Schmidt and G.P. D'Arch, "Entry Region Effects on Flow and Pressure Drop of Lithium in Fusion Reactor Blankets", Proceedings of the Texas Symposium on Technology of Controlled Thermonuclear Fusion Experiments and Engineering Aspects of Fusion Reactors, Austin, Texas (November 20-22, 1972).

108. E. Linn Draper, Jr., Charles Brauer, "Lithium-Lead Collimator Fabrication for Radioisotopic Source Neutron Radiography," Trans. Am. Nucl. Soc., Vol. 15:1, p. 142-143, (1972).

109. E. Linn Draper, Jr., James B. Freim, "Theoretical and Experimental Evaluation of Nuclear Data and Calculation Techniques for Fusion Reactor Blanket Design", Texas Symposium on the Technology of Controlled Thermonuclear Fusion Experiments and the Engineering Aspects of Fusion Reactors, November 20-22, 1972.

110. E. Linn Draper, Jr., "Status of CTR Related Integral Experiments" presented at the conference on "Nuclear Data and Neutronics of CTR Blankets" held in Seattle, Washington, September 19-21, 1972.

111. E. Linn Draper, Jr., "Fusion Reactor Engineering in the Nuclear Engineering Curriculum at The University of Texas at Austin", Trans. Am. Nucl. Soc. (1972).

112. E. Linn Draper, Jr., S.J. Gage, "The Fusion-Fission Breeder: Its Potential in a Fuel Starved Thermal Reactor Economy", presented at the Texas Symposium on the Technology of Controlled Thermonuclear Fusion Experiments and the Engineering Aspects of Fusion Reactors, November 20-22, 1972.

113. James B. Freim, E. Linn Draper, Jr., "Experimental Determination of the Fusion Spectrum in Graphite", Trans. Am. Nucl. Soc., (1972).

114. G.D. Atkinson, Jr., S.J. Gage, G.D. Bouchey, "Cyclic Activation with a Californium-252 Source", Nuclear Technology (1972).

115. G.D. Atkinson, Jr., "What You Always Wanted to Know About Californium Source Facilities", invited Ppaer, National Topical Meeting on the Applications of Californium-252, Austin, Texas (1972).

116. T.L. Bauer, G.D. Atkinson, Jr., "Discrimination Between Plutonium and Uranium by Gamma Ray Analysis Following Cf-252 Interrogation", National Topical Meeting on the Applications of Californium-252, Austin, Texas (1972).

117. E. Linn Draper, Jr., Editor, Proceedings of Texas Symposium on the Technology of Controlled Thermonuclear Fusion Experiments and the Engineering Aspects of Fusion Reactors, published by USAEC.

118. E. Linn Draper, Jr., Editor, Proceedings of the Implications of Nuclear Power in Texas, published by the Texas Atomic Energy Research Foundation.

119. E. Linn Draper, Jr., J.R. Deen, J.J. Chromik, "Measurement of the Integral Fission Cross Section of Th-232 in a Cf-252 Fission Neutron Spectrum," Trans. Am. Nucl. Soc. (1973).

120. D.G. Anderson, E. Linn Draper, Jr., "Fission Product Mass-Yield Measurements From Intermediate Energy Neutron Fission of Plutonium-239 and Plutonium-241", Trans. Am. Nucl. Soc., 1973.

121. E. Linn Draper, Jr., and James B. Freim, "Experimental Determination of the Fusion Spectrum in Graphite", Trans. Am. Nucl. Soc., 16, 9, (1973).

122. E. Linn Draper, Jr., "Fusion Reactor Engineering in the Nuclear Engineering Curriculum at The University of Texas at Austin", Trans. Am. Nucl. Soc., 16, 16 (1973).

123. E. Linn Draper, Jr., Theodore A. Parish, and Brian J. McArdle, "A Neutronic-Photonic Comparison of Vanadium and Niobium Containing Fusion Reactor Blankets", Trans. Am. Nucl. Soc., (November 1973).

124. John H. Vanston, Jr., "Use of Partitive Analytical Forecasting (PAF) Techniques for Fusion Development Analysis", Trans. Am. Nucl. Soc., (November 1973).

125. Theodore A. Parish and E. Linn Draper, Jr., "Neutronic and Photonic Analyses of Fusion Reactor Blankets Containing Thorium," Fifth Symposium on Engineering Problems of Fusion Research, Princeton, New Jersey, November 5, 1973.

126. C.E. Locke and D.R. Paul, "Graft Copolymer Modification of Polyethylene-Polystyrene Blends. I. Graft Preparation and Characterization". Journal of Applied Polymer Science, Vol. 17, pp. 2597-2617 (1973.)

127. C.E. Locke and D.R. Paul, "Graft Copolymer Modification of Polyethylene-Polystyrene Blends. II. Properties of Modified Blends", Journal of Applied Polymer Science, Vol. 17, pp. 2791-3800 (1973).

128. J.R. Deen, "Measurement of Fission Product Yields from Thorium-232 in a Californium-252 Fission Neutron Spectrum", Ph.D. Dissertation, The University of Texas at Austin, 141 pp., (May 1973).

129. L.D. Hansborough, "Overall Tritium Considerations for Controlled Thermonuclear Reactors", Masters Thesis, The University of Texas at Austin, 154 pp. (May 1973).

130. "M.E. Senglaub, "Cross Section Studies Based on the Statistical Model", Masters Thesis, The University of Texas at Austin, 109 pp., (August 1973).

131. E. Linn Draper, Jr., M.J. Voltin, Jr., J.L. Macdonald, C.T. Rombough, L.D. Hansborough, S.G. Barbee, and J.H. Vanston, Jr., "A University's Involvement in Municipal Decision-Making on Nuclear Power", Trans. Am. Nucl. Soc., (1973).

132. E. Linn Draper, Jr., J.L. Macdonald, and M.J. Voltin, Jr., "Nuclear vs. Coal: An Economic Comparison of Power Plant Economics in Texas", Trans. Am. Nucl. Soc., (1973).

133. R.E. Henry, "Forensic Applications of Neutron Activation Analysis", presented at the Combined Meeting of the Texas Association for Radiation Research and South Central Photobiology Group, San Marcos, Texas, November 9-10, 1973.

134. G.D. Atkinson, Jr., "Applications of Neutron Activation Analysis to the Life Sciences", presented at the Combined Meeting of the Texas Association for Radiation Research and South Central Photobiology Group, San Marcos, Texas, November 9-10, 1973.

135. S.P. Nichols, "Experimental Determination of Neutron Fermi Age from Californium-252 Fission Spectrum to Cadmium Covered Indium Resonance in a Graphite Medium" Masters Thesis, The University of Texas at Austin, 101 pp., January 1974.

136. T.A. Parish, "Neutornic and Photonic Analyses of Simulated Fusion Reactor Blankets Containing Thorium and Natural Uranium", Ph.D. Dissertation, The University of Texas at Austin, 329 pp. January 1974.

137. J.H. Vanston, Jr., "Use of the Partitive Analytical Forecasting (PAF) Technique for Analysis of the Effects of Various Funding and Administrative Strategies on Nuclear Fusion Power -lant Development", Ph.D. Dissertation, The University of Texas at Austin, 459 pp., January 1974.

138. E.M. B. Sorensen, "Thermal Effects on the Biological Magnification of Arsenic in Green Sunfish, Lepomis Cyanellus", Ph.D. Dissertation, The University of Texas at Austin, 233 pp., May 1974.

139. E. Linn Draper, Jr., and J.R. Deen, "Measurement of Fission Product Yields from Thorium-232 in a Californium-252 Fission Neutron Spectrum", Trans. Am. Nucl. Soc., 17, 531 (1973).

140. E. Linn Draper, Jr., M. Etzion, S.P. Nichols and W.G. Davey, "Neutron Fermi Age in Graphite from Fission and Fusion Sources to Indium Resonance", CONF-740402, USAEC, (April 1974).

141. E. Linn Draper, Jr., and T.A. Parish, "Neutronic and Photonic Analyses of Fusion Reactor Blankets Containing Natural Uranium", CONF-740402, USAEC, (April 1974).

142. G.D. Atkinson, Jr., B.D. Adams, and S.J. Gage, "A Programmable and Automated System for Gamma and X-Ray Analysis", PROC. IEEE 1973 NUCLEAR SCIENCE SYMPOSIUM, San Francisco, California (1973).

143. G.D. Atkinson, Jr., and R.E. Henry, "Neutron Activation Analysis: Environmental and Biological Applications", Sixth Annual Meeting of the Texas Association for Radiation Research, San Marcos, Texas (1973).

144. M. Etzion, R.G. Spangler, E. Linn Draper, Jr., "Multiple Foil Activation Measurement of the Californium-252 Fission-Neutron Spectrum, Trans. Am. Nucl. Soc., (October 1974).

145. A. H. Pradzynski, "Determination of Selenium in Water on the ppb Level" presented before the Texas Association for Radiation Research, Dallas, Texas, (November 22, 1974).

146. Thomas L. Bauer, "Discrimination of Uranium-235 and Plutonium-239 by Cyclic Activation and Delayed Gamma Ray Analysis Using Californium-252 as a Neutron Interrogation Source", Masters Thesis, Mechanical Engineering Department, The University of Texas at Austin, 178 pp. (August 1974).

147. Olan D. Thompson, "Optimization of Shipping Containers for Radioisotopic Neutron Sources", Masters Thesis, Mechanical Engineering Department, The University of Texas at Austin, 30 pp., (August 1974).

148. J.R. Deen, E. Linn Draper, Jr., "Measurement of the Fission Product Yields and the Energy Integral Fission Cross Section of Thorium-232 in a Californium-252 Fission-Neutron Spectrum", Nuclear Technology, 25, 416 (1975).

149. E. Linn Draper, Jr., T.A. Parish, M. Etzion, "Utilization of a Small Accelerator for Fusion Reactor Blanket Design", Proceedings of the Third Small Accelerator Conference, USAEC, CONF-741021 (1974).

150. R.G. Spangler, E. Linn Draper, Jr., T.A. Parish, "14 MeV Cross Section Measurements of Threshold Reactions for Seven Metals", Trans. Am. Nucl. Soc., 22, 818 (November 1975).

151. W.R. Smith, Jr., E. Linn Draper, Jr., "Measured and Calculated Fast Neutron Spectra in a Graphite Medium", Trans. Am. Nucl. Soc., 22, 800 (November 1975).

152. J.W. Davidson, E. Linn Draper, Jr., "Costs for Partitioning Strategies Involved in High-Level Nuclear Waste Management", Trans. Am. Nucl. Soc., 22, 348 (November 1975).

153. M.J. Voltin, Jr., E. Linn Draper, Jr., "Sensitivity of Total Fuel Cycle Cost to Variations in Enrichment Tails Assay Strategies", Trans. Am. Nucl. Soc., 22, 322 (November 1975).

154. T.A. Parish, J.W. Davidson, E. Linn Draper, Jr., "Transmutation of Fission Products in Fusion Reactor Blankets", Trans. Am. Nucl. Soc., 22, (November 1975).

155. T.A. Parish, J.W. Davidson, E. Linn Draper, Jr., "The Effects of the D-T Fusion Neutron Energy Spectrum on High Energy Reaction Rates", submitted to the Sixth Symposium on Engineering Problems of Fusion Research, San Diego, California (November 18-21, 1975).

156. A.H. Pradzynski, R.E. Henry, J.L.S. Stewart, "Determination of Selenium in Water on the ppb Level by Coprecipitation and Energy Dispersive X-Ray Spectrometry", Radiochem. Radioanal. Letters, 21(5) 277-285 (1975).

157. B.E. Bulla, E. Linn Draper, Jr., R.E. Henry, M.J. Voltin, Jr., et.al., Texas Nuclear Power Policies: A Study of Alternatives, Volume II: Methodology. The University of Texas at Austin Center for Energy Studies, Policy Alternative Study No. 1 (1975).

158. A.H. Pradzynski, R.E. Henry, J.L.S. Stewart "Determination of Transition Metals by Radioisotope-Excited Energy Dispersive X-Ray Spectrometry", Trans. Am. Nucl. Soc., 21, No. 3 34-35 (1975).

159. A.H. Pradzynski, R.E. Henry, J.L.S. Stewart, "Nondestructive Determination of Toxic Elements in Toys", Proc. of 10th Symposium on Nondestructive Elements, San Antonio, Texas, 257-265 (April 23-25, 1975).

160. R.E. Henry, "Determination of ppb Levels of Selected Elements in Natural Water Using Radiusiotope-Excited Energy Dispersive X-Ray Fluorescence Analysis", presented at the Eighth Annual Meeting of the Texas Association for Radiation Research, Austin, Texas (October 31 -- November 1, 1975).

161. S.P. Nichols, "Application of the Partitive Analytical Forecasting (PAF) Technique to the United States Controlled Thermonuclear Research Effort," Ph.D. Dissertation, The University of Texas at Austin (December 1975).

162. C.T. Rombough, "The Total Energy Investment in Nuclear Power Plants", Ph.D. Dissertation, The University of Texas at Austin, (January 1975).

163. J.L. Macdonald, "Investigation of Pattern Recognition Techniques for the Identification of Splitting Surfaces in Monte Carlo Particle Transport Calculations", Ph.D. Dissertation, The University of Texas at Austin (August 1975).

164. J.W. Davidson, "A Cost-Benefit Analysis for Partitioning Strategies Involved in High-Level Nuclear Waste Management", Masters Thesis, The University of Texas at Austin, (May 1975).

165. T. A. Parish, J. W. Davidson, and E. Linn Draper, Jr., "The Minimization of the Hazard Resulting from Transmutation of Fission Products," Transactions of the American Nuclear Society, 23, 59, June 1976.

166. T. A. Parish, "Fusion-Fission Hybrid Studies at The University of Texas," U.S.-U.S.S.R. Symposium on Fusion-Fission Reactors, Lawrence Livermore Laboratory, July 1976.

167. T. A. Parish, J. W. Davidson and E. Linn Draper, Jr., "Neutronic Performance of Graphite Fusion Reactor Blankets Containing Sr^{90} and I^{129}," Second ANS Topical Meeting on the Technology of Controlled Thermonuclear Fusion, Richland, Washington, September 1976.

168. T. A. Parish, J. W. Davidson and J. B. Cornwell, "The Effectiveness of a Sr^{90} Fusion Reactor Transmutation Waste Management Program," Transactions of the American Nuclear Society, 24, November 1976.

169. A. H. Pradzynski and J. R. Rhodes, "Development of Synthetic Standard Samples for Trace Analysis of Air Particulates," ASTM Special Technical Publication No. 598, 1976, pp. 320-336.

170. A. H. Pradzynski, R. E. Henry and J. S. Stewart, "Determination of PPB Concentrations of Transition Metals by Radioisotope-Excited Energy-Dispersive X-Ray Spectrometry, Journal of Radioanalytical Chemistry, 32, 1976, p. 219-28.

171. A. H. Pradzynski, R. E. Henry and E. L. Draper, Jr., "Determination of PPB Concentrations of Uranium, Thorium and Molybdenum in Water using APDC Preconcentration and Radioisotope Excited X-Ray Emission Spectrometry," Proceedings of ERDA Symposium on X- and Gamma-Ray Sources and Applications, Ann Arbor, Michigan, May 19-21, 1976, pp. 175-177.

172. A. H. Pradzynski, R. E. Henry and E. L. Draper, Jr., "Determination of Trace Elements of Hydrogeochemical Prospecting by APDC-Coprecipitation and X-Ray Spectrometry," invited paper at The International Conference on World Nuclear Energy a Status Report. Transactions of Am. Nuclear Society, 24, 1976, p. 119.

173. R. R. Gay, G. F. Brockett and R. T. Johnson, "Two-Phase Flow Measurement Techniques for Nuclear Safety Research," Two-Phase Flow and Heat Transfer Symposium-Workshop, Miami Beach, Florida (1976).

174. C. W. Savery and R. R. Gay, "Effect of Entrained Droplet Phase Upon Predicted Compartmental Pressures in Nuclear Containments," Two-Phase Flow and Heat Transfer Symposium-Workshop, Miami Beach, Florida (1976).

175. Rodney R. Gay, "Reactor Hydrodynamics During the Reflood Phase of a Loss-of-Coolant Accident," Nuclear Technology, Vol. 36, No. 2, Dec. 1977, pp. 229-237.

176. D. E. Klein, S. R. Bull, and J. B. Miles, "Flow Visualization Around GCFR Fuel Rod Roughness Elements," Trans. Am. Nuclear Soc., 28, June, 1978.

177. D. E. Klein, S. R. Bull, and J. B. Miles, "Pressure Drop for GCFR Fuel Rod Roughness Elements," Trans. Am. Nuclear Soc., 30, November 1978.

178. E. M. B. Sorensen, R. E. Henry and R. Ramirez-Mitchell, "Time Dependent Localization of Arsenic in Subcellular Hepatocyte Fractions," J. of Pathology and Toxicology, Vol. 2, No. 4, 1979, pp. 1161-1171.

179. E. M. B. Sorensen, R. E. Henry, and R. Ramirez-Mitchell, "Arsenic Accumulation, Tissue Distribution, Cytotoxity in Teleosts following Indirect Aqueous Exposure," Bulletin of Environmental Contamination and Toxicology, Vol. 21, 1979, pp. 162-169.

180. J. W. Davidson and T. A. Parish, "Fission Product Toxicity Reduction via Transmutation Using D-T Fusion Neutrons," Eight Symposium on Engineering Problems of Fusion Research, San Francisco, California, November 1979.

181. J. W. Davidson and T. A. Parish, "An Evaluation of the Requirements and Performance of a Transmutation Waste Management System, Trans. Am. Nuclear Soc., 33, November 1979.

182. S. A. Hodge, J. P. Sanders, and D. E. Klein, "Determination of Friction Factors and Heat Transfer Coefficients for Flow Past Artifically Roughened Surfaces, Oak Ridge National Laboratory Report, ORNL-5599, November 1979.

183. D. E. Klein, "Nuclear Problems and Prospects," National Energy Policy Issues, Council on Energy Resources, The University of Texas at Austin, May 1979.

184. D. E. Klein, H. H. Woodson, and J. W. Davidson, "Commercial Nuclear Power Generation," Council on Energy Resources, The University of Texas at Austin, June 1979.

185. E. M. B. Sorensen, R. R. Mitchell, A. Pradzynski, T. Bauer and L. Graham, "Morphometric Analyses of Arsenic-Induced Histopathological Changes in Parenchymal Hepatocytes," Tennessee Academy of Science Annual Meeting, Nashville, TN, November 16-17, 1979.

186. A. H. Pradzynski, "Determination of V and Ba in Marine Sediments and Biota," Internal Report, Nuclear Engineering Teaching Laboratory, The University of Texas at Austin, Department of Mechanical Engineering (1979).

187. N. E. Hertel, B. W. Wehring, and J. J. Dorning, "Integral Test of ENDF/B-IV High-Energy Neutron Cross Section Data for Tungsten," Trans. Am. Nucl. Soc. 32, 631 (1979).

188. R. H. Johnson, K. R. Koch, B. W. Wehring, and N. E. Hertel, "TDL Measurements in an Iron Sphere Containing a DT Source," Trans. Am. Nucl. Soc. 32, 632(1979).

189. B. W. Wehring, J. J. Dorning, N. E. Hertel, D.T. Ingersoll, R. H. Johnson, "Benchmark Shielding Problems Obtained from Integral Tests of Neutron Cross Sections," Trans. Am. Nucl. Soc. 33, 666 (1979).

190. N. E. Hertel, R. H. Johnson, J. J. Dorning, and B. W. Wehring, "Measurements and Analyses of Neutron Transport Through Iron," Proc. Conf. Nuclear Cross Sections and Technology, Knoxville, TN, Oct. 22-26, 1979, NBS Special Publication #594, pp. 568-571.

191. N. E. Hertel, B. W. Wehring, "Absolute Monitoring of DD and DT Nuetron Fluences Using the Associated-Particle Technique," Nucl. Instr. Meth. 172, 501(1980).

192. S. A. Hodge, J. P. Sanders, and D. E. Klein, "Slope and Intercept of the Dimensionless Velocity Profiles for Artificially Roughened Surfaces, Int. J. Heat Mass Transfer, Vol. 23, February 1980, pp. 135-149.

193. N. E. Hertel, J. B. Smathers, and R.G. Graves, "Gamma-Ray Spectra Measured in a Tissue-Equivalent Medium Irradiated with Neutron Radiotherapy Sources," Trans. Am. Nucl. Soc. 35, 457 (1980).

194. N. E Hertel, W. E. Murphie, and R. J. Calhoun, "Measurements of Neutron and Gamma-Ray Spectra in a Phantom Irradiated with 14-MeV Neutrons," presented at the Health Physics Society Annual Meeting, Louisville, KY, June 21-26, 1981.

195. D. E. Klein, S. R. Bull and J. B. Miles, "Pressure Drop Measurements and Flow Visualization Surrounding Roughness Elements," Journal of Energy, Vol. 4, No. 3, May-June 1980, p. 112-119.

196. D. E. Klein, "ANS Student Involvement in Public Information-The University of Texas at Austin," Trans. Am. Nuclear Soc., 34, June 1980 (invited).

197. R. B. Pope, H. R. Yoshimura, J. E. Hamann, and D. E. Klein, "An Assessment of Accident Thermal Testing and Analysis Procedures for Radioactive Materials Shipping Package," ASME 80-HT-38, April 1980.

198. J. E. Hamann, D. E. Klein, R. B. Pope, and H. R. Yoshimura, "Modelling of Pool Fire Environments Using Experimental Results of a Two-Hour Test of a Railcar/Cask System, " Paper #147, PATRAM-80, West Berlin, FRG., Nov. 1980.

199. M. A. Ross and D. E. Klein "Synthetic Fuel Production Utilizing Texas Lignite and a VHTR for Process Heat," Trans. Am. Nuclear Soc., 35, Nov. 1980.

200. J.W. Davidson and D. E. Klein (co-editors), Proceedings of the International Conference on Nuclear Waste Transmutation, University of Texas Press, March 1981.

201. M. A. Ross and D. E. Klein, "Synthetic Fuel Production Using Texas Lignite and a VHTR for Process Heat," Number 3, March 1982, Nuclear Technology, Vol. 56.

202. T. L. Sanders and D. E. Klein, "A Modified Numercial Scheme for GCFR Flow Transient Analysis," Trans. Am. Nuclear Soc., 39, November 1981.

203. M. A. Ross and D. E. Klein, "Synthetic Fuel Production Using Texas Lignite and A Very High Temperature Gas Cooled Reactor for Process Heat and Electrical Power Generation," Center for Energy Studies, The University of Texas at Austin, Research Report No. 13, May 1981.

204. M. M. Razzaque, J. R. Howell and D. E. Klein, "Finite Element Solution of Heat Transfer for Gas Flow Through a Tube," AIAA Journal, Vol. 20, No. 7, July 1982.

205. S. Yang, J. R. Howell and D.E. Klein, "Radiative Heat Transfer Through a Randomly Packed Bed of Spheres by the Monte Carlo Method," AIAA/ASME 3rd Joint Thermophysics, Fluids, Plasma & Heat Transfer Conference, ASME 82-HT-5, St. Louis, Missouri, June 1982.

206. D.E. Klein and J. Andersen et al., "Peer Review of the Preliminary Design and Program Interfaces for the Transuranic Waste Package Transporter (TRUPACT)," Sandia Report, SAND 81-2405, June 1982.

207. T. L. Sanders and D. E. Klein, "Transient Thermal-Hydraulic Analysis Using a Modified Version of COBRA IV," 7th International Heat Transfer Conference, Munich, Germany 82-IHTC-104, September 1982.

208. S. Yang, J. R. Howell and D. E. Klein, "Monte Carlo Simulation of Thermal Conduction Through a Randomly Packed Bed of Spheres," 7th International Heat Transfer Conference, Munich, Germany, 82-IHTC-91, September 1982.

209. T. L. Sanders and D. E. Klein, "Comparison Analysis of Severe Flow Blockages for Computational Efficiency Using COBRA," Proceedings from Gas-Cooled Reactors Today Conference, British Nuclear Energy Society, London, England, September 1982.

210. M. M. Razzaque, J. R. Howell and D. E. Klein, "Finite Element Solution of Radiative Heat Transfer in a Two-Dimensional Rectangular Enclosure with Gray Participating Media," 82-WA/HT-51, ASME Annual Meeting, Phoenix, Arizona, November 1982.

211. J. B. Smathers, N. E. Hertel, R. G. Graves, "In Phantom Photon Spectra Measurements for High-Energy Neutron Therapy Sources," Proceedings: Fourth Symposium on Neutron Dosimetry:Beam Dosimetry, 1-5 June 1981, Neuherberg/Munchen, Federal Republic of Germany, EUR 7448en (1981).

212. N.E. Hertel, B. W. Wehring and J. J. Dorning, "Measurements and Analyses of High-Energy Neutron Transport Through Tungsten," (accepted for publication subject to revision in Nuclear Science and Engineering, November 1981).

213. Y. Kunimoto, J. W. Davidson, and N. E. Hertel, "A Core Inventory Model for Fuel Trajectory Analysis in Fusion-Fission Symbiotic Systems," Trans. Am. Nucl. Soc., 41, 1978, June 1982.

214. N. E. Hertel and W. E. Murphie, "The Use of Neutron and Gamma-Ray NE-213 Spectral Measurements and Calculations to Obtain Dosimetric Information for DT Neutrons," Medical Physics 10,66, (1983).

215. R. Laucius, J. W. Davidson, and N. E. Hertel, "Calculation of the Differential Efficiencies of Organic Scintillators to Neutrons Above 10 MeV," Trans. Am. Nucl. Soc., 43, 625, November 1982.

216. J. W. Davidson and N. E. Hertel, "Bonner Ball Detection Responses for Neutrons from Thermal Energies to 17.3 MeV," Health Physics Society Annual Meeting, Baltimore, Maryland.

217. N. E. Hertel, J. W. Davidson and R. M. Laucius, "NE-213 Response Matrix for Neutron Spectrometry Up to 50-MeV," Health Physics Society Annual Meeting, Baltimore, Maryland.

218. N. E. Hertel, J. W. Davidson, and R. M. Laucius, "An NE-213 Response Matrix to 50 MeV," Trans. Am. Nucl. Soc., 45, 607 (1983).

219. J. W. Davidson and N. E. Hertel, "An Equal Probability Neutron Detection System Using Bonner Spheres," Trans. Am. Nucl. Soc., 45, 609 (1983).

220. D. E. Klein, "Coupled Radiative and Conductive Heat Transfer in a Two Dimensional Rectangular Enclosure with Gray Participating Media Using Finite Elements," ASME/JSME Thermal Engineering Joint Conference, ASME-H-35, Honolulu, Hawaii, March 1983.

221. S. Yang, J. R. Howell, D. E. Klein, "Radiative Heat Transfer Through a Randomly Packed Bed of Spheres by the Monte Carlo Method," (submitted to the Journal of Heat Transfer).

222. M. M. Razzaque, J. R. Howell, D. E. Klein, "Finite Element Solution of Radiative Heat Transfer in a Two Dimensional Rectangular Enclosure with Gray Participating Media," (submitted to Journal of Heat Transfer).

223. M. M. Razzaque, J. R. Howell, D. E. Klein, "Coupled Radiative and Conductive Heat Transfer in a Two Dimensional Rectangular Enclosure with Gray Participating Media Using Finite Elements," (submitted to Journal of Heat Transfer).

224. Sorensen, E. M. B., C. W. Harlan, M.D., T. L. Bauer and A. Pradzynski. Hepatocyte changes following selenium accumulation in a freshwater teleost. The American Journal of Forensic Medicine and Pathology 3(3) 8p., 1982.

225. Sorensen, E. M. B., and T. L. Bauer. Selenium-induced Condition Factor and Organ Weight Changes in Naturally-exposed Redear Sunfish. (Submitted to Toxicology).

226. Sorensen, E.M.B., T.L. Bauer, J.S. Bell, and C.W. Harlan, "Selenium Accumulation and Cytotoxicity in Teleosts Following Chronic, Environmental Exposure," (accepted by Bulletin of Environmental Contamination and Toxicology).

227. Sorensen, E.M.B. and T.L. Bauer, "Selenium Induced Hematological Dyscrasia in Teleosts," (accepted by Archives Environmental Contamination and Toxicology).

228. Sorensen, E.M.B., P.M. Cumbie, T.L. Bauer, J.S. Bell, and C.W. Harlan, "Histopathological, Hematological, and Other Changes Associated with Selenium Accumulation in Fish from Belews Lake, North Carolina," (ready for submission to Archives Environmental Contamination and Toxicology).

229. Sorensen, E.M.B., R.R. Mitchell, A. Pradzynski, T.L. Bauer, and L. Graham, "Sterological Analyses of Hepatocyte Changes Parallel Arsenic Accumulation in the Livers of Green Sunfish," (accepted by The Journal of Environmental Pathology, Toxicology, and Oncology).

230. Hertel, N.E. and J.W. Davidson, "The Effect of Cadmium Covers on Bonner Sphere Responses," to appear in the Proceeding of the Personnel Radiation Dosimetry Symposium, Knoxville, Tennessee, October, 1984.

231. Hertel, N.E. and J.W. Davidson, "The Response of Bonner Spheres from Thermal Energies to 17.3 MeV,"(accepted for publication Nuclear Instruments and Methods A, February, 1985).

232. Patterson-Hine, A., J.W. Davidson, and D.E. Klein, "Characterization of Product Buildup in Continuously Processed Molten Salt Fusion Breeder Blankets," Trans. American Nuclear Soc., 45, San Francisco, California, Oct. 30-Nov. 3, 1983.

233. Patterson-Hine, A., J.W. Davidson, and D.E. Klein, "Contributions to the Thermal Power of Continuously Processed TMHR Molten Salt Blankets," 10th Symposium on Fusion Engineering, Philadelphia, Pennsylvania, December 5-9, 1983.

234. Polansky, G.F., J.P. Lamb, and D.E. Klein, "A Finite Element Analysis of Incompressible Laminar and Turbulent Flow with Heat Transfer," 5th International Symposium on Finite Elements and Flow Problems, The University of Texas at Austin, Austin, Texas, Jan. 23-26, 1984.

235. Ally, M., D.E. Klein, and T.L. Bauer, "Preconcentration Methods of Trace Elements in Water for EDXRF and INAA," 5th International Conference on Nuclear Methods in Environmental and Energy Research, Mayaguez, Puerto Rico, April 2-6, 1984.

236. Klein, D.E. and W.H. Miller, "Student ANS Branch Involvement in Public Information," Trans. Am. Nuclear Society, June 1984 - invited paper.

237. Iskander, F.Y., D.E. Klein, and T.L. Bauer, "Toxic and Other Elements in American Cigarette Tobacco Compared with International Brands," 17th Annual Meeting of Texas Association for Radiation Research, Denton, Texas, Nov. 1984.

238. Iskander, F.Y. and R.H. Filby, "Formation of Anatase from Ti(IV)-pre-asphaltene Complexes under Coal Liquefaction Conditions," Fuel, 63, 280 (1984).

239. Iskander, F.Y. and R.H. Filby, "Speciation of Titanium in Solvent Refined Coal using SESC-INAA," Proceeding of American Nuclear Society Meeting, Fifth International Conference, Mayaguez, Puerto Rico, April 2-6, 1984.

240. Iskander, F.Y., "Neutron Activation Analysis of an Egyptian Cigarette and its Ash," J. Radioanal. Nucl. Chem. 89, 511 (1985).

241. Iskander, F.Y., "Egyptian and Foreign Cigarettes. 1. Determination of Trace Elements in Cigarette Filter Before and After Smoking," J. Radioanal. Nuc. Chem. 91 (1985).

242. Iskander, F.Y., "Cigarette Ash as Source of Environmental Pollution," Environ. Pollut. (accepted).

243. Iskander, F.Y., T.L. Bauer, and D.E. Klein, "Determination of Trace Elements in American Cigarette Paper by Neutron Activation Analysis," (submitted to Beitr. Tobakforsch. Int.).

244. Iskander, F.Y., "Egyptian and Foreign Cigarettes. 2. Determination of Trace Elements in Tobacco, Ash and Wrapping Paper," (submitted to J. Radioanal. Nucl. Chem.).

245. Iskander, F.Y., T.L. Bauer and D.E. Klein, "Determination of 28 Elements in American Cigarette Tobacco by Neutron Activation Analysis," (submitted to Analyst).

246. Iskander, F.Y., D.E. Klein and T.L. Bauer, " Determination of Trace Impurities in Aspirin Tablets by Neutron Activation Analysis," (submitted to J. Radioanal. Nucl. Chem.).

247. Jacobs, F.S. and F.Y. Iskander, "Vanadium Sorption by Crude Oils," (submitted to Fuel).

248. Iskander, F.Y. and M.M. Morad, "Multielement Analysis of Hard Red Winter Wheat and Its Bran," (submitted to J. Food Science).

249. Morad, M.M., F.Y. Iskander and L.W. Rooney, "Physico-chemical Properties of Alkali-cooked Corn using Traditional and Pre-soaking Procedures," (submitted to Cereal Chem.).

THE UNIVERSITY OF TEXAS
COLLEGE OF ENGINEERING
AUSTIN, TEXAS ,8712

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

March 29, 1985

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 1984 annual report. These are being submitted according to CFR 10 Section 50.59.

Sincerely yours,

T L Bauer

T.L. Bauer
Reactor Supervisor
SOP #3664

Dale Klein

Dale Klein, Director
Nuclear Engineering
Teaching Laboratory

TLB:DK:bb
Enclosure

IE24
1/12