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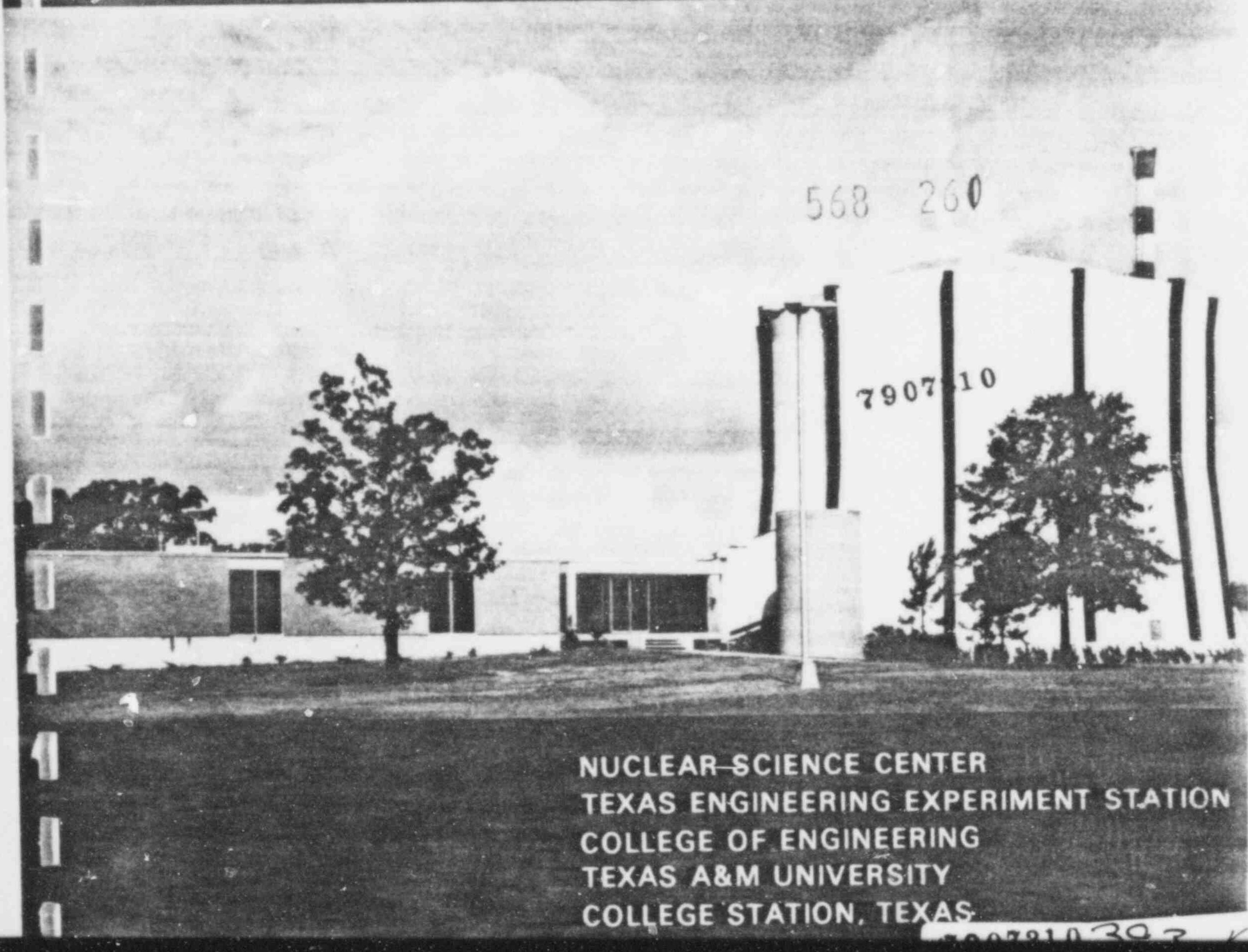
FIFTEENTH PROGRESS REPORT OF THE TEXAS A&M UNIVERSITY NUCLEAR SCIENCE CENTER

JANUARY 1, 1978-DECEMBER 31, 1978
CONTRACT EY-76-C-05-4207



NUCLEAR SCIENCE CENTER
TEXAS ENGINEERING EXPERIMENT STATION
COLLEGE OF ENGINEERING
TEXAS A&M UNIVERSITY
COLLEGE STATION, TEXAS

FIFTEENTH PROGRESS REPORT

of the

TEXAS A&M UNIVERSITY
NUCLEAR SCIENCE CENTER

January 1, 1978 - December 31, 1978

Prepared by

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D. E. Feltz
C. E. Harris
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and the

Nuclear Science Center Staff

Submitted to

U. S. Department of Energy

and

Texas A&M University

by

John D. Randall, Director

Nuclear Science Center

Texas Engineering Experiment Station

College Station, Texas

June 1979

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I. INTRODUCTION

The Nuclear Science Center is operated by the Texas Engineering Experiment Station as a service to Texas A&M University. The facility is available to the University, other educational institutions, governmental agencies, and private organizations and individuals.

This report has been prepared by the staff of the Nuclear Science Center of the Texas Engineering Experiment Station to satisfy the reporting requirements of USDOE Contract Number EY-76-C-05-4207 and of 10 CFR 50.59. The report covers the period from January 1, 1978 through December 31, 1978.

The reactor utilization remained at a high level with the total number of irradiations, sample irradiation hours and total experiment hours comparing favorably with the previous reporting period. The reactor was not pulsed during the reporting period due to a restriction on pulsing until the fuel damage study is completed.

Plans for the installation of an operational full FLIP core continued with the computer analysis of several core configurations. In addition to increasing core life, the FLIP core will provide additional irradiation capabilities for improved utilization of the reactor.

II. REACTOR UTILIZATION

A. Utilization Summary

Utilization of the NSCR during the reporting period is shown in Figure 1 and Table I. Figure 1 presents reactor operation from January 1962 through December 1978. During the present reporting period the NSCR was used by more than 650 students and 48 faculty and staff members representing 22 departments at Texas A&M University. In addition, more than 202 faculty and students from 9 other colleges and universities used the facilities, and 4,084 visitors were registered during 1978, including 14 high school groups. A total of 22 non-university organizations had programs that were dependent upon the NSCR.

During sixteen years of operation, the NSC has provided services to 30 departments at Texas A&M University, 98 other colleges and universities, 53 industrial organizations and 14 government and state agencies (See Appendix IV and V for listings).

B. Utilization by the Texas A&M University System

During 1978 the following personnel from various departments at Texas A&M University used the NSCR for research. Appendix I describes the projects.

Chemistry Department

Faculty and Staff: Dr. M. W. Rowe, Assistant Professor
Dr. E. Siefert, Post Doctorate
Dr. Y. N. Tang, Associate Professor
Dr. A. Clearfield, Assistant Professor
Dr. T. Vickery, Professor

Students:		
	R. Ferrieri	R. Clark
	G. Harrison	G. Day
	R. Tabor	M. Hyman

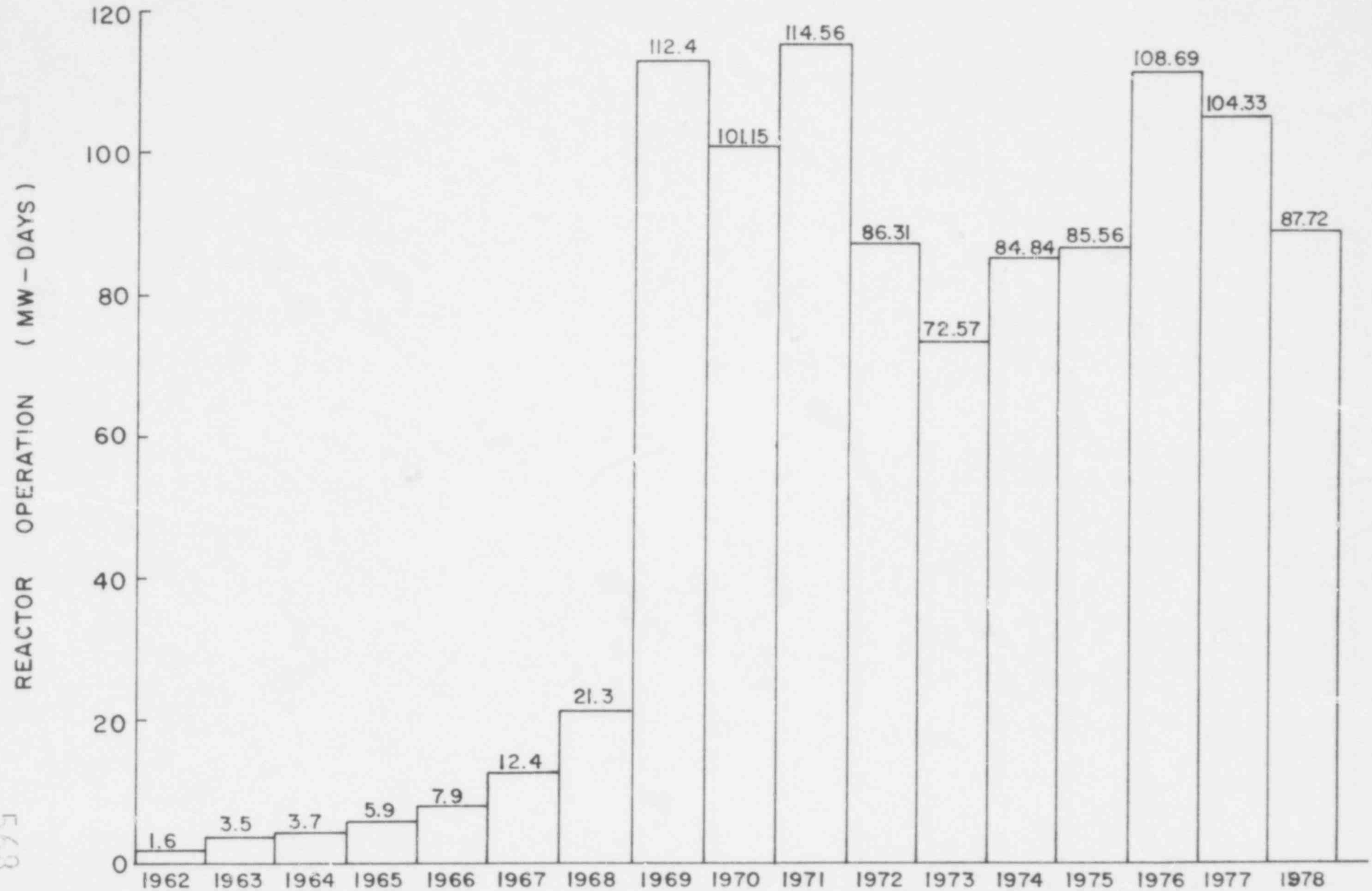

FIGURE I. YEARLY REACTOR OPERATION

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TABLE I

REACTOR UTILIZATION SUMMARY

	1978 Annual Total
*Number of Days Reactor Operated	235
Reactor Operation (MW-Days)	87.72
Number of Hours at Steady State	2170.34
Average Number of Operating Hours per week	43.41
Total Number of Pulses	0
Total Pulse Reactivity Insertion	0
Number of Irradiations	802
Number of Samples Irradiated	9,151
Sample Irradiation Hours	32,393.48
Average Number of Irradiations per Operating Day	3.41
Irradiation Experiment Hours	14,066.29
Beam Port Experiment Hours	82.90
Irradiation Cell Experiment-Hours	0
Total Experiment-Hours	14,149.20
Fraction of Utilization Attributable to Commercial Work	0.33
Number of Visitors	4,084

*Note: 50 Weeks of Operation Available

Oceanography

Faculty:	Dr. W. M. Sackett, Professor Dr. B. J. Presley, Professor J. Schofield, Research Associate J. Trefry, Research Associate
Students:	Ron Pflaum Frederick Weber

Center for Trace Characterization

Staff:	Mr. W. C. Kuykendall, Jr., Deputy Director Dr. J. McGinley, Assistant Research Chemist Dr. D. Moore, Assistant Research Chemist Dr. J. Efimenko, Assistant Research Chemist	
Students:	D. Hobson P. Andurer M. Yalo	S. Johnson A. McGinley

Geology Department

Faculty:	Dr. R. B. Scott, Associate Professor Dr. T. T. Tieh, Associate Professor Dr. W. Huang, Associate Professor		
Students:	J. Chatham M. Miller	J. Straccia E. Ledger	S. Parks

College of Medicine

Faculty:	Dr. M. D. Devous, Research Associate	
Students:	George Cathey Robert Randall	John Westover Patrick Giam

Nuclear Engineering Department

Faculty:	Dr. R. G. Cochran, Professor and Head Dr. R. R. Hart, Associate Professor Dr. J. D. Randall, Professor Dr. R. D. Neff, Professor Dr. J. B. Smathers, Professor		
Students:	S. Williams L. Albert	W. Simmons M. Urbantke	D. Wootan

Nuclear Science Center

Staff:	Mr. E. F. Bates, Health Physicist Mr. D. E. Feltz, Associate Director Dr. J. D. Randall, Director Mr. K. L. Walker, Reactor Coordinator Mr. J. P. Taft, Research Engineer Mr. B. J. Browning, Reactor Supervisor

Animal Science Department

Faculty: Dr. W. C. Ellis, Professor

Staff: Mr. John Snell, Research Associate

Students: Carlos Lascano, Graduate Assistant

Industrial Education

Faculty: Dr. G. D. Gutcher

Students: Ken Usiak

Radiological Safety Office

Staff: Dr. R. D. Neff, Radiological Safety Officer

Students: J. Harville

Soil and Crop Sciences

Faculty: Mr. R. Drops, Research Associate

Veterinary Physiology and Pharmacology

Faculty: Dr. D. Hightower, Professor

Staff: Dr. R. Badertscher, Clinical Associate

Students: S. Tamulinas

In addition to the research performed by the above personnel, the NSCR was used as an educational aid in numerous academic courses offered by the University. Table II indicates the academic courses and the number of students using the facility.

C. Other Educational Institutions

In addition to Texas A&M University, services were provided to the following educational institutions. A description of some of the projects utilizing the reactor are presented in Appendix I.

Lamar University -- Beaumont, Texas

Faculty: Dr. Harold Baker -- Head, Chemistry Department

Students: Chemistry Class

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McLennan Community College -- Waco, Texas

Faculty: Mr. Don Tatum -- Physics Department

Students: Physics Classes

Sam Houston State University -- Huntsville, Texas

Faculty: Dr. Charles K. Manka -- Physics Department

Students: Physics Classes

Rice University -- Houston, Texas

Faculty: Dr. Thomas W. Leland -- Professor, Chemical Engineering

Students: Chemical Engineering Class

Henderson County Junior College -- Athens, Texas

Faculty: Mr. White -- Physical Education Department

Students: Physics Classes

TABLE II

ACADEMIC USE OF THE REACTOR

UNDERGRADUATE COURSES

Department and Course	Credit Hours	Number Students	Student Credit Hours	Reactor Hours	Student Reactor Hours
CHEMISTRY					
106 Chemical Perspectives	4	367	1468	1	367
NUCLEAR ENGINEERING					
101 Engineering Analysis	2	53	106	1	53
405 Nuclear Engineering Experiments	3	54	108	3	162
408 Principles of Radiation Protection	3	18	54	3	54
402 Nuclear Detection and Isotope Technology Laboratory	3	62	186	1	54
PHYSICS					
213 Physics for Students of Agriculture	3	40	120	1	40
220 Modern Physics	4	183	732	1	183
351 Experimental Physics for Non-Scientists	1	14	14	1	14
CIVIL ENGINEERING					
489A Power Plant Construction	3	31	93	1	31
HEALTH EDUCATION					
429 Man, Environment, and Health	3	71	213	1	71
ENVIRONMENTAL DESIGN					
489Q Special Topics	3	10	30	1	10
MARINE ENGINEERING (Moody College)					
305 Nuclear Marine Engineering	3	8	24	1	8
Totals		911	3148	16	1047

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TABLE II (Cont'd)
GRADUATE COURSES

Department and Course	Credit Hours	Number Students	Student Credit Hours	Reactor Hours	Student Reactor Hours
BIO-CHEM./BIO-PHYSICS					
626 Radioisotope Techniques	3	7	21	2	14
NUCLEAR ENGINEERING					
605 Nuclear Measurements Laboratory	3	5	15	7	35
606 Reactor Experimentation	3	6	18	18	108
685 Problems	3	1	3	7	7
ARCHITECTURE					
633 Environmental Controls Systems	3	10	30	1	10
INDUSTRIAL EDUCATION					
691 Research	12	1	12	29	29
685 Problems	3	9	27	1	27
INDUSTRIAL HYGIENE					
683 Evaluation and Control of the Occupational Environment	4	14	56	1	14
CHEMISTRY					
617 Application of Instrumental Methods of Analysis	3	5	15	6	30
685 Problems	3	13	39	1	13
VET. PHYSIOLOGY					
626 Bio-nucleonics	4	7	28	2	14
PLANT SCIENCES					
609 Quantitative Plant Physiology	4	9	36	1	9
Totals		87	300	76	310

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<u>Texas Eastern University</u> -- Tyler, Texas

Faculty: Dr. David Riddle -- Professor, Chemistry Department

Students: Chemistry Class

<u>Blinn College</u> -- Brenham, Texas

Students: Math Club

<u>Baylor University</u> -- Waco, Texas

Faculty: Dr. Ken-Hsi Wang -- Physics Department
Dr. Van Tweedie -- Chemistry Department

Students: Physics Class
Chemistry Class

<u>Texas State Technical Institute</u> -- Waco, Texas

Faculty: Rob York -- Chairman, Nuclear Systems Technology
Mr. H. Diegl -- Instructor, Nuclear Systems Technology
Mr. B. R. Mahan -- Instructor, Nuclear Systems Technology

Students: Nuclear Technology Class

<u>University of Texas at Dallas</u>

Experimenter: J. D. Randall

<u>M. I. T.</u>

Experimenter: M. Frey

High School Tours	No. Students
Cross Plains High School -- Cross Plains, Texas	30
McCallum High School -- Austin, Texas	8
Jasper High School -- Jasper, Texas	38
Beaumont High School -- Beaumont, Texas	9
Lampassas High School -- Lampassas, Texas	21
Georgetown High School -- Georgetown, Texas	15
De Soto High School -- Dallas, Texas	7
Bryan High School -- Bryan, Texas	20
Hardin-Jefferson High School -- Sour Lake, Texas	11
Grapeland High School -- Grapeland, Texas	15
Stephen F. Austin High School -- Bryan, Texas	58
Ennis High School -- Ennis, Texas	10
Waxahachie High School -- Waxahachie, Texas	22
San Saba High School -- San Saba, Texas	8

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D. Non-University Institutions

National Aeronautics and Space Administration -- Houston, Texas

Experimenter: Dr. D. P. Blanchard

Nuclear Sources and Services -- Houston, Texas

Experimenter: R. D. Gallagher

Shell Developing Company -- Houston, Texas

Experimenters: L. H. Griffin E. L. Woody
R. H. Hunt

Texas Instruments, Inc. -- Dallas, Texas

Experimenters: J. White J. Keenan
M. Jack

Gulf Nuclear -- Houston, Texas

Experimenter: E. Acree

Texaco Inc. -- Houston, Texas

Experimenters: I. R. Supernaw A. J. Kinsella, Jr.
K. L. Walker

M. D. Anderson Hospital (University of Texas Medical Center)

Experimenter: J. Cundiff

Jefferson County D. A.

Experimenter: J. D. Randall

Oklahoma Medical Examiner

Experimenter: J. D. Randall

U. S. Air Force

Experimenter: R. Shaprey

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III. FACILITY OPERATIONS

A. Facility Safety and Operational Improvements

Work Platform for the Reactor Bridge

An aluminum platform with rubber mat covering was attached to the west side of the reactor bridge (see figure 2). The work platform is used to perform tasks such as sample handling, fuel handling and reactor maintenance. The platform remains attached during bridge movement, thus providing access for all reactor operating positions in the pool. Prior to the installation a platform available only at the stall position required removal when the reactor was moved to the large pool section. The new platform has improved reactor operation procedures and safety.

Facility Locks Re-Keyed

A new key system was established for the NSC facility to improve security. The plan was simplified by consolidating several individually keyed locks. The new key plan was initiated by the NSC and the locksmith work performed by the Texas A&M University key shop.

Puerto Rico FLIP Fuel Identification

The upper end fittings of the Puerto Rico FLIP fuel elements were modified to identify the elements as containing FLIP fuel. A flat surface was filed on the tip of the end fitting. This produces a shinny end appearance when viewed underwater from above as compared to a dull appearance for standard TRIGA fuel elements that are not filed. The identification procedure is required by Technical Specification 5.1.a(5).

Pool Level Alarm Circuit Modification

A pool level alarm light was installed on the reception room facility radiation monitor panel. The pool level indication has a latching feature with a reset. The alarm light was installed to aid in the evaluation of emergency conditions.

Lab Building Addition

Laboratory and conference space was added to the lab building as shown in figure 3. The space was provided by attaching a concrete block building structure to the existing lab building using the old dock area as the foundation. A conference room with sink, cabinets, movie projection booth, movie screen and chalk board provides a much needed area for lectures and conferences.

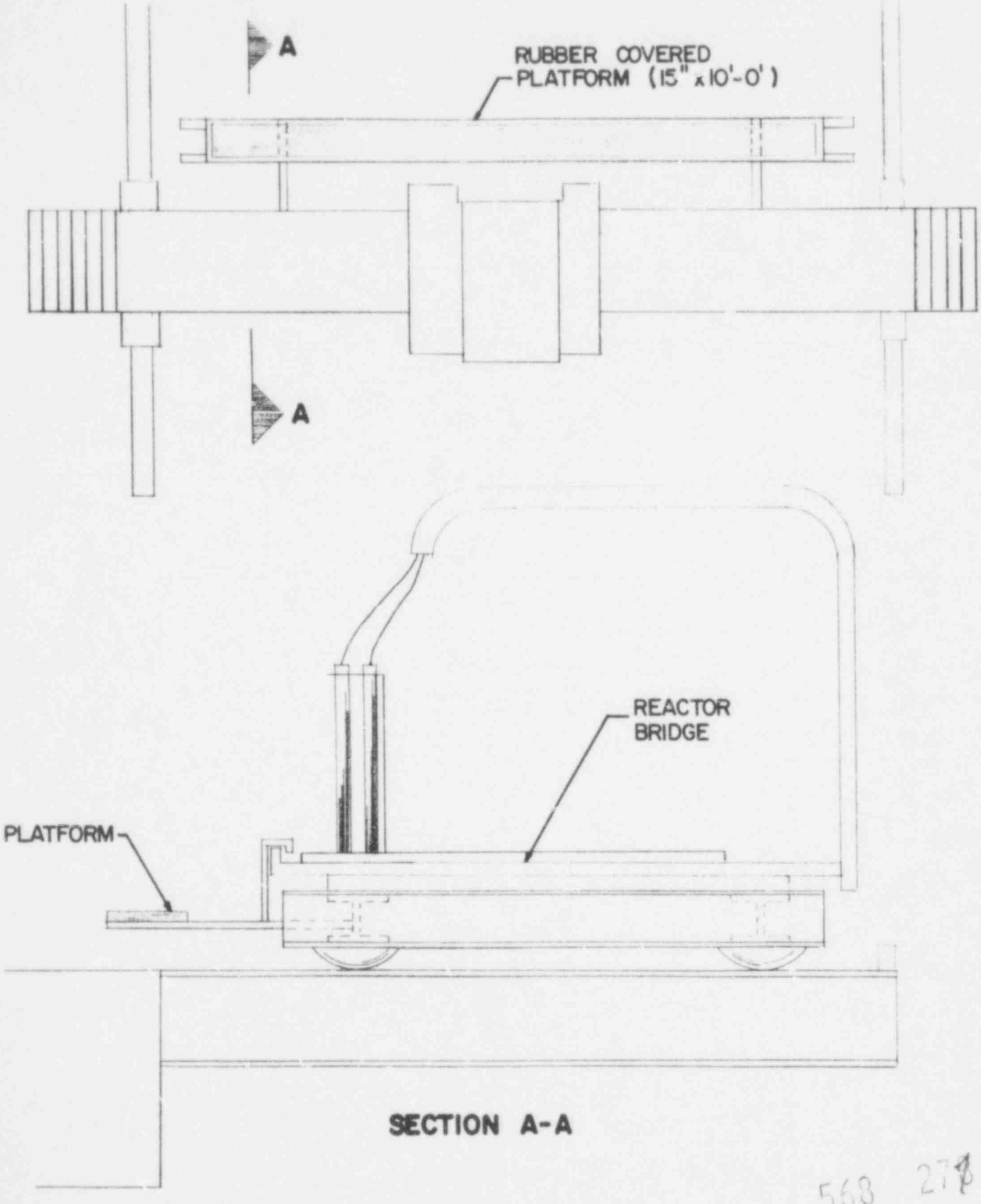

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FIGURE 2. REACTOR BRIDGE WORK PLATFORM

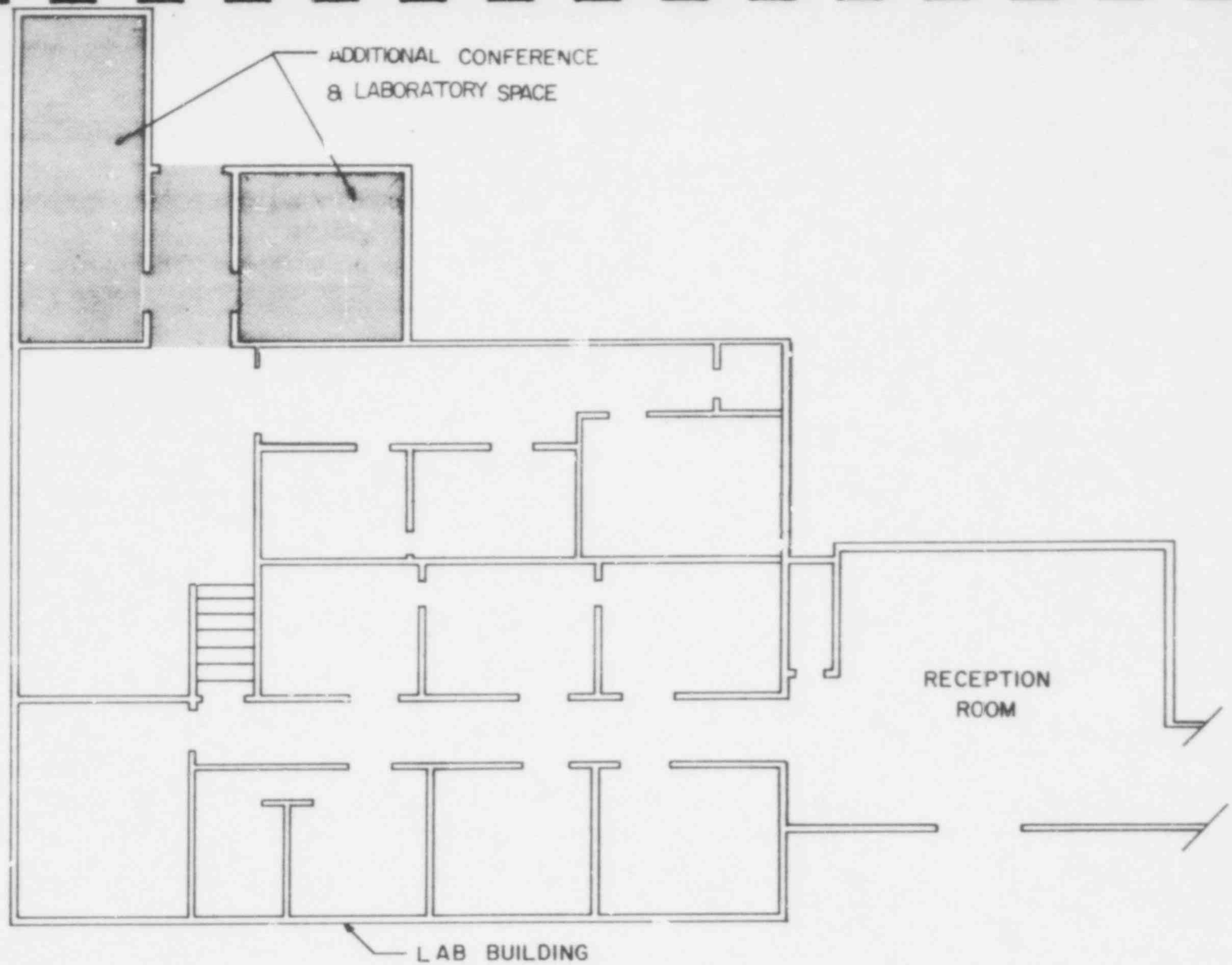

FIGURE 3. ADDITIONAL LABORATORY SPACE

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The new lab space with "hot" sink for radiation waste control, special room exhaust, and lab vacuum will be used primarily to handle sour gas well samples. A total of 418 square feet of laboratory and conference space was added.

B. Improvements to Reactor Systems and Experimental Facilities

Console Changes or Improvements Made During the Reporting Period

a. The auxiliary alarm panel was modified to provide visual and audible signals for personnel control of the beam port No. 4 neutron radiography facility. "C-2" circuits were installed for personnel control of the lower research level and the neutron radiography sample preparation room. The auxiliary panel alarm layout was improved by the grouping of alarms and the selection of audible alarms using a bell or a door chime. The alarm panel circuit was modified to provide a test of all alarm lights. A switch was added to provide selected facility "door open" audible signals to aid the second shift operations personnel in surveillance of the facility.

b. A new reset panel was installed providing an improved layout of switches that are easier to identify and use. The period scram bypass switch was relocated to the rear of the log power instrument due to its infrequent use. The console power reset switch was also moved to the rear of the console. Separate switches were provided for testing the main and auxiliary panalarms. A fuel temperature scram reset switch was added to the reset panel.

c. The dual linear measuring instrument (safety amplifier) was modified to provide latching scram signals and resets for detector high voltage failure and high flux scram. Prior to the change the scram indication did not latch in for display on the main panalarm. If the problem cleared itself the indication on the instrument would also clear. The meter faces for each channel were marked to indicate a 10% test signal reading.

C. Operational Problems and Solutions

Replacement of Reactor Bridge Platform Jacks

The four scissor jacks used to lift the bridge yoke and reactor frame structure were replaced. The old jacks became difficult to operate and replacement of shaft thrust bearings did not correct the problem. It was determined by inspection that the lead screws on the jacks had experienced excessive wear and the jacks should be replaced.

Pool Water Leak During Removal of Boral Liner in Beam Port No. 4

The boral liner in the small diameter section of beam port No. 4 was removed using an extended chisel tool to cut through the ¼ inch thickness of the boral. During removal of the boral the tool struck the flanged end of the aluminum beam port extension tube causing the flange to leak at the O-ring seal. The leak was small but action was taken to prevent loss of pool water from the stall. The pool gate was positioned and replacement of the damaged beam port extension was reviewed by the operations staff. The pool stall was drained and a new beam port extension was installed. O-rings were replaced on all beam port flanges and the seal on the primary water return flapper valve was replaced. The pool walls of the stall were cleaned and adjustments were made to the neutron radiography reflector. After filling the pool and testing the stall, pool divers installed an extension to beam port No. 5 located in the large pool section. Pool water loss was prevented during installation of the extension by plugging the end of the beam port with a pneumatic pipe plug device and a backup seal provided by closure of the O-ring sealed beam port shield door.

Replacement of Bearings in the Primary Pool Water Cooling Pump

The pump shaft bearings on the primary pool water cooling pump were replaced due to overheating of the old bearings. A garden hose water supply was connected to cool the bearings until replacement could be scheduled. The bearing cooling procedure permitted continued operation of the reactor through a busy schedule. The bearings were replaced and the pump returned to normal operation.

Installation of Vibration Reducing Snubbers on Water System Gauges

Gauges used to measure water pressures are often damaged by vibrations from pulsating water pressures within the system. Snubbers that reduce pressure surges were installed on gauges used in the reactor pool water cooling system and recirculation system (to prevent damage to the gauges). The snubbers were very effective.

D. Changes in Operating Procedures

The RSB approved two experiment authorizations during the reporting period. The authorizations are described below:

Authorization Number and Title		Safety Evaluation Summary
EA-57-1	Neutron Radiography, Scram Circuit Modification	A reactor scram occurs if the Beam Port #4 cave door is opened when the reactor is operating within 18 inches of the beam port reflector. The scram circuit insures the safety of persons entering the cave and those working near the neutron radiography facility.
E-2	"Use of Pneumatic Systems"	The authorization is an update of the previous authorization EA-6. The authorization covers the use of pneumatic transfer systems to provide rapid sample handling between laboratories and irradiation positions in or near the reactor core for sample activation and production of any isotope in the periodic table. The use of CO_2 as the transfer gas insures low levels of radioactivity by activation. Area radiation detectors are located at sample receiver locations with readouts to the reactor control room for surveillance. The reactor operator has primary control of the systems with option to transfer control to the experimenter.

The following new SOP's were reviewed and approved by the RSB during the reporting period:

SOP Number	Title
III-Q	Special Nuclear Materials Accountability
IV-F	Neutron Radiography Beam Port No. 4
VIII-F	Review Requirements for Security Plan
IX-A	Introduction to Emergency Plan

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Changes to the following SOP's were approved by the RSB during the reporting period:

SOP Number	Title
I	Policy and Procedures (Changes to establish the "Modifications Authorization")
II-F-I	Reactor Shutdown (Revision of NSC Form 533 Daily Shutdown Check List)
VIII-E	Testing and Maintenance of Security Systems (Revision of Intrusion Alarm Drill)
IX-B-5 and IX-B-6	Emergency Procedures and Plans (Changes to response to intrusion and pool level alarms)
II-J	Power Calibration (corrections)
Figure I-D-1	Experiment Authorization Form 111 (revised)
Figure I-D-2	Modification Authorization Form 115 (revised)
Figure IV-A-2	Description of Services Requested, Form 111 (revised)
III	Reactor Maintenance and Surveillance (Changes to NSC Forms 540, 541, 542, 543, 544 and 570)

E. Unscheduled Shutdowns

There were no unscheduled shutdowns of the NSCR during 1978.

F. Reactor Maintenance and Surveillance

1. A calibration of the fuel temperature measuring channel was performed on 1-9-78. The LSSS was set at 535°C (975°F).

2. A channel check of the fuel element temperature measuring channel was made daily by recording the fuel element temperature and the pool water temperature prior to reactor startup.

3. The control rods were calibrated on 1-9-78 and 2-13-78 with the following results:

Core IV A

Control Rod	Rod Worth
SS #1	$2.89
SS #2	2.00
SS #3	3.34
SS #4	4.34
R	0.53

The shutdown margin was determined to be $0.87

4. The reactivity worth of all experiments were either estimated or measured, as appropriate, before reactor operation with the experiment. The most reactive experiment irradiated had a worth of -53¢.

5. Pulse tests were not performed during the reporting period due to the non-pulsing restriction initiated on 1 October 1976. This restriction has been enforced since the discovery of damaged FLIP fuel elements adjacent to the transient rod.

6. The scram times of the control rods were measured with the following results:

Date	Control Rod	Time In Seconds
1-9-78	SS #1	0.62
	SS #2	0.62
	SS #3	0.55
	SS #4	0.62
1-20-78	SS #1	0.61
1-27-78	SS #4	0.66
2-24-78	SS #3	0.60
2-27-78	SS #2	0.67
3-3-78	SS #4	0.72
	SS #4	0.70
3-21-78	SS #3	0.61
	SS #4	0.64
9-25-78	SS #4	0.68

7. A channel test of each of the reactor safety system channels for the intended mode of operation was performed prior to each day's operation. The pool level alarm was tested weekly.

8. Channel calibrations were made of the power level monitoring channels by the calorimetric method as follows:

CHANNEL CALIBRATIONS

Date	Indicated Power	Actual Power	% Error
1-9-78	400	387.8	- 3.1
*6-5-78	400	373.5	- 6.6

(* Rods tilted)

9. The ventilation system was verified to be operable by conducting a test of the system each week throughout the year.

10. Emergency evacuation drills were conducted on 1-27-78, 9-22-78, 12-6-78.

11. Checks were performed to verify that the NSC security alarm system was operable each week throughout the year.

12. Calibration dates for facility air monitors and area radiation monitors were as follows:

Monitoring System	Date of Calibration
Ch #1 - Stack Particulate	3-3-78
Ch #2 - Fission Product	3-1-78
Ch #3 - Stack Gas	8-31-78
Ch #4 - Building Particulate	6-30-78
Ch #5 - Building Alpha	6-30-78
Ch #6 - Building Gas	8-31-78
Area Radiation Monitors	1-9-78

13. An intrusion alarm test was conducted on June 21, 1978. The intrusion drill was audited by a member of the Reactor Safety Board. The response time by the University Police was very good and the radio operator followed the procedures as required.

14. A review of the security plan for the reporting period was made by the NSC staff and the RSB in January 1979. The conscientious and responsive attitude of the University Police toward the security of the NSC was noted. A revised listing of instructions was prepared for use by the radio operators in their response to intrusion and pool level alarms. Procedures for response tc intrusion and pool level alarms by the University Police were also upgraded.

IV. FACILITY ADMINISTRATION

A. Organization

The organizational chart of the Nuclear Science Center is presented in Figure 4. D. E. Feltz was promoted from Assistant Director to Associate Director of the NSC in September 1978. K. L. Walker joined the NSC Management in June 1978 as Reactor Coordinator. J. P. Taft assumed the duties of the day shift reactor supervisor following the resignation of B. J. Browning. J. P. Taft and C. E. Harris received their Senior Reactor Operator License in March 1978.

B. Personnel

The following is a list of personnel of the Nuclear Science Center for the period January 1, 1978 - December 31, 1978.

Facility Administration and Reactor Operations Staff

+Browning, B. J.	- Reactor Supervisor (terminated)
+Feltz, D. E.	- Associate Director and Manager of Reactor Operations
+Harris, C. E.	- Reactor Operator
Jones, C. E.	- Reactor Operator (trainee) (terminated)
+Randall, J. D.	- Director
Rogers, R. D.	- Reactor Operator (trainee)
*Stasny, G. S.	- Reactor Operator
+Taft, J. P.	- Research Engineer
+Theis, J. W.	- Reactor Supervisor
Waldrep, G. W.	- Reactor Operator (trainee)
Walker, K. L.	- Reactor Coordinator

*Licensed Reactor Operator

+Licensed Senior Reactor Operator

Technical Service and Maintenance

Allen, D. R.	- Electronics Technician
Ball, J. R.	- Co-Op Research Aide

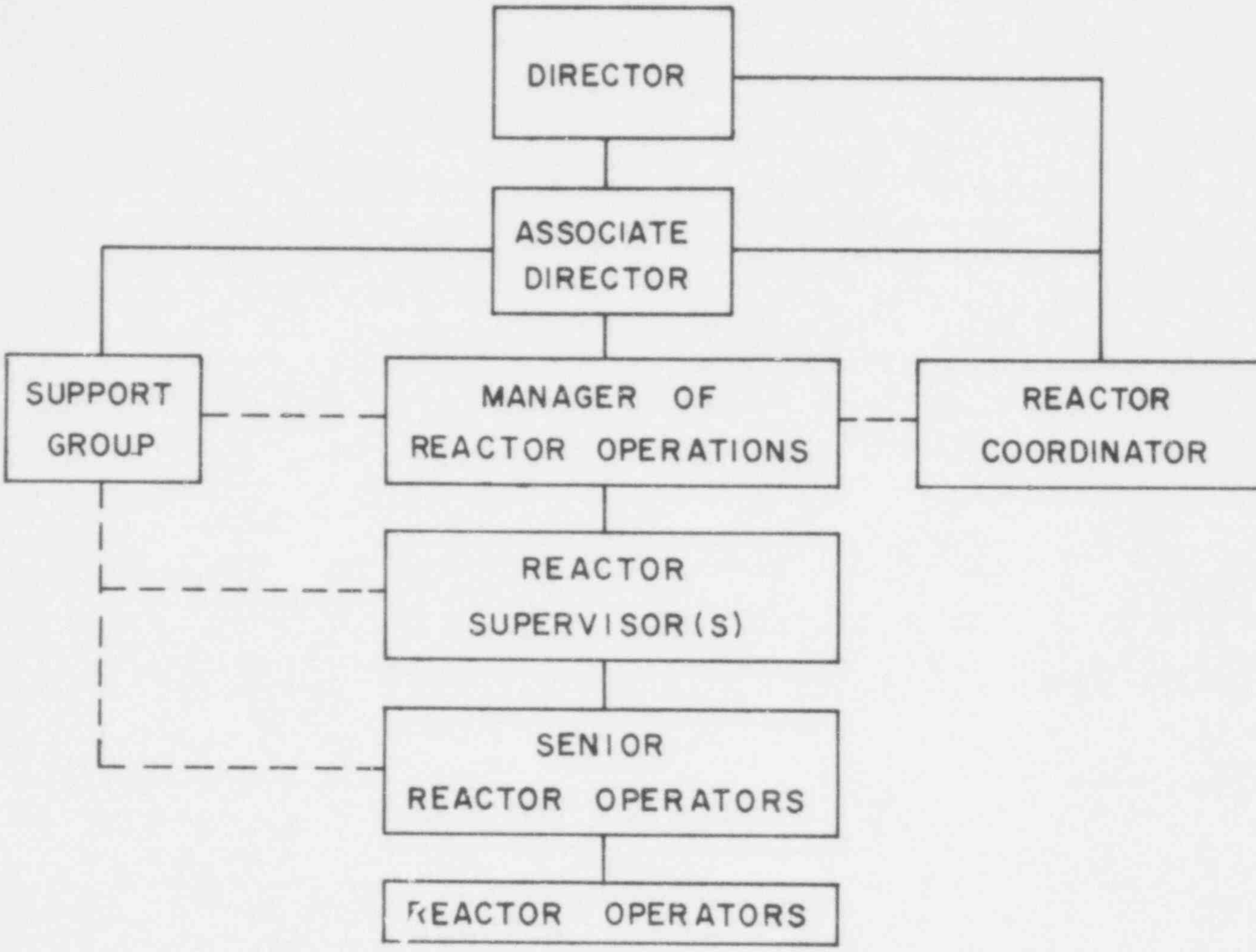

FIGURE 4 THE NUCLEAR SCIENCE CENTER ORGANIZATIONAL CHART

Technical Service and Maintenance (cont.)

Buckner, R. K.	- Student Technician (terminated)
Echols, R. M.	- Draftsman I
Greene, R. K.	- Co-Op Research Aide
Fickey, J. B., Jr.	- Maintenance Worker II
Greer, K. W.	- Maintenance Worker (terminated)
Horn, C. R.	- Mechanical Equipment Foreman
Overman, W. W.	- Student Worker II (terminated)
Urbantke, M. G.	- Research Associate
Perks, M. F.	- Co-Op Research Aide (terminated)
Price, J. E.	- Co-Op Research Aide
Restivo, A. L.	- Facility Maintenance Foreman
Simmons, W.	- Research Associate (terminated)
Jamieson, M.	- Student Worker IV

Clerical

Mitchell, Y.	- Secretary
Snow, S. S.	- Secretary (terminated)
Westbrook, B. M.	- Bookkeeper

Health Physics Staff

Bates, E. F.	- Senior Health Physicist
Bell, S. R.	- Co-Op Research Aide (terminated)
Clements, R.	- Co-Op Research Aide (terminated)
Woelfel, R. E.	- Health Physicist
Huereque, E.	- Co-Op Research Aide

C. Reactor Safety Board

Committee Composition

Dr. R. R. Berg, Chairman, Professor and Director, Office of University Research

(January 1, 1978 - December 31, 1978)

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Committee Composition (cont.)

Dr. J. K. Gladden, Professor of Chemistry
(January 1, 1978 - December 31, 1978)

Dr. D. Hightower, Professor of Veterinary Physiology and Pharmacology
(January 1, 1978 - December 31, 1978)

Dr. L. C. Northcliff, Associate Professor of Physics
(January 1, 1978 - December 31, 1978)

Dr. F. Sicilio, Associate Professor of Chemistry
(January 1, 1978 - December 31, 1978)

Dr. H. R. Thornton, Associate Professor of Mechanical Engineering
(January 1, 1978 - December 31, 1978)

Dr. R. G. Cochran, (Ex-Officio), Professor and Head of Nuclear Engineering
(January 1, 1978 - December 31, 1978)

Dr. R. D. Neff, (Ex-Officio), Professor and University Radiological Safety Officer
(January 1, 1978 - December 31, 1978)

Dr. J. D. Randall, (Ex-Officio), Professor of Nuclear Engineering and Director of Nuclear Science Center
(January 1, 1978 - December 31, 1978)

Meeting Frequency

The Reactor Safety Board (RSB) met two times during the calendar year 1978.

RSB Audits

During the reporting period RSB audits of NSC activities were conducted on the following dates: 3/13/78, 6/21/78, 9/28/78.

APPENDIX I

Description of Projects Utilizing the NSCR

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DESCRIPTION OF PROJECTS UTILIZING THE NSCR

A. Texas A&M University

Veterinary Physiology

TOXICITY OF ANTIMONY IN CHANNEL CATFISH

Personnel

Dr. B. J. Camp -- Professor
Mr. Stacy Tamulinas -- Graduate Assistant

Channel Catfish are exposed to subacute levels of antimony for thirty days. Tissue samples from the fish are then analyzed using neutron activation analysis to ascertain where the antimony is concentrated. Blood chemistry tests and histopathology are used to determine if there is a correlation between the antimony present and any lesions produced.

Veterinary Medicine

DEVELOPMENT OF PROSTATIC IMAGING AGENT

Personnel

Robert R. Badertscher, II -- Clinical Research Associate
Dr. Dan Hightower -- Professor
Dr. David M. Hood -- Professor

The main objective of this project was to develop a prostatic imaging agent with the dog as a model. Our hypothesis was that Palosein, a copper containing superoxide dismutase enzyme, could be used as a labeled scanning agent which is selectively taken up by the prostate gland and externally imaged in neoplastic conditions. To accomplish this, we attempted to exchange activated ^{64}Cu for the two copper atoms in the Palosein molecule, by adjusting the pH of the 0.1 molar sodium acetate solution down to 3.7 for 30 minutes, and then neutralizing the pH back to 7.0 with sodium hydroxide. The supernate was passed through a G-25 Sephadex column and 1.0 ml fractions were collected for approximately one hour.

Chemistry

TRACE ANALYSIS OF CEMENTS

Personnel

Dr. Thomas Vickery -- Assistant Professor
Ms. Gabrielle Harrison -- Graduate Assistant

The trace elements analyzed will be used in the establishment of a procedure for the "fingerprinting" of cements. NAA is used here to acquire (1) a profile of the elements present in the samples, (2) a quantitative determination of the concentration of the trace elements of interest, informations that would complement any further data obtained from other methods.

College of Medicine

Experimenter -- Dr. Mike Devous

A canine model of congestive heart failure was developed in which "infarction-like" damage to the left ventricle was induced by β-radiation in multiple states.

Center for Trace Characterization

PROJECTS USING NEUTRON ACTIVATION ANALYSIS

Personnel

Dr. Emile A. Schweikert -- Professor, Chemistry
Dr. David Moore -- Assistant Research Chemist
Dr. John McGinley -- Assistant Research Chemist
Ms. Ann McGinley -- Graduate Assistant
Melinda Yulo -- Graduate Assistant
Dr. John Efimenko -- Assistant Research Chemist

The Center for Trace Characterization utilized the 1 Megawatt reactor and Nuclear Science Center on a variety of research projects during the past year. The majority of these projects involved Instrumental Neutron Activation Analysis (INAA) for the determination of trace substances in a variety of matrices at the ppm and sub-ppm level. Basically, the INAA work falls in three categories: (1) Pollution, (2) Anthropology-Archaeology, and (3) Marine Life.

(1) Pollution. (a) The CTC cooperated with NASA in the analysis of air particulate samples for 25-30 trace elements in an effort to identify sources of air pollution and establish baseline measurements. (b) Vanadium and Barium measurements were made on marine biota and ocean and river sediments to obtain baseline concentration values prior to oil drilling operations. Similar measurements were also made to assist in the study of the basic geochemistry of these metals.

(2) Anthropology-Archaeology. (a) A study was undertaken to trace regional origins via trace metal content of various flint and churd samples obtained in West Texas Indian diggings.

(3) Marine Life. Benchmark investigations of trace metals in the marine environment was conducted under a bureau of land management contract.

Radiological Safety Office

SEDIMENT DATING AND SEDIMENTATION RATES AS DETERMINED BY FALLOUT

Personnel

Dr. R. D. Neff -- Radiological Safety Officer
Joe Harville -- Graduate Assistant

The purpose of this project is to determine if it is possible to measure the ver ical distribution in an ocean core of fallout related rad onuclides. From this measured distribution and the known yearly atmospheric fallout rate, it is believed that a correlation can be drawn which will allow a determination of the data of the sediment sample, as well as, an approximation of the rate of sedimentation.

Chemistry

POTASSIUM IN ZIRCONIUM SAMPLES

Personnel

Dr. A. Clearfield -- Professor
Gary Day -- Graduate Assistant

The purpose of the work at the Nuclear Science Center was to determine potassium in samples of the inorganiz ion exchanger zirconium bis (monohydrogen orthophosphate). These samples were obtained from calorimetric experiment whose interpretation require a knowledge of the load (or percent composition) of the solid phase. Standard samples were prepared from zirconium pyrosphosphate and potassium biphthalate ($KHC_8H_4O_4$) in known mass ratios. All standards and samples were dried at 100°C for 24 hours, weighed into plastic vials ($\sim$ 0.1 gm each) and sealed. Samples and standards were irradiated for 1 minute, allowed to decay for 5 minutes and counted using detector number one on the Canberra Scorpio MCA 2000 System for 300 seconds. Standards were then used to compute the radiation flux for each element required (Zr, Hf, K) and these fluxes were then used in the MASCAL program to compute the mass (and thus % composition) of each element in the unknown samples. In all about 60-65 samples and standards were used and the results were quite adequate for the purpose intended.

Chemistry

Au^{198} AS A STATIC ELECTRICITY ELIMINATOR

Personnel

Dr. A. Clearfield -- Professor
Gary Day -- Graduate Assistant

During the course of the determination of the equilibrium constant of the following reactor, it was decided the extent of reaction gravimetrically:

$$Zr(MPO_4)_{2(s)} + 2HCl_{(g)} \rightarrow Zr(HPO_4)_{2(s)} + 2MCl_{(s)}$$

where M = Li, Na, K.

The corrective atmosphere and high temperatures involved led to the use of Au^{198} foil as a static electricity eliminator inside the balance assembly. Three foils were activated ($\sim$ 3mc each) and one dropped into the balance every four days. Static elimination proved excellent but the short half-life precludes further use.

Chemistry

Personnel

Dr. Yi-Noo Tang -- Professor
Dr. E-Chung Wu -- Professor
R. R. Clark -- Graduate Assistant
M. A. Griffin -- Graduate Assistant
Ray Johnson -- Graduate Assistant
Dr. E. E. Seifert -- Post Doctorate Work
R. A. Ferrieri -- Graduate Assistant

Recoil tritium atoms, generated from ^3He (n,p) ^3H process with thermal neutrons from the reactor, reacted with organic compounds such as C_2H_5F, C_2H_5Cl and C-C_4H_8 to yield products either from abstraction or substitution. The substituted products thus formed carried a large amount of residue energy. The pressure dependence of the unimolecular decompositions of these substitutional products has been investigated under a very wide range of pressure including the use of large aluminium containers for low pressure studies. The results indicated that (1) essentially all excited molecules will decompose under a very low pressure condition, and (2) the fraction decomposed (or stablized) varied as a linear function of log P_{eff}. The affective pressure, P_{eff}, were calculated by taking into consideration the relative collisional efficient of the component molecules in each system. Further studies on pressure effect and the analysis of energetics of these and other similar systems are in progress.

The reactions of recoil ^{31}Si atoms formed by the nuclear transformation, $^{31}P(n,p)^{31}Si$, have been studied. In such systems, it has been shown that recoil ^{31}Si atoms will abstract either H from PH_3 or F from PF_3 to give the corresponding silylenes, $^{31}SiH_2$ or $^{31}SiF_2$. The reactions of the silylenes thus formed with various conjugated dienes are the major concern of this program. It has been shown that these silylenes formed in the nuclear recoil system consist of about 20% singlet and 80% triplet. The addition of silylenes in all of these forms will add to conjugated dienes to give the corresponding silacyclopent-3-enes. The relative reactivities of the butadiene, various pentadienes and hexadienes are being studied, and the nature of a large steric effect observed in some of the addition reactions is under serious consideration.

Geology

Personnel

Dr. Thomas T. Tieh -- Associate Professor
Dr. Wen H. Huang -- Associate Professor
James Chatham -- Graduate Assistant
Steve Parks -- Graduate Assistant
Ernest Ledger -- Graduate Assistant
J. Straccia -- Graduate Assistant
M. Miller -- Graduate Assistant

1) Work involved mapping of uranium content throughout a South Texas mine; also examination for Uranium-material or straight Uranium content in clay.

2) Release of U and TH from granitic rocks. Granitic rock material representative of unweathered rock, weathered granitic rock from soil profiles developed in situ on parent granitic rocks, and granitic material transported by a local stream traversing granitic rock was sampled in order to characterize parameters upon which the distribution and release of U and Th during weathering and local transportation are critically dependent. In addition to field reconnaissance and examination of the samples with standard petrographic techniques, all samples were analyzed by nuclear techniques.

Particle track analysis was used on thin sections of the granite to determine the pre-weathering distribution and approximate concentration of U among the constituent phases of the rock. Gamma ray spectrometry of natural decay products was used to determine U, Th, and K in the parent granite, soil profile material, and in the stream sediment. Delayed-neutron counting was used to determine U in stream sediment samples, soil profile samples and size and mineralogic fractions of those samples to better delineate phases critical to U and Th loss and transportation.

While Th favors accumulation in soil materials, U is seen to be mobilized early in weathering, with considerable loss from the granitic material to the ground water system. In areas of favorable structure, this loss of easily-mobilized U from granitic rocks is known to have contributed to the formation of economic deposits of U.

Oceanography

Personnel

Dr. B. J. Presley -- Professor
J. Schofield -- Research Associate
J. Trefry -- Research Associate
Ron Pflaum -- Student Assistant

Work involved analysis of vanadium content to marine organisms (fish, 300-plankton, and shrimp in particular) from the South Texas Outer Continental Shelf to assess possible vanadium contamination from petroleum-related activity. With support from the Bureau of Land Management, a method of extracting the Vanadium from the biota, and thus obtaining reliable data in the PPB levels, is being developed.

Oceanography

URANIUM IN ANOXIC SEDIMENTS ON THE GULF COAST

Personnel

Dr. William Sackett -- Professor
Frederick Webber -- Graduate Assistant

A worldwide increase in nuclear power dependency and a continual depletion of high grade uranium ores are resulting in the utilization of lower and lower grade uranium deposits. For example sandstones in the South Texas Coastal Plain with from 0.1 to 0.2% uranium are presently being mined. In the future, high uranium-bearing materials in the sea may become important economic sources of this valuable element.

One potential source of uranium in the ocean is anoxic environments. Several studies have shown that there is more than an order of magnitude uranium enrichment in anoxic sediments (up to 0.01%). Anoxic sediments along the Gulf

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Coast such as found in the newly discovered Orca basin and in various estuarine and near shore environments may show similar or greater enrichments than those found elsewhere. Thus, the goal of this work is to determine uranium concentrations in sediments in various anoxic environments along the Gulf Coast in order to provide the data base for the evaluation of anoxic Gulf Coast marine sediments as future uranium sources.

Nuclear Engineering

Personnel

Dr. Ron Hart -- Associate Professor
Les Albert -- Graduate Assistant

MEASUREMENTS OF ^{31}P CONCENTRATIONS PRODUCED BY NEUTRON TRANSMUTATION DOPING OF SILICON

The absolute concentrations of ^{31}P, produced by the irradiations of float-zoned silicon samples in the Texas A&M University Research Reactor, have been measured in an accuracy of ± 10%. The neutron fluence was varied from 10^{16} to 10^{18} n/cm^2, which corresponded to ^{31}P concentrations in the 10^{12} to 10^{14} atoms/cm^3 range. The results are based on measurements of the absolute activities of ^{31}Si by detection of 1.266 MeV gamma rays. Secondary standards of Fe were required for the larger neutron fluences. The ^{31}P concentrations were compared to the concentrations of electrically active P following 850°C anneals for 1 hour. These concentrations were determined in the same samples from temperature-dependent Hall effect measurements at Hughes Research Laboratories. The two results agree within experimental error, thus confirming that transmuted P in the 10^{12} to 10^{14} atoms/cm^3 range is completely electrically active following 850°C, 1-hour anneals of float-zoned silicon. In addition, a corrected value for the gamma abundance of ^{31}Si was established to be 5.6×10^{-4} ± 10%.

MEASUREMENT OF THE NEUTRON ENERGY SPECTRUM IN THE THERMAL ROTISSERIE

Personnel

Dr. Ron Hart -- Associate Professor
David Wootan -- Graduate Assistant

In neutron transmutation doping of semiconductor material, accurate calculations of resulting dopant concentrations require a thorough knowledge of the neutron flux at various energies. In this project, the specially averaged energy spectrum was measured in the NSC thermal neutron rotisserie irradiation device.

Using input generated from activation of threshold and fission foils, the SAND-II computer code was employed for spectrum unfolding. The results showed a total neutron flux of 1.15 x 10^{13} n/cm^2-sec above 10^{-10} MeV.

Animal Science

FLOW OF INGESTED FORAGE PARTICLES THROUGH THE G.I. TRACT OF CATTLE

Personnel

Dr. W. C. Ellis -- Professor
Mr. John Snell -- Research Associate
Mr. Carlos Lascano -- Graduate Assistant

An experiment was conducted utilizing several different rare earth radionuclides as flow markers of ingested forage particles through the gastrointestinal tract of grazing cattle. Isotopes used include ^{141}Ce, ^{169}Yb, ^{147}Nd.

Ingested forage was collected from several surgically modified heifers grazing within university owned land. This material was then labelled with one radionuclide and introduced into each animal's stomach. Collection of ingesta and feces was done, and these were prepared and analyzed on a NaI(Tl) detector. From assay, information concerning particle flow was collected.

B. Other Universities

Lamar University

SENIOR LABORATORY EXPERIMENT IN RADIOACTIVITY

Personnel

Dr. H. T. Baker -- Head, Department of Chemistry

Seniors and graduate level students enrolled in Chemistry 331 used the reactor and a gamma spectroscopy system in an experiment designed to demonstrate principles of radioactive decay and techniques of neutron activation analysis.

McClennan Community College

NEUTRON ACTIVATION ANALYSIS

Personnel

Mr. Don Tatum -- Physics Instructor

A laboratory experiment was performed to expose the class to the environment of a reactor facility and to demonstrate the principles and techniques of neutron activation analysis using gamma-ray spectroscopy.

Texas State Technical Institute

RADIOACTIVE DECONTAMINATION EXERCISE

Mr. H. Diegel -- Instructor, Nuclear Systems Technology

As part of a final laboratory exam, students participated in a mock emergency situation involving live radioactive isotopes. A controlled area of the NSC was contaminated and students were required to survey the area, identify sources and contamination levels, and clean up the area. This was performed as part of a second year health physics class and illustrated the basic techniques of controlling such a situation.

NEUTRON ACTIVATION ANALYSIS

Personnel

Mr. Rob York -- Chairman, Nuclear Systems Technology
Mr. Bill Mahan -- Instructor, Nuclear Systems Technology

A laboratory experiment was performed to demonstrate the principles and techniques of neutron activation analysis using gamma-ray spectroscopy. This work was performed as a laboratory experiment of the Nuclear Systems Technology 204 course, Radioisotope and Radiation Application.

NUCLEAR REACTOR EXPERIMENTS

Personnel

Mr. Rob York -- Chairman, Nuclear Systems Technology
Mr. Bill Mahan -- Instructor, Nuclear Systems Technology

A series of experiments were performed in order to familiarize the students with reactor concepts and characteristics. These included:

(1) control rod calibration,
(2) radial core flux distribution determination,
(3) reactor startup.

Rice University

SENIOR LABORATORY EXPERIMENT IN NUCLEAR ENGINEERING

Personnel

Dr. Thomas W. Leland -- Professor of Nuclear Engineering

Twelve senior and first year graduate students enrolled in Chemical Engineering 631 used the reactor in a one-day experiment sequence as part of an introductory course in Nuclear Engineering. The experiments were:

(1) A tour of the reactor facility with special emphasis on operational procedures for startup, control, monitoring devices, and safety features.

(2) Measurement of a flux traverse through the core of the reactor by irradiating a copper wire, counting segments cut along the traverse, and plotting the relative flux versus position.

(3) A control rod calibration using the positive period method.

APPENDIX II

Publications, Theses, and Papers Presented at Technical Meetings Which Involved Use of NSC Facilities From 1976 to Date

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Publications, Theses, and Papers Presented at Technical Meetings Which Involved Use of NSC Facilities From 1976 to Date

1. O.F. Zeck, G.P. Genarro, Y.Y. Su and Y. -N. Tang, "Effect of Additives on the Reaction of Monomeric Silicon Difluoride with 1, 3-Butadiene," J. Amer. Chem. Soc., 98, 3474 (1976).

2. R.A. Ferrieri, E.E. Siefert, M.J. Griffin, O.F. Zeck and Y. -N. Tang, "Relative Reactivities of Conjugated Dienes towards Silicon Difluoride," J.C.S. Chem. Comm., 6 (1977).

3. M.D. Devous, Sr., "A Radiation-Induced Model of Chronic Congestive Heart Failure", Scott and White Hospital, Department of Radiology and Nuclear Medicine, May, 1977.

4. M.D. Devous, Sr., "A Canine Model of Gongestive Heart Failure", University of Florida, Department of Radiology and Department of Cardiology, November 1977.

5. D.E. Feltz, J.D. Randall and R.F. Schumacher, "Report on Damaged FLIP TRIGA Fuel", Fifth Triga Owner's Conference, Tucson, Arizona, March 1977.

6. J.D. Randall, "Forensic Activation Analysis", NSCR Technical Report No. 36, November 1977.

7. R.R. Hart, L.D. Albert, "Measurement of P^{31} Concentrations Produced by Neutron Transmutation Doping of Silicon", Presented at International Conference on Neutron Transmutation Doping, University of Mo., April, 1978.

8. D. Wootan, "Measurement of Neutron Flux in Thermal Rotisserie", Master's Thesis in Nuclear Engineering, November, 1978.

9. Huang, W., J. Chatham, "Uranium in Lignite: I Geological Occurrence in Texas", Tenth International Congress on Sedimentology, Volume 1, A-L, pp. 317, 1978.

10. Huang, W., S. Parks, "Uranium Resources in Some Tertiary Sediments of Texas Gulf Coastal Plain: I Geologic Occurrences in the Lower Miocene Sediments", Tenth International Congress on Sedimentology, Vol. 1, A-L, pp. 318, 1978.

11. Huang, W., K. Pickett, "Future Controlling In-Situ Leaching of Uranium from Sandstone and Lignite Deposits in South Texas", Proceedings of Uranium Mining Technology, Update 78, Reno, Nevada, November, 1978.

12. Presley, R.J., R. Pflaum, J. Trefry, "Fallout and Natural Radionuclides in Mississippi Delta Sediments", Environmental Oceanographic Science, Vol. 59, No. 4, April, 1978 (abstract).

13. Lescano, C., W.C. Ellis, "An Evaluation of Lanthanides as Particulate Matter Markers", American Society of Animal Science (abstract), Tucson, Arizona, 1979.

14. Bachinski, S.W. and Scott, R.B., 1979, "Rare-Earth and Other Trace Element Contents and the Origin of Mineetes: Grochim. Cosmochim. Acta", Vol. 43, 93.

15. Scott, R.B., Temple, D.G., and Peron, P., 1979, "Nature of Hydrothermal Exchange Between Oceanic Crust and Seawater at 26°N. Lat., Mid-Atlantic Ridge: In Benthic Boundary Layer Processes", an IOGC Symposium on the Benthic Boundary Layer, In Press.

16. Tiezzi, L.J., and Scott, R.B., 1979, "Crystal Fractionation in a Cumulate Gabbro, Mid-Atlantic Ridge, 26°N, Lat.: Jour. Geophys. Research", In Press.

17. McGoldrick, P.J., Keays, R.R. and Scott, R.B., 1979, "Thallium: A Sensitive Indicator of Rock/Seawater Interaction of Sulfur Saturation of Silicate Melts: Geochim. Cosmochim. Acta", In Press.

18. Zakoriadze, G., Scott, R.B., and Lilly, D.H., 1979, "Petrology and Geochemistry of the Palao-Kyushu Remnant Arc, Site 448, DSDP Leg 59: Trans American Geophys. Union", v. 50, 94.

19. Scott, R.B., 1979, "Petrology and Geochemistry of Ocean Plateaus", A TAMU Symposium on Ocean Plateaus.

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Appendix III

Effluent Release Summary

Environmental Survey Program

Radiation and Contamination Control Program

and

Personnel Exposure Summary

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EFFLUENT RELEASE SUMMARY

Introduction

Summaries of radioactive effluent released from the Nuclear Science Center for 1978 are included in this appendix. These data are presented in tabular form and include atmospheric, liquid and solid waste releases.

Particulate Releases

Radioactive particulates are monitored at the base of the central exhaust stack and summarized on a monthly basis. The annual average release rate was 1.15 E-11 µCi/cc. Total radioactivity released for 1978 was 8.58 E-04 Ci. There were no radioisotopes with > 8 day half-lives identified from isotopic analyses of the filter papers. These analyses revealed only the decay daughters of Radon-Thoron. These data are presented in Table 1.

Gaseous Releases

Argon-41 is the major gaseous effluent produced and released at the Nuclear Science Center. This effluent is measured by photopeak counting the gaseous discharges in the central exhaust stack. Total argon-41 radioactivities released during 1978 was 2.30 Ci. This reflects a 20% decrease of radioactivities released in 1977. This reduction is the result of no reactor operations utilizing the irradiation cell and an extended effort by experimenter personnel in the proper use and operation of the NSC pneumatic irradiation systems. These data are summarized on a monthly basis and presented in Table 2.

Liquid Waste Releases

Radioactive liquid effluents are collected in liquid waste holdup tanks prior to release from the confines of the Nuclear Science Center. Sample analyses for radioactivity concentrations and radioisotope identification were determined for each release. There were 31 liquid waste releases totaling 5.17 E05 gallons from the Nuclear Science Center during 1978. The total radioactivity released for 1978 was 6.53 E-03 Ci with an average concentration of 3.33 E-06 µCi/cc. Radioisotopes were identified as ^{60}Co, ^{58}Co, ^{54}Mn, ^{65}Zn, ^{192}Ir, ^{124}Sb, ^{57}Co, ^{137}Cs, ^{122}Sb, and ^{24}Na. Releases were below the limits specified in 10CFR20. Summaries of these release data are presented in tables 3-14.

Solid Radioactive Waste

There was 242 ft^3 of solid waste materials generated at the Nuclear Science Center in 1978. This waste was transferred to the Radiological Safety Office, Texas License No. 6-448, for disposal. The bulk of this waste, 191 ft^3 was mixed resin beads and charcoal from the demineralizer system. The remaining 42 ft^3 was in the form of paper, poly gloves, rags, and other expendable laboratory items. Total radioactivity was 6.34 E-03 Ci. Radioisotopes were identified as ^{124}Sb, ^{192}Ir, ^{51}Cr, ^{60}Co, ^{65}Zn, ^{152}Eu, ^{109}Cd, ^{54}Mn, and ^{57}Co. These data are summarized in Table 15.

TABLE 1

PARTICULATE EFFLUENT RELEASES

ANNUAL SUMMARY

1978

Month	Exhaust Volume cc	Concentration µCi/cc	Total Radioactivity µCi	Ci
January	6.31 E 12	4.67 E-12	29.47	2.95 E-05
February	5.71 E 12	6.53 E-12	37.28	3.73 E-05
March	6.31 E 12	6.17 E-12	38.93	3.89 E-05
April	6.12 E 12	1.01 E-11	61.81	6.18 E-05
May	6.31 E 12	6.89 E-12	43.47	4.35 E-05
June	6.12 E 12	9.07 E-12	55.51	5.55 E-05
July	6.31 E 12	1.82 E-12	11.48	1.15 E-05
August	6.31 E 12	1.60 E-11	101.00	1.01 E-04
September	6.12 E 12	1.38 E-11	84.45	8.45 E-05
October	6.31 E 12	5.08 E-12	32.05	3.21 E-05
November	6.12 E 12	3.23 E-11	197.67	1.98 E-04
December	6.31 E 12	2.61 E-11	164.70	1.65 E-04

Total Volume: 7.44 E 13 cc

Annual Average Release: 1.15 E-11 µCi/cc

Total Radioactivity Released: 8.58 E-04 Ci

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TABLE 2

GASEOUS EFFLUENT RELEASES

ARGON-41

ANNUAL SUMMARY

1978

Month	Exhaust Volume cc	Concentration* µCi/cc	Concentration** µCi/cc	Percent** MPC	Radioactivity* Total (Ci)
January	6.31 E 12	3.10 E-08	1.55 E-10	0.4	1.95 E-01
February	5.71 E 12	3.10 E-08	1.55 E-10	0.4	1.77 E-01
March	6.31 E 12	3.10 E-08	1.55 E-10	0.4	1.95 E-01
April	6.12 E 12	3.35 E-08	1.68 E-10	0.4	2.05 E-01
May	6.31 E 12	4.62 E-08	2.31 E-10	0.6	2.92 E-01
June	6.12 E 12	4.62 E-08	2.31 E-10	0.6	2.82 E-01
July	6.31 E 12	1.37 E-08	6.85 E-11	0.2	8.69 E-02
August	6.31 E 12	6.68 E-08	3.34 E-10	0.8	4.21 E-01
September	6.12 E 12	2.35 E-08	1.18 E-10	0.3	1.43 E-01
October	6.31 E 12	2.10 E-08	1.05 E-10	0.3	1.33 E-01
November	6.12 E 12	1.62 E-08	8.10 E-11	0.2	1.10 E-01
December	6.31 E 12	1.13 E-08	5.65 E-11	0.1	7.13 E-02

Total Volume: 7.44 E 13 cc

Annual Average Release*: 3.09 E-08 µCi/cc

Total Radioactivity Released*: 2.30 Ci

*As Measured in the Central Exhaust Stack

**As Determined at 100 meters, approximate boundary of exclusion area, with 200/1 Dilution Factor; SAR, Pages 103-105, August 1967

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TABLE 3
RADIOACTIVE LIQUID EFFLUENT RELEASES
SUMMARY
1978

Isotope	Number Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{65}Zn	22	3.74 E 05	1.16 E-06	1.0 E-04	1.2	1.65 E-03
^{60}Co	24	4.04 E 05	1.05 E-06	3.0 E-05	3.5	1.62 E-03
^{54}Mn	25	4.20 E 05	8.90 E-07	1.0 E-04	0.9	1.42 E-03
^{58}Co	22	3.72 E 05	5.18 E-07	1.0 E-04	0.5	7.31 E-04
^{24}Na	4	8.31 E 04	2.09 E-06	3.0 E-05	7.0	6.60 E-04
^{51}Cr	2	3.40 E 04	2.84 E-06	2.0 E-03	0.1	3.66 E-04
^{192}Ir	12	2.04 E 05	8.65 E-08	4.0 E-05	0.2	6.70 E-05
^{124}Sb	2	3.40 E 04	4.57 E-08	2.0 E-05	0.2	5.89 E-06
^{57}Co	1	1.30 E 04	8.11 E-08	4.0 E-04	<.1	4.00 E-06
^{137}Cs	1	1.30 E 04	3.24 E-08	2.0 E-05	0.2	1.60 E-06
^{122}Sb	1	1.30 E 04	2.43 E-08	3.0 E-05	0.1	1.20 E-06

Total Releases: 31

Total Volume*: Gallons 5.17 E 05 cc 1.96 E 09

Average Concentration: 3.33 E-06 µCi/cc

Total Radioactivity: 6.52 E-03 Ci

*Includes fresh water dilutent

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TABLE 4

RADIOACTIVE LIQUID EFFLUENT RELEASES

MONTHLY SUMMARY

January 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{60}Co	2	3.40 E 04	3.62 E-07	3.0 E-05	1.2	4.67 E-05
^{54}Mn	2	3.40 E 04	6.65 E-07	1.0 E-04	0.7	8.57 E-05
^{58}Co	2	3.40 E 04	7.95 E-07	1.0 E-04	0.8	1.02 E-04
^{65}Zn	2	3.40 E 04	7.44 E-07	1.0 E-04	0.7	9.59 E-05

Total Releases: 2

Total Volume: Gallons 3.40 E 04 cc 1.29 E 08

Average Concentration: 2.56 E-06 µCi/cc

Total Radioactivity: 3.30 E-04 Ci

*Includes fresh water dilutent

TABLE 5

RADIOACTIVE LIQUID EFFLUENT RELEASES

MONTHLY SUMMARY

March 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{58}Co	1	1.70 E 04	3.32 E-08	1.0 E-04	<.1	2.14 E-06
^{54}Mn	1	1.70 E 04	1.00 E-07	1.0 E-04	0.1	6.48 E-06
^{65}Zn	1	1.70 E 04	1.06 E-07	1.0 E-04	0.1	6.88 E-06
^{60}Co	1	1.70 E 04	1.73 E-07	3.0 E-05	0.6	1.12 E-05

Total Releases: 1

Total Volume: Gallons 1.70 E 04 cc 6.44 E 07

Average Concentration: 4.14 E-07 µCi/cc

Total Radioactivity: 2.67 E-05 Ci

*Includes fresh water dilutent

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TABLE 6

RADIOACTIVE LIQUID EFFLUENT RELEASES

MONTHLY SUMMARY

April 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{192}Ir	4	6.05 E 04	9.82 E-08	4.0 E-05	0.2	2.25 E-05
^{58}Co	5	8.20 E 04	3.64 E-07	1.0 E-04	0.4	1.13 E-04
^{54}Mn	6	9.60 E 04	6.13 E-07	1.0 E-04	0.6	2.23 E-04
^{65}Zn	4	6.65 E 04	9.62 E-07	1.0 E-04	1.0	2.43 E-04
^{60}Co	6	9.60 E 04	7.09 E-07	3.0 E-05	2.4	2.58 E-04
^{24}Na	1	1.40 E 04	6.52 E-07	3.0 E-05	2.2	3.46 E-05

Total Releases: 6

Total Volume: Gallons 9.60 E 04 cc 3.64 E 08

Average Concentration: 2.45 E-06 µCi/cc

Total Radioactivity: 8.94 E-04 Ci

*Includes fresh water dilutent

TABLE 7

RADIOACTIVE LIQUID EFFLUENT RELEASES

MONTHLY SUMMARY

May 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{192}Ir	1	1.70 E 04	8.44 E-08	4.0 E-05	0.2	5.44 E-06
^{51}Cr	1	1.70 E 04	7.44 E-07	2.0 E-03	<.1	4.80 E-05
^{58}Co	2	3.40 E 04	3.72 E-07	1.0 E-04	0.4	7.90 E-05
^{54}Mn	2	3.40 E 04	1.11 E-06	1.0 E-04	1.1	1.44 E-04
^{65}Zn	2	3.40 E 04	1.28 E-06	1.0 E-04	1.3	1.65 E-04
^{60}Co	2	3.40 E 04	1.83 E-08	3.0 E-05	<.1	2.37 E-06

Total Releases: 3

Total Volume: Gallons 5.10 E 04 cc 1.93 E 08

Average Concentration: 2.29 E-06 µCi/cc

Total Radioactivity: 4.44 E-04 Ci

*Includes fresh water dilutent

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TABLE 8

RADIOACTIVE LIQ'ID EFFLUENT RELEASES

MONTHLY SUMMARY

June 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{57}Co	1	1.70 E 04	6.17 E-08	4.0 E-04	0.2	3.98 E-06
^{58}Co	3	5.10 E 04	1.31 E-06	1.0 E-04	1.3	2.54 E-04
^{60}Co	4	6.80 E 04	2.11 E-06	3.0 E-05	7.0	5.45 E-04
^{54}Mn	3	5.10 E 04	2.26 E-06	1.0 E-04	2.3	4.37 E-04
^{65}Zn	3	5.10 E 04	2.44 E-06	1.0 E-04	2.4	4.73 E-04
^{24}Na	2	3.40 E 04	5.44 E-07	3.0 E-05	1.8	2.02 E-05
^{51}Cr	1	1.70 E 04	4.93 E-06	2.0 E-03	0.2	3.18 E-04
^{122}Sb	1	1.70 E 04	1.89 E-08	3.0 E-05	<.1	1.22 E-06

Total Releases: 5

Total Volume: Gallons 8.50 E 04 cc 3.22 E 08

Average Concentration: 6.52 E-06 µCi/cc

Total Radioactivity: 2.10 E-03 Ci

*Includes fresh water dilutent

TABLE 9

RADIOACTIVE LIQUID EFFLUENT RELEASES

MONTHLY SUMMARY

July 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{137}Cs	1	1.70 E 04	2.49 E-08	2.0 E-05	1.0	1.61 E-06
^{58}Co	1	1.70 E 04	1.86 E-07	1.0 E-04	0.2	1.20 E-05
^{54}Mn	2	3.40 E 04	2.24 E-07	1.0 E-04	0.2	2.89 E-05
^{65}Zn	2	3.40 E 04	2.38 E-07	1.0 E-04	0.2	3.07 E-05
^{60}Co	2	3.40 E 04	2.80 E-07	3.0 E-05	1.0	3.62 E-05

Total Releases: 2

Total Volume: Gallons 3.40 E 04 cc 1.28 E 08

Average Concentration: 8.49 E-07 µCi/cc

Total Radioactivity: 1.09 E-04 Ci

*Includes fresh water dilutent

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TABLE 10
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY
August 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{24}Na	1	1.70 E 04	8.60 E-06	3.0 E-05	28.6	5.55 E-04
^{192}Ir	2	2.83 E 04	1.49 E-07	4.0 E-05	0.4	1.60 E-05
^{58}Co	2	2.83 E 04	1.10 E-06	1.0 E-04	1.1	1.18 E-04
^{54}Mn	2	2.83 E 04	2.34 E-06	1.0 E-04	2.3	2.52 E-04
^{65}Zn	2	2.83 E 04	2.85 E-06	1.0 E-04	2.8	3.06 E-04
^{60}Co	2	2.83 E 04	3.19 E-06	3.0 E-05	10.6	3.43 E-04

Total Releases: 3

Total Volume: Gallons 5.03 E 04 cc 1.91 E 08

Average Concentration: 8.34 E-06 µCi/cc

Total Radioactivity: 1.59 E-03 Ci

*Includes fresh water dilutent

TABLE 11
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY
September 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{192}Ir	2	3.40 E 04	1.39 E-07	4.0 E-05	0.3	2.70 E-05
^{58}Co	2	3.40 E 04	7.63 E-07	1.0 E-04	0.8	9.84 E-05
^{54}Mn	3	3.35 E 04	1.76 E-06	1.0 E-04	1.8	2.24 E-04
^{65}Zn	2	3.40 E 04	2.18 E-06	1.0 E-04	2.2	2.82 E-04
^{60}Co	2	3.40 E 04	2.37 E-06	3.0 E-05	7.9	3.06 E-04

Total Releases: 4

Total Volume: Gallons 6.75 E 04 cc 2.56 E 08

Average Concentration: 3.66 E-06 µCi/cc

Total Radioactivity: 9.37 E-04 Ci

*Includes fresh water dilutent

TABLE 12

RADIOACTIVE LIQUID EFFLUENT RELEASES

MONTHLY SUMMARY

October 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{54}Mn	1	1.65 E 04	2.06 E-08	1.0 E-04	<.1	1.29 E-06
^{65}Zn	1	1.65 E 04	4.63 E-08	1.0 E-04	<.1	2.91 E-06

Total Releases: 1

Total Volume: Gallons 1.65 E 04 cc 6.25 E 07

Average Concentration: 6.72 E-08 µCi/cc

Total Radioactivity: 4.20 E-06 Ci

*Includes fresh water dilutent

TABLE 13

RADIOACTIVE LIQUID EFFLUENT RELEASES

MONTHLY SUMMARY

November 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{192}Ir	1	1.79 E 04	3.75 E-08	4.0 E-05	<.1	2.42 E-06
^{124}Sb	1	1.70 E 04	4.71 E-08	3.0 E-05	0.2	3.04 E-06
^{58}Co	2	3.15 E 04	3.86 E-08	1.0 E-04	<.1	4.61 E-06
^{54}Mn	2	3.15 E 04	8.58 E-08	1.0 E-04	<.1	1.02 E-05
^{65}Zn	2	3.15 E 04	1.87 E-07	1.0 E-04	0.2	2.24 E-05
^{60}Co	2	3.15 E 04	1.31 E-07	3.0 E-05	0.4	1.57 E-05

Total Releases: 2

Total Volume: Gallons 5.55 E 04 cc 2.10 E 08

Average Concentration: 2.78 E-07 µCi/cc

Total Radioactivity: 5.84 E-05 Ci

*Includes fresh water dilutent

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TABLE 14

RADIOACTIVE LIQUID EFFLUENT RELEASES

MONTHLY SUMMARY

December 1978

Isotope	Number of Releases	Volume* Gallons	Concentration µCi/cc	MPC-W µCi/cc	MPC %	Radioactivity Ci
^{192}Ir	2	3.40 E 04	2.27 E-08	4.0 E-05	<.1	2.93 E-06
^{58}Co	2	3.40 E 04	2.70 E-08	1.0 E-04	<.1	3.49 E-06
^{124}Sb	1	1.70 E 04	4.34 E-08	2.0 E-04	<.1	2.80 E-06
^{54}Mn	1	1.70 E 04	7.03 E-08	1.0 E-04	<.1	4.53 E-06
^{65}Zn	1	1.70 E 04	2.34 E-07	1.0 E-04	0.2	1.51 E-05
^{60}Co	1	1.70 E 04	1.20 E-07	3.0 E-05	0.4	7.79 E-06

Total Releases: 2

Total Volume: Gallons 3.40 E 04 cc 1.29 E 08

Average Concentration: 2.84 E-07 µCi/cc

Total Radioactivity: 3.66 E-05 Ci

*Includes fresh water dilutent

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TABLE 15

SOLID RADIOACTIVE WASTE DISPOSAL

ANNUAL SUMMARY

1978

Radioisotope	Radioactivity μCi	Ci
^{124}Sb	292.0	2.92 E-04
^{192}Ir	19.9	1.99 E-05
^{51}Cr	163.3	1.63 E-04
^{60}Co	2720.3	2.72 E-03
^{65}Zn	568.5	5.68 E-04
^{152}Eu	723.0	7.23 E-04
^{109}Cd	700.0	7.00 E-04
^{54}Mn	1121.6	1.12 E-03
^{57}Co	30.3	3.03 E-05

Total Volume: 242 Ft^3

Total Radioactivity: 6.34 E-03 Ci

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ENVIRONMENTAL SURVEY PROGRAM

Introduction

The environmental survey samples were collected in accordance with the schedules of the cooperative surveillance program between the Texas State Department of Health and Texas A&M University. These samples were analyzed for gross gamma and beta activities and isotope identification. Data from these samples remained basically unchanged from 1977 and reflect the continued use of retention facilities and sample analysis for laboratory effluents prior to their release. Sample analysis indicate that the activities are remaining at normal background levels in the unrestricted environment.

The environmental survey program was expanded in 1977 to include the measurement of integrated radiation exposures at the site boundaries. These measurements are made for a period of approximately 90 days using commercially available thermoluminescent dosimeters (TLD's) of lithium fluoride chips in glass encapsulated bulbs. These dosimeters are provided and processed by Texas Department of Health, Division of Occupational Health and Radiation Control. Ambient background for these measurements is determined from a control dosimeter located southeast of Easterwood Airport approximately 800 meters east of the Nuclear Science Center site. This location is at a right angle to the prevailing southeasterly winds which occur a large majority of the time on an annual basis.

Table 20 lists the average exposure rate above ambient background per megawatt hour of reactor operation for a number of locations at the site boundary. The highest exposure points are at the middle north and northwest corner of the site boundary. Additionally, a dosimeter is located adjacent to the radioactive waste storage building and the instrument calibration range. Exposure data from this dosimeter is not considered as a result of reactor operations but does reflect the maximum site boundary exposure of 41.7 micro R/hr. This site boundary location is further protected from free access to the general public for an additional 100 meters of fenced Texas A&M University property. A dosimeter at this location reveals only background radiations.

Summaries of the environmental survey program for 1978 are presented in Tables 16-20.

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TABLE 16

ENVIRONMENTAL SURVEY PROGRAM

FIRST QUARTER SUMMARY

1978

W A T E R

Radioactivity (Pci/L)

Location	Number Samples	Average	Maximum	Minimum
NSC Creek	3	390 ± 103	890 ± 300	70 ± 4
Sanitary Outflow	5	8.62 ± 3.2	14 ± 4	4 ± 1
Wnite Creek	2	13.55 ± 3.5	14 ± 6	13 ± 1.2
Lower Brazos	1	33 ± 6.4		
Upper Brazos	1	10.2 ± 5.2		

V E G E T A T I O N

Radioactivity (Pci/gm, ASHED)

Location	Number Samples	Average	Maximum	Minimum
Cyclotron	1	9.4 ± .4		
NSC Site (Inside Fence)	1	9.2 ± .7		
NSC Site (Outside Fence)	1	8.5 ± .7		
White Creek	1	13.1 ± 1.2		
NSC Creek	1	17.0 ± .7		

M I L K

Radioactivity (Pci/L)

Location	Number Samples	Isotope	Average	Maximum	Minimum
TAMU Dairy	5	^{140}Ba	<200		
		^{137}Cs	<10		
		^{131}I	<50		
		^{40}K	1290	1840	1020

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TABLE 17

ENVIRONMENTAL SURVEY PROGRAM

SECOND QUARTER SUMMARY

1978

W A T E R

Radioactivity (Pci/L)

Location	Number Samples	Average	Maximum	Minimum
NSC Creek	4	28 ± 4.5	47	11
White Creek	1	18 ± 5.6		
Sanitary Outflow	3	13 ± 4.2	19.7	7
Upper Brazos	1	11 ± 4.7		
Lower Brazos	1	8 ± 4.6		

V E G E T A T I O N

Radioactivity (Pci/gm, Dry wt.)

Location	Number Samples	Average	Maximum	Minimum
Cyclotron	3	8.13 ± .7	10.9	6.7
NSC Site (Inside Fence)	3	7.53 ± .9	11.9	4.5
NSC Site (Outside Fence)	3	7.56 ± .9	8.3	7.2
White Creek	3	7.80 ± .8	9.3	5.8
NSC Creek	2	6.95 ± .8	7.3	6.6

M I L K

Radioactivity (Pci/L)

Location	Number Samples	Isotope	Average	Maximum	Minimum
TAMU Dairy	2	^{90}Sr	6.3 ± 1.5		
		^{131}I	<10		
		^{137}Cs	<10		
		^{140}Ba	<10		
		^{40}K	1290	1340	1240

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TABLE 18

ENVIRONMENTAL SURVEY PROGRAM

THIRD QUARTER SUMMARY

1978

W A T E R

Radioactivity (Pci/L)

Location	Number Samples	Average	Maximum	Minimum
NSC Creek	1	31 ± 9		
White Creek	1	19 ± 5		
Upper Brazos River	1	2.6 ± 1.5		
Lower Brazos River	1	7.7 ± 4		
Sanitary Outflow	3	13.9 ± 4.7	15.7	11.4

V E G E T A T I O N

Radioactivity (Pci/gm, Dry wt.)

Location	Number Samples	Average	Maximum	Minimum
Cyclotron	3	25.3 ± 2.6	48 ± 5	5 ± .6
NSC Site (Inside Fence)	3	13 ± 1.2	22 ± 1.7	7. ± 1
NSC Site (Outside Fence)	3	9.0 ± 1.1	15 ± 1.5	6 ± .8
White Creek	2	12.5 ± 1.2	14 ± 1.4	11 ± 1.1
NSC Creek	3	13.3 ± 1.3	18. ± 1.3	6 ± .6

M I L K

Radioactivity (Pci/L)

Location	Number Samples	Isotope	Average	Maximum	Minimum
TAMU Dairy	4	^{90}Sr	5.40	6.8	3.5
		^{137}Cs	<10		
		^{131}I	<10		
		^{140}Ba	<10		
		^{40}K	1220	1400	1000

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TABLE 19

ENVIRONMENTAL SURVEY PROGRAM

FOURTH QUARTER SUMMARY

1978

W A T E R

Radioactivity (Pci/L)

Location	Number Samples	Average	Maximum	Minimum
White Creek	1	6.6 ± 3.5		
Sanitary Outflow	2	11.4 ± 5.1	12.5 ± 5.8	10.4 ± 4.5
NSC Creek	1	40 ± 8		

V E G E T A T I O N

Radioactivity (Pci/gm, Dry wt.)

Location	Number Samples	Average	Maximum	Minimum
Cyclotron	2	27 ± 4	30 ± 5	24 ± 3
NSC Site (Inside Fence)	2	19.5 ± 2	24 ± 2	15 ± 2
NSC Site (Outside Fence)	2	18.3 ± 2	22.6 ± 2	14 ± 3
White Creek	2	18 ± 3	20.0 ± 3	16 ± 3
NSC Creek	2	22 ± 3	26 ± 5	18 ± 2

M I L K

Radioactivity (Pci/L)

Location	Number Samples	Isotope	Average	Maximum	Minimum
TAMU Dairy	2	^{131}I	<10		
		^{137}Cs	<10		
		^{140}Ba	<10		
		^{40}K	1275	1360	1190

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TABLE 20
ENVIRONMENTAL RADIATION MONITORING PROGRAM
INTEGRATED RADIATION EXPOSURE
November 10, 1977 - December 31, 1978

Station Number	Location	Exposure (Gross MR)	Exposure (Net MR)	Exposure Rate (Micro R/hr)
1	Background	68	68	-
2	NSC Fence Northwest	93	25	2.5
3	NSC Fence West	110	42	4.2
4	NSC Fence North	116	48	4.8
5	NSC Fence East	89	21	2.1
6	Radioactive Waste Storage Building	488	420	41.7
7	100 Meters East of NSC Boundary	73	5	0.5

RADIATION AND CONTAMINATION CONTROL PROGRAM

Introduction

The detection and elimination of radiation hazards is an integral part of the Radiation Safety Program at the Nuclear Science Center. The radiation and smear survey programs contribute to the control and elimination of these health hazards. This program is effective in preventing the spread of radioactive contamination, improper storage of radioactive materials, and unwarranted exposures to radiation.

Radiation Survey

The Nuclear Science Center uses an area radiation monitoring system consisting of nine (9) detector channels located throughout the Reactor and Laboratory Buildings. This system is equipped with alarm settings and remote readouts in the control and reception rooms. Radiation levels and operational checks are recorded on a daily basis. This system functions as a radiation safety monitor for the early detection of impending radiation hazards. The Nuclear Science Center Facilities and site boundaries are surveyed monthly with beta-gamma sensitive instruments. These measurements are taken to determine proper storage and identification of radioactive materials and that visitor and routine work areas are free of radiation hazards. Additionally, radiation monitoring support is provided for the reactor operations and experimenter groups to insure the safe handling of radioactive materials and control of personnel exposures. There were no unexpected radiation levels or improper storage of radioactive materials detected during 1978. These surveys revealed only background radiations at the site perimeter fence.

Contamination Survey

The Nuclear Science Center is routinely surveyed for radioactive contamination every week. This program includes the collection, analysis and evaluation of approximately 250 smear samples and the decontamination of areas and stored materials with removable beta-gamma radioactivities of greater than 200 dpm/100 cm^2. This program was effective in the elimination of contaminated areas and ascertaining that visitor and personnel traffic patterns were free of radioactive contamination.

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PERSONNEL EXPOSURES

Radiation exposures to personnel at the Nuclear Science Center for 1978 were within the limits of 10CFR20. The maximum exposure received by an individual for the year was 1100 mrem. A total of 4.420 MANREM was received for 1978. More important, the exposures reflect an extended effort by all personnel to minimize and eliminate radiation exposures whenever practicable. These exposure data becomes more significant when one considers that in addition to routine reactor operations, 9,200 samples containing 822 Ci of radioactivity were produced and processed at the Nuclear Science Center in 1978.

The access control procedures for visiting personnel were effective in preventing exposure to radiation. There were 4,084 visitors to the Nuclear Science Center during 1978. The maximum exposure to any visitor was less than the minimum measurable quantities. These values are 10 millirems for X or gamma, 40 millirems for hard Beta, 20 millirems for fast neutrons and 10 millirems for thermal neutron radiations.

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APPENDIX IV

Universities, Colleges, Industrial Organizations, Government and State Agencies Served by the NSC During Sixteen Years of Operation

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Other Universities and Colleges

Baylor University
Baylor, College of Medicine
University of Texas
Texas Women's University
University California, Los Angles
Lamar State College of Technology
New Mexico State University
Rice University
Austin College
Southern Methodist University
California State Poly. College
Washington University
Hastings College
Winona State College
Wisconsin State University
Milwaukee Institute of Technology
Arkansas State College
Ball State Teachers College
Texas Southmost College
Stephen F. Austin College
Louisiana State University
Xavier University
Temple University Penn.
Bemidgi State College
Chadran State College
Sam Houston State
University of New Hampshire
Catholic College for Women
Taft College
Blue Field College
Potomac St. College
Thames Valley St. Tech. College
Victoria College
Tennessee Tech. University
Wharton County Jr. College
Grayson County College
West Virginia Inst. of Tech.
Galveston College
Arkansas Poly College
Eastern Kentucky University
Sue Bennett College
Cheyney St. College
University of Genova
University of Southern Louisiana
University of Oklahoma
Somerset Community College
Grave City College
Louisiana Tech.
Abraham Baldwin College
Kent St. University

Other Universities and Colleges (Con't)

State University of Ohio
Alfred St. College
Community College of the Finger Lakes
Nebraska Weslyan University
Lock Haven St. College
San Bernadino Valley College
North Park College and Theological Seminary College
Fort Valley State College
Denison University
State University College, N.Y.
Auburn University
Clarion State College
University of Alaska
University of Arkansas
University of Houston
Southwest Texas State College
Iowa State University
Blinn College
State College of Arkansas
The Defiance College
San Antonio College
Laredo Jr. College
University of Corpus Christi
South Dakota State
Arapahoe Jr. College
California St. College
Pan American College
Tarleton St. College
Columbus College
Howard Payne College
Prairie View A&M College
Longwood College
S.D. School of Mines
North Shore Community College
University of Wisconsin
Hill Jr. College
McLennan Community College
Southeast Missouri St. College
Southwestern State College
Mary Hardin Baylor
Texas State Technical Inst.
North Texas State University
University of Arizona
McNeese State University
Texas Eastern University
Henderson County Jr. College
Massachusetts Institute of Technology
University of Texas at Dallas

Industrial Organizations

States Marine Lines
Southwest Research Institute
Humble Oil and Refining Co.
Institute of Research and Instrumentation
Estrada Incorporated
Shell Chemical Co.
Mobil Oil Co.
Texas Instruments Inc.
Todd Shipyards Corp.
Shell Development Co.
Tennessee Gas Transmission Co.
Lane Well Co.
Petro-Tex Chemical Corp.
Babcock and Wilcox Co.
Medical Arts
Texaco Inc.
Monsanto co.
Hastings Radiochemical Works
E.I. DuPont DeNemours and Co.
Mission Engineering
ESSO Research and Engineering
Diamond Alkali Co.
Dow Chemical Co.
Celanese Co.
Independent Exploration Co.
Comfaco
Rivera Foods
North American Aviation
Gulf Research
Xomox
Texas Nuclear
Bio Assay Lab-Bio Nuclear
NAPKO Corp.
D.W. Mueller, Consultant
General Nuclear Corp.
Nuclear Environmental Eng. Corp.
Shell Development, Oakland Calif.
Nuclear Sources and Services
Exxon
Atomic Energy Industrial
Hughes Research Lab
TRACO Inc.
Lloyd Barber and Associates
Temple Industries
Chemtral Inc.
Jet Research
Resource Engineering
Ranger Engineering
Turbine Lab
Gulf Nuclear

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Industrial Organizations (Cont'd)

Westinghouse Electric

Avery Oil Company

Bell Helicopter

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Government and State Agencies

M.D. Anderson Hospital

Houston Police Department

Houston, District Attorney

Brooks Medical Center

National Aeronautics and Space Administration

North East Radiological Health Lab

Department of the Army

Wichita Falls, District Attorney

Corpus Christi, District Attorney

Dallas County, District Attorney

Denton County, District Attorney

Jefferson County, District Attorney

Oklahoma Medical Examiner

U.S. Air Force

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APPENDIX V

Texas A&M University Departments Served by The NSC During Sixteen Years of Operation

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TAMU Department and Agencies

Department of Biochemistry and Biophysics

Department of Nuclear Engineering

Department of Oceanography

Activation Analysis Research Laboratory

Department of Physics

Department of Petroleum Engineering

Department of Animal Science

Department of Range Science

Department of Mechanical Engineering

Department of Wildlife and Fisheries Sciences

Department of Chemistry

Department of Large Animal Veterinary Medicine and Surgery

Radiological Safety Office

Cyclotron Institute

Department of Plant Sciences

Nuclear Science Center

Department of Veterinary Physiology and Pharmacology

Department of Radiation Biology

Center for Trace Characterization

Bioengineering Program, College of Engineering

Texas Engineering Extension Service, Electronic Training

Department of Geology

Department of Forest Science

Department of Soil and Crop Sciences

College of Medicine

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TAMU Departments (Con't)

Department of Health and Physical Education

Department of Architecture

Department of Building Construction

Department of Industrial Engineering

Department of Industrial Education

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