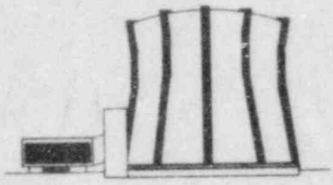
TEXAS ENGINEERING EXPERIMENT STATION

THE TEXAS A&M UNIVERSITY SYSTEM

COLLEGE STATION, TEXAS 77843



NUCLEAR SCIENCE CENTER
713/845-7551

16 May 1983

Mr. Cecil O. Thomas, Chief
Standardization and Special Projects Branch
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: Docket No. 50-128

Dear Mr. Thomas:

In accordance with the reporting requirements of Technical Specifications 6.7.2 for the Texas A&M University Nuclear Science Center Reactor, we hereby submit 3 copies of our annual report, Nineteenth Progress Report" for the period of January 1, 1982 - December 31, 1982.

Sincerely,

Donald E. Feltz

Donald E. Feltz
Director

DEF/ym

Enclosure

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

JANUARY 1, 1982 - DECEMBER 31, 1982

CONTRACT DE-AC05-76ER04207

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

N I N E T E E N T H P R O G R E S S R E P O R T

of the

T E X A S A & M U N I V E R S I T Y
N U C L E A R S C I E N C E C E N T E R

January 1, 1982 - December 31, 1982

Prepared by

H. J. Deigl
J. G. Head
R. J. Land
J. E. Petesch
R. D. Rogers

and the

Nuclear Science Center Staff

Submitted to

U. S. Nuclear Regulatory Commission

and

U. S. Department of Energy

and

The Texas A&M University System

by

D. E. Feltz, Director

Nuclear Science Center

Texas Engineering Experiment Station

College Station, Texas

April, 1983

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I. INTRODUCTION

The Nuclear Science Center is operated by the Texas Engineering Experiment Station as a service to the Texas A&M University System and the State of Texas. 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 DE-AC05-76ER04207 (formerly EY-76-C-05-4207) and of 10CFR50.59. The report covers the period from January 1, 1982 through December 1, 1982.

Reactor utilization continued at about the same pace as the previous year with a slight decrease in the total number of irradiations, number of samples irradiated, and total experiment hours. Reactor operation of 93.3 Mw-days for 1982 represents approximately an 11% decrease over the previous year. There was, however, a significant increase in the number of sample irradiation hours primarily due to a smaller number of experimenters irradiating an extensive number of samples when compared to the previous reporting year. The reactor was not pulsed during the reporting period, but the fuel damage study was completed and preparations are being made to pulse in 1983.

Core VII-A was established during this reporting period and was used throughout most of 1982. This was only a minor modification to Core VII which combined the neutron sources into one canister allowing an additional pneumatic receiver to be placed in the core. Core VIII was established in December, 1982 and involved the installation of the transient rod in preparation to reinitiate a pulsing program for the NSCR.

Several major facility modifications and improvements were completed during the past year. The machine shop relocation begun in 1981 was completed this past year. In addition the reactor control room was remodeled, and work began to upgrade the demineralizer room by repainting, repairing leaky valves, and resurfacing the floor. A new Beam Port #4 water shutter was installed to reduce personnel radiation exposure during experimental use, and the evacuation horn system was modified to allow the air horns to be silenced from the reception room once all personnel have been accounted for. Because of leakage and corrosion problems associated with the exhaust system for the chemistry lab and sample handling cell, this system was replaced with a single high capacity blower and an acid/caustic neutralizing filter. Also, an increased need for a high flux rotisserie resulted in the installation of a new rotisserie motor to be used in the reactor west face notch.

Several operational problems occurred during 1982 some of which resulted in a loss of reactor operating time. The waste storage tank leak reported in 1981 was corrected with the purchase and installation of a new fiberglass tank. A new high velocity raw water stirrer system has also been developed for the waste storage tanks due to frequent failures of the old mechanical system. There was also an extensive number of electronic problems associated with reactor systems which had to be corrected throughout the year.

Administratively during 1982 Donald E. Feltz became Acting Director and assumed the duties of former Director, Dr. John D. Randall who was reassigned to the Nuclear Engineering Department at Texas A&M University. In addition a loss of experienced personnel in supervisory and management positions resulted in having to acquire and to train new individuals for these key positions. Efforts are, however, underway to stabilize the staff and reduce personnel turnover.

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 1969 through December 1982. During the present reporting period the NSCR was used by approximately 1,200 students and 25 faculty and staff members representing 13 departments at Texas A&M University. In addition, more than 350 faculty and students from 12 other educational institutions used the facilities, and 6,280 visitors were registered during 1982, including 14 high school groups. A total of 23 non-university organizations had programs that were dependent upon the NSCR.

During twenty years of operation, the NSC has provided services to 36 departments at Texas A&M University, 102 other colleges and universities, 75 industrial organizations, and 20 federal and state agencies. (See Appendix IV and V for listings).

B. Utilization by the Texas A&M University System

During 1982 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, Associate Professor
- Dr. E. Siefert, Post Doctorate
- Dr. Y. N. Tang, Professor
- Dr. A. Clearfield, Professor
- Dr. R. Zingaro, Professor
- Mr. C. M. Hong, Research Assistant
- Dr. B. J. Menta, Research Associate

Students:
- M. Tobey
- S. Cheng
- D. Brown
- M. Blanda
- L. Quayle
- W. Ilger

Civil Engineering

Staff: Bob Harbert, Lecturer

Technical Services Personnel: J. Head

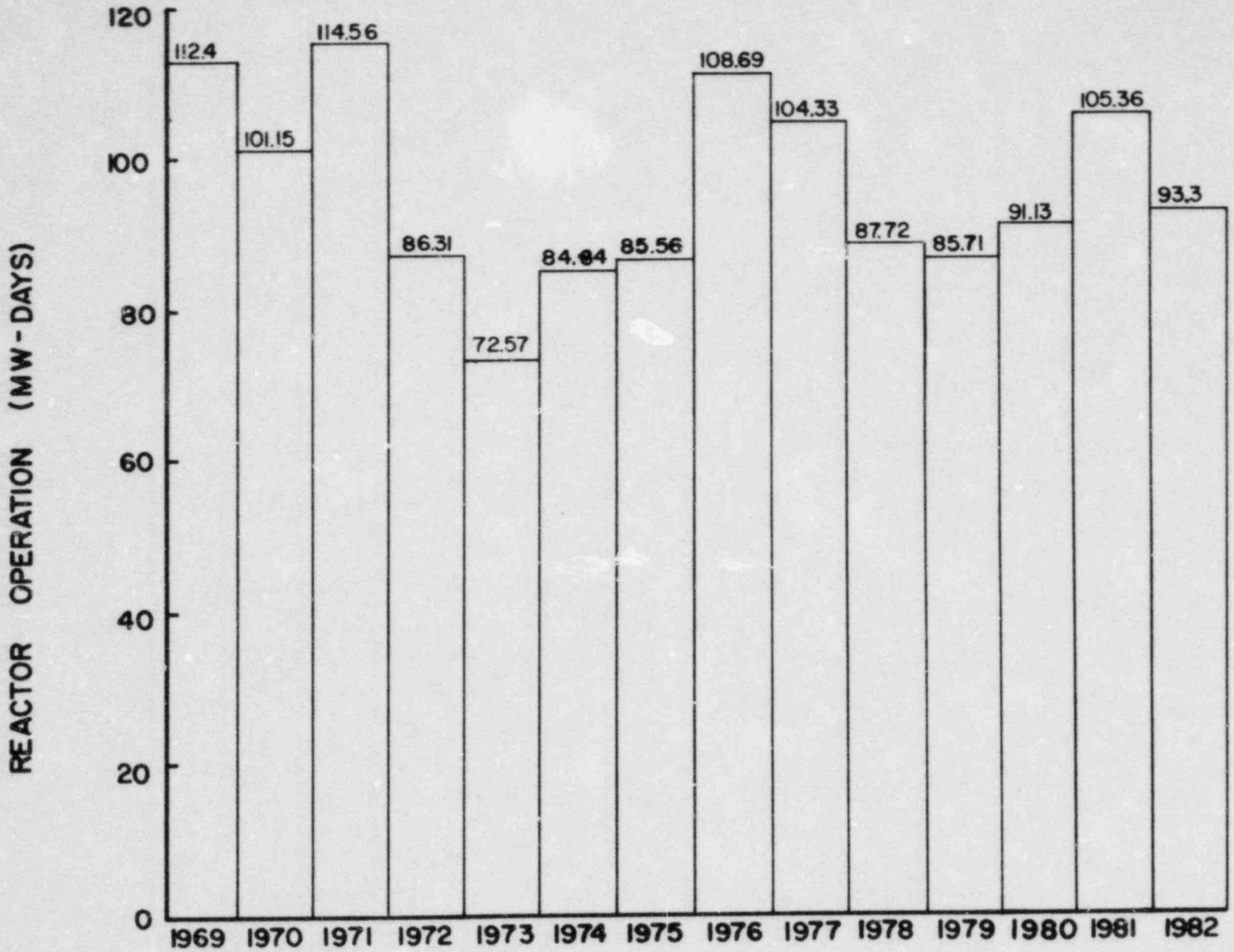

Figure I. Yearly Reactor Operation

TABLE I

REACTOR UTILIZATION SUMMARY

	1982 Annual Total
*Number of Days Reactor Operated	243
Reactor Operation (MW-Days)	93.3
Number of Hours at Steady State	2420.67
Average Number of Operating Hours Per Week	43.1
Total Number of Pulses	0
Total Pulse Reactivity Insertion	0
Number of Irradiations	833
Number of Samples Irradiated	13625
Sample Irradiation Hours	154,434.95
Average Number of Irradiations per Operating Day	3.43
Irradiation Experiment-Hours	12515.61
Beam Port Experiment-Hours	214.97
Irradiation Cell Experiment Hours	5.77
Total Experiment-Hours	12736.35
Fraction of Utilization Attributable to Commercial Work	.39
Number of Visitors	6280

*Note: 50 Weeks of Operation Available

Oceanography

Faculty: Dr. B. J. Presley, Associate Professor

Staff: Dr. P. Boothe, Research Associate

Student: F. Fenner

Center for Trace Characterization

Staff: Dr. Dennis James, Research Chemist

Nuclear Engineering Department

Faculty: Dr. C. A. Erdman, Professor and Head
Dr. R. D. Neff, Professor
Dr. R. R. Hart, Professor
Dr. J. D. Randall, Professor
Dr. T. A. Parish, Associate Professor
Dr. G. Schlapper, Assistant Professor

Students:

J. Holland	M. Brady	S. Lee
P. Harding	E. Parma	J. O'Donnell
L. Wojcik	M. Schuller	J. Salsman
N. Sowsawat		

Nuclear Science Center

Staff: Dr. J. D. Randall, Director
Mr. R. D. Rogers, Manager, Reactor Operations
Ms. M. L. Geer, Health Physicist
Mr. R. Land, Research Assistant
Mr. J. Head, Research Associate
Mr. G. W. Waldrep, Reactor Supervisor
Ms. K. McKinley, Research Associate

Animal Science Department

Faculty: Dr. W. C. Ellis, Professor

Students: K. Pond
A. Desweyser
R. Machen

Radiological Safety Office

Staff: Dr. R. D. Neff, Radiological Safety Officer
Mr. J. Simek, Assistant Radiological Safety Officer
P. Sandel

Students: J. Holland
R. Yupari

Veterinary Physiology and Pharmacology

Faculty: Dr. D. Hightower, Professor

Students: D. Followill

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 through the Department of Energy Reactor Sharing Program. A description of some of the projects utilizing the reactor is presented in Appendix I.

McNeese State University -- Lake Charles, Louisiana

Experimenter: Dr. Jim Beck -- Physics Department

McLennan Community College -- Waco, Texas

Faculty: Mr. Don Tatum -- Physics Department

Students: Physics Classes

Lamar University

Faculty: Dr. H. T. Baker

Technical Services Personnel: K. McKinley

University of Nebraska

Faculty: Dr. W. Pond

Technical Services Personnel: K. McKinley

Sam Houston State University -- Huntsville, Texas

Faculty: Dr. Charles Manka -- Physics Department
B. Covington

Students: Physics Classes

Baylor College of Medicine -- Waco, Texas

Faculty: Dr. Robert McLaurin

Technical Services Personnel: J. Head

TABLE II

ACADEMIC USE OF THE REACTOR

Department	Course No.	Instructor	No. Students and Purpose
Architecture	633	Trost	16 - Tour
Architecture	633	Trost	9 - Tour
Architecture	633	Trost	14 - Tour
Chemistry	116	Kolar	117 - Tour
Chemistry	116	Kolar	95 - Tour
Chemistry	116	Kolar	124 - Tour
Chemistry	116	Kolar	80 - Tour
Chemistry	116	Kolar	80 - Tour
Chemistry	116	Kolar	14 - Tour
Chemistry	116	Kolar	135 - Tour
Chemistry	116	Kolar	90 - Tour
Chemistry	116	Schweikert	6 - Tour
Engineering Design Graphics	105	Mason	15 - Tour
Engineering Technology	402	Morgan	12 - Tour
Engineering Technology	402	Morgan	15 - Tour
Geography	309	Cook	11 - Tour
Nuclear Engineering	101	Parish	21 - Tour
Nuclear Engineering	101G	Schlapper	8 - Tour
Nuclear Engineering	201	Randall	9 - Lecture Review
Nuclear Engineering	402	Randall	12 - Lab
Nuclear Engineering	402	Randall	17 - Lab
Nuclear Engineering	402	Randall	12 - Lab
Nuclear Engineering	402	Randall	14 - Lab
Nuclear Engineering	405	Erdman	9 - Lab
Nuclear Engineering	405	Erdman	20 - Lab/Class
Nuclear Engineering	479	Schlapper	11 - Class
Nuclear Engineering	479	Schlapper	9 - Lab
Nuclear Engineering	606	Randall	6 - Lab
Nuclear Engineering	606	Randall	6 - Lab/Class
Nuclear Engineering	606	Randall	6 - Lab/Class
Nuclear Engineering	606	Randall	6 - Lab/Class
Nuclear Engineering	606	Randall	6 - Lab/Class

Department	Course No.	Instructor	No. Students and Purpose
Physics	351	Duller	14 - Tour
Physics	351	Duller	26 - Tour
Recreation and Parks	375	Kaiser	28 - Tour
Recreation and Parks	375	Kaiser	12 - Tour
Recreation and Parks	375	Kaiser	21 - Tour
Recreation and Parks	375	Kaiser	14 - Tour
		Total	1130

Texas State Technical Institute -- Harlingen, Texas

Faculty:	Mr. Pedro Jimenez -- Chairman Nuclear Technology
Students:	Nuclear Technology Classes

Louisiana State University

Faculty:	Dr. R. Dokka Dr. F. Iddings Dr. R. Knaus

Sul Ross University

Faculty:	Dr. D. Nelson

Louisiana Tech University

Faculty:	Dr. R, Thompson

East Texas State University

Faculty:	R. Daley

High School Tours	No. of Students
Anderson High School -- Anderson, Texas	35
Caldwell High School -- Caldwell, Texas	27
Cy Fair School System -- Houston, Texas	47
McAllen High School -- McAllen, Texas	56
Breckenridge High School -- Breckenridge, Texas	30
A&M Consolidated High School -- College Station, Texas	295
Trinity Jr. High School -- Trinity, Texas	25
Stephen F. Austin Jr. High School -- Bryan Texas	76
Jasper High School -- Jasper, Texas	37
Tomball High School -- Tomball, Texas	23
Holiday Independent High School -- Daisetta, Texas	13
Bryan High School -- Bryan, Texas	43
Gatesville High School -- Gatesville, Texas	14
Jersey Village High School -- Houston, Texas	27

D. Non-University Institutions

National Aeronautics and Space Administration -- Houston, Texas

Experimenters:	R. Seymour	P. Kempton
	M. Strait	T. See

Nuclear Sources and Services -- Houston, Texas

Experimenters: R. D. Gallagher
E. Johnson

Shell Development Company -- Houston, Texas

Experimenters: L. H. Griffin E. L. Wood
J. Papajohn

Texas Instruments -- Dallas, Texas

Experimenters: S. Halfacre
B. Grade

Gulf Nuclear -- Houston, Texas

Experimenters: E. Acree
T. Duncan
G. Pettyjohn

American Hoechst

Experimenter: R. Randolph

Technical Services Personnel: K. McKinley

Mobil

Experimenter: H. Reedom

Technical Services Personnel: K. McKinley

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

Experimenter: J. Cundiff

Hughes Research -- Carlsbad, California

Experimenters: R. Hart
E. Parma

Core Labs -- Corpus Christi, Texas

Experimenter: J. Jackson

Technical Services Personnel: J. Head D. Brown
R. Yupari A. Parlos

Radian Corporation -- Austin, Texas

Experimenter: R. M. Mann

Technical Services Personnel: K. McKinley

Exxon Corporation

Experimenters: R. E. Olson
D. R. Olsen
P. Masson

Technical Services Personnel: M. Otte

Orange Police Department

Experimenter: Orange County District Attorney

Nuclear Science Center Representative: Dr. J. D. Randall

General Electric

Experimenters: C. W. Reinitz
R. Pyles

Technical Services Personnel: K. McKinley

Jet Research

Experimenter: K. Rowe

Technical Services Personnel: J. Head

Kansas Gas and Electric

Experimenters: KG&E Health Physicists

TEEX Personnel: Dr. R. Buchanan
A. Hassel
M. Otte
C. Holste

Teledyne

Experimenter: D. F. Schutz

Technical Services Personnel: R. Land
G. Waldrep

Research Concepts

Experimenter: Dr. William Bartlett

Engineers/Designers, Inc.

Experimenter: T. Morris

Technical Services Personnel: J. Head

Tracerco

Experimenters: W. Ramage
D. Ferguson

SW Research

Experimenter: J. Hageman

Broz Lab

Experimenter: F. J. Broz

Technical Services Personnel: M. Otte

TRIAD

Experimenters: Dr. W. C. Triplett

Technical Services Personnel: Dr. J. D. Randall
G. Waldrep
R. Yupari

III. FACILITY OPERATIONS

A. Facility Safety and Operational Improvements

Machine Shop Relocation

As reported in the 1981 annual report, continued expansion at the NSC involved the addition of a new machine shop adjacent to the storage shed. The shop relocation was completed in January, 1982.

Reactor Control Room Modifications

In March, 1982 remodeling of the reactor control room was completed. This included repainting, carpeting, providing new chairs for operators, and installing a new reactor schedule board.

Evacuation Horn System Modification

In March, 1982 the evacuation horn system was modified to allow the horn to be disabled using controls in the reception room after all personnel have been accounted for following evacuation of the facility. This was done in an effort to reduce noise and confusion during emergency evacuations. As seen in Figure 2 a solenoid operated isolation valve was installed, and a bypass line was provided should the solenoid fail to function properly. The bypass valve is operated manually behind the control room panels. It should also be noted that since the solenoid valve is normally open, a loss of power to the facility will only result in an inability to silence the air horns from the reception room.

Upgrading of the Demineralizer Room

During August, 1982 reactor operations personnel repainted the demineralizer room and its associated piping. In addition leaking valves were repacked, and the acid pump used for regenerating the ion exchanger was remounted on the wall. The concrete floor has deteriorated over the years due to exposure to acid, and work has now begun on resurfacing and providing for better drainage. This work is expected to be completed in 1983.

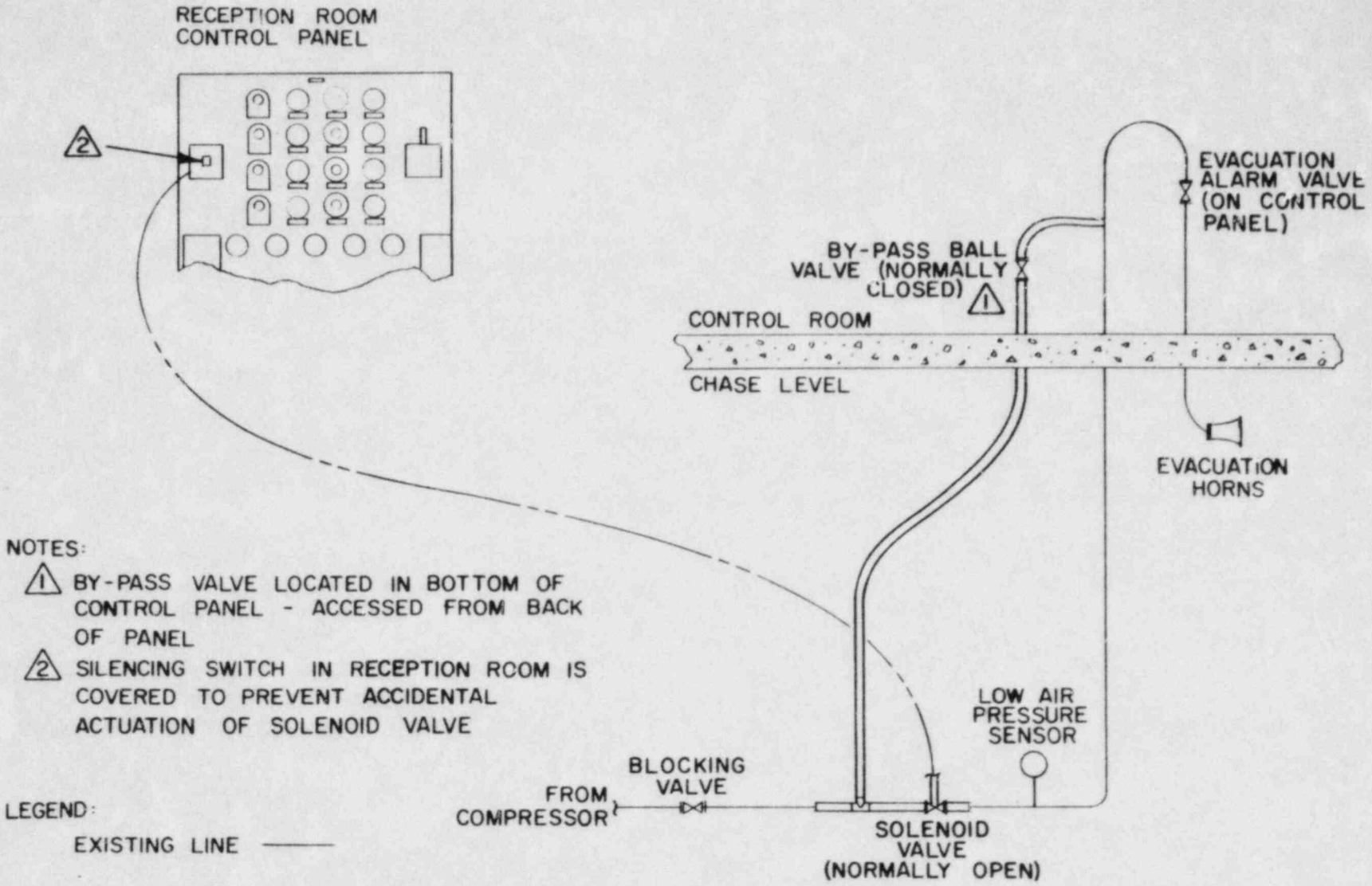

Figure 2. Evacuation Horn System Modification

B. Improvements to Reactor Systems and Experimental Facilities

New Core Loadings

Core VII-A (see Figure 3) was established January 6, 1982. This new core was only a minor modification to Core VII in that the neutron sources were relocated within a single tube in grid location E-2 and an extra pneumatic receiver was positioned in D-2. This core was used throughout the year until December 3, 1982 at which time Core VIII (Figure 4) was established. As can be seen this change consisted simply of the installation of the transient rod in preparation for reinitiating pulsing operations of the NSCR.

Addition of West Face Rotisserie Motor

Due to an increased need for a rotational irradiation device within a high flux area a new rotisserie motor assembly was installed for use with the B-5 grid position. A smaller rotisserie designed to rotate within a 3" x 3" core notch is used with this system, and a remote motor control switch and a power "ON" light have been installed in the control room.

Beam Port #4 Water Shutter

In May, 1982 a new Beam Port #4 shutter system was installed and tested. This new beam port extension (see Figure 5) has the capability of being flooded with water which serves as a neutron/gamma shield. Water evacuation is accomplished using low pressure air and solenoid operated valves. Water level is determined using a float switch as incorporated in the shutter design, and digital indication of the beam port condition is provided in the beam port #4 sample prep room. This new shutter system reduces personnel radiation when handling film cassettes between irradiations.

Installation of Pneumatic System Controller for Shell Laboratory

As discussed in the 1981 annual report a new lab was established for the Shell Development Company. In March, 1982 the pneumatic transfer system for this lab was modified such that a controller separate from the control room central unit was available for use. A permit switch was installed in the control room, but the experimenter has the capability to establish his desired timing sequence. In addition to this change in the laboratory the south pneumatic station on the mechanical chase level was modified such that the Shell lab has its own separate piping system.

Modification of the Chemistry Lab and Sample Handling Cell Exhaust System

Because of leakage and corrosion problems associated with the exhaust system for the chemistry lab and sample handling cell, the

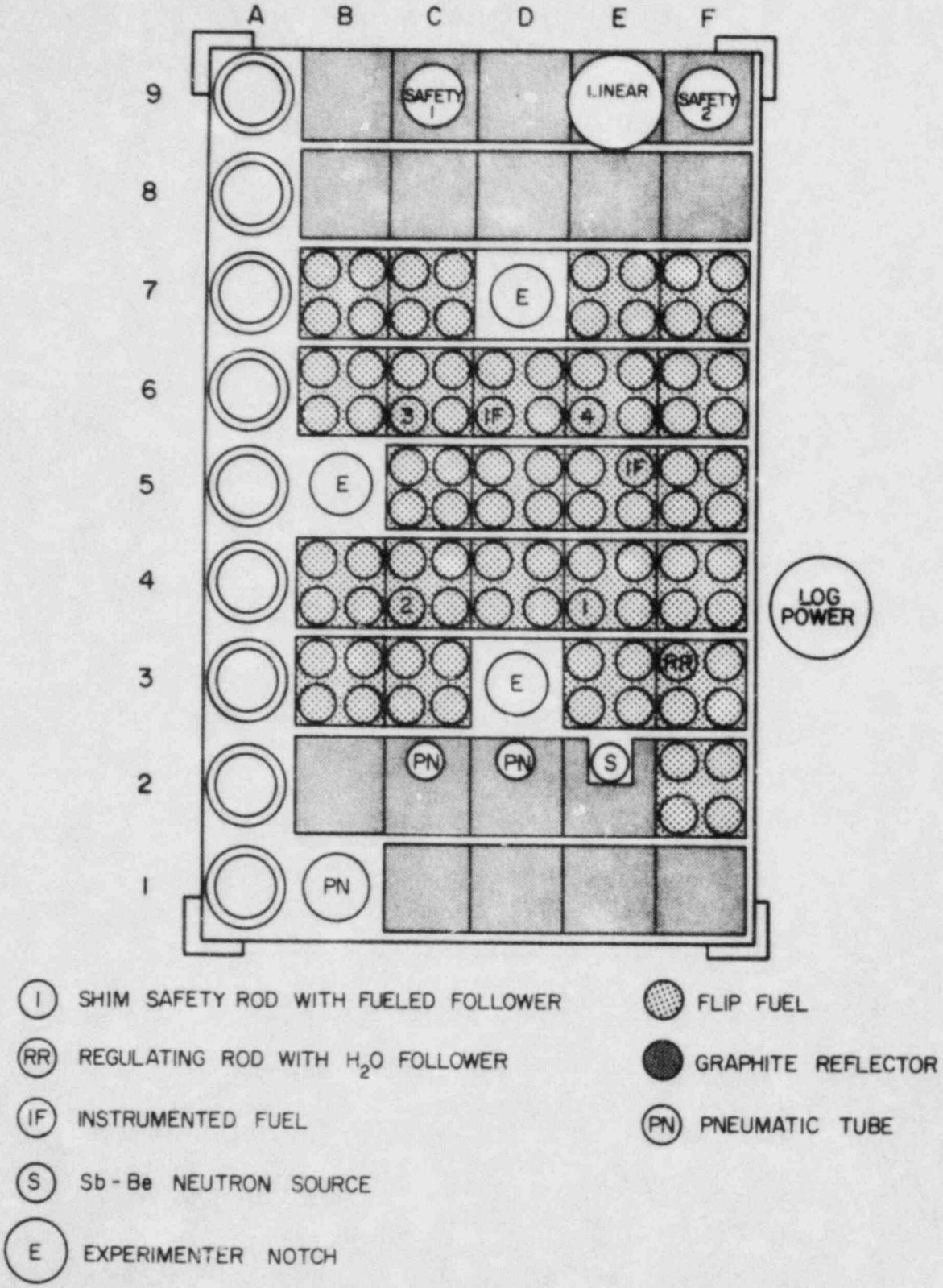

Figure 3. Core VII-A, 91 Flip Elements

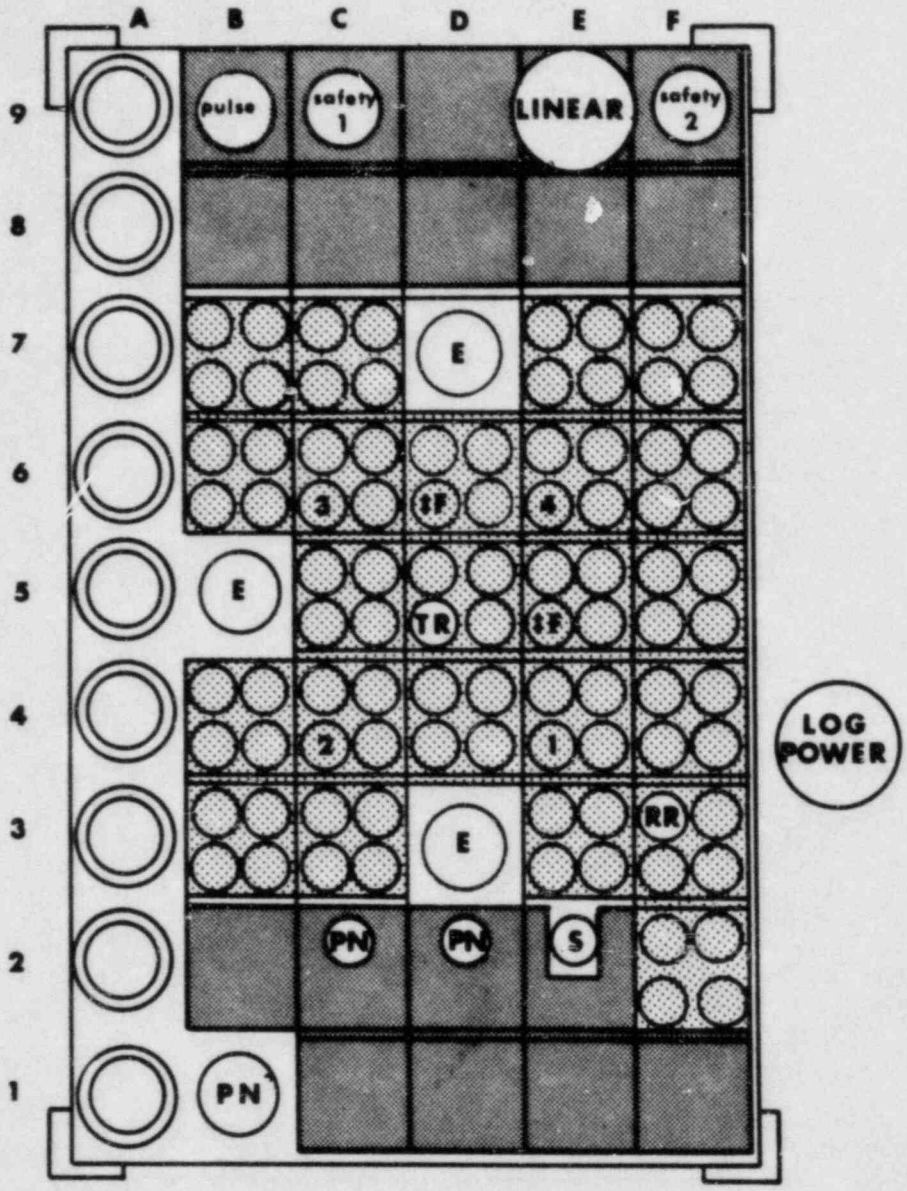

Figure 4. Core VIII, 90 Flip Elements

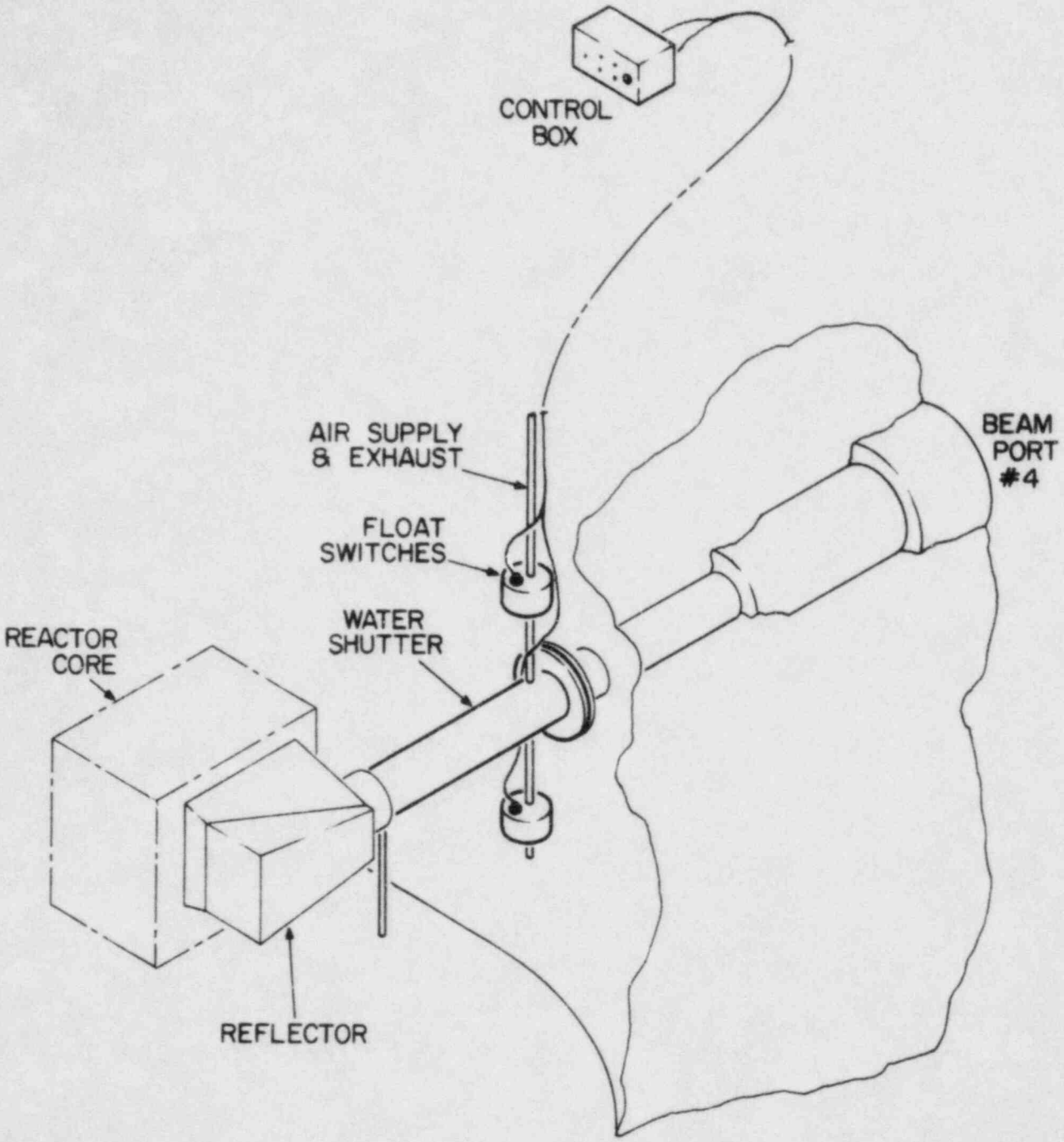

Figure 5. Beam Port #4 Water Shutter

system was replaced with a single high capacity blower and an acid/caustic neutralizing filter. The new system (Figure 6) was designed such that a negative pressure is maintained in all lines upstream of the blower. The exhaust from the chemistry lab hood is drawn through a chemical filter prior to discharging to the central exhaust system, and a damper box is installed downstream of the filter to adjust for proper flow rates from the chemistry lab and sample handling cell. Negative pressure in the line from the sample handling cell has been achieved with the elimination of the small suction blower previously used. In addition there will be a direct connection from the bridge to the blower for handling future venting requirements for the pneumatic system.

C. Operational Problems

Waste Storage Tank Replacement

As reported in the 1981 annual report work was begun on the relocation of the radioactive waste storage tanks to a new slab. Tank #1 was found to have a leak, and following a decision not to repair the tank, a new fiberglass tank was installed in October, 1982. The new tank has a volume of 12,500 gallons and was declared operational in November, 1982.

Modification of the Waste Storage Tank Stirrer System

Because the previous motor driven stirrer system for the waste storage tanks had experienced frequent failures, a new system as shown in Figure 7 has been developed. This high velocity raw water system consists of a flexible hose with a quick disconnect and a distribution header within the tank. The hose is disconnected at all times when stirring is not in progress to minimize the possibility of contaminating the raw water system. In addition a siphon break hole is provided at the high point of the raw water system within each tank to prevent accidental siphoning.

Electronic Problems Associated with Reactor Systems

Equipment age resulted in a significant loss of operating time for the reactor during the past year. On two occasions frayed and deteriorating cables resulted in short circuits and excessive electronic noise within the console. A large amount of reactor operating time was lost in October, 1982 due to a series of dropped rods occurring because of a weak armature magnet for the shim safety control rod and electronic noise being generated by a faulty high voltage power supply in the Safety Channel instrument. Because these two problems occurred simultaneously and were intermittent in nature, locating the cause proved to be very difficult. Efforts are being made to carefully inspect and locate these problems by implementing a surveillance program to reduce failures which could occur as the components continue to age.

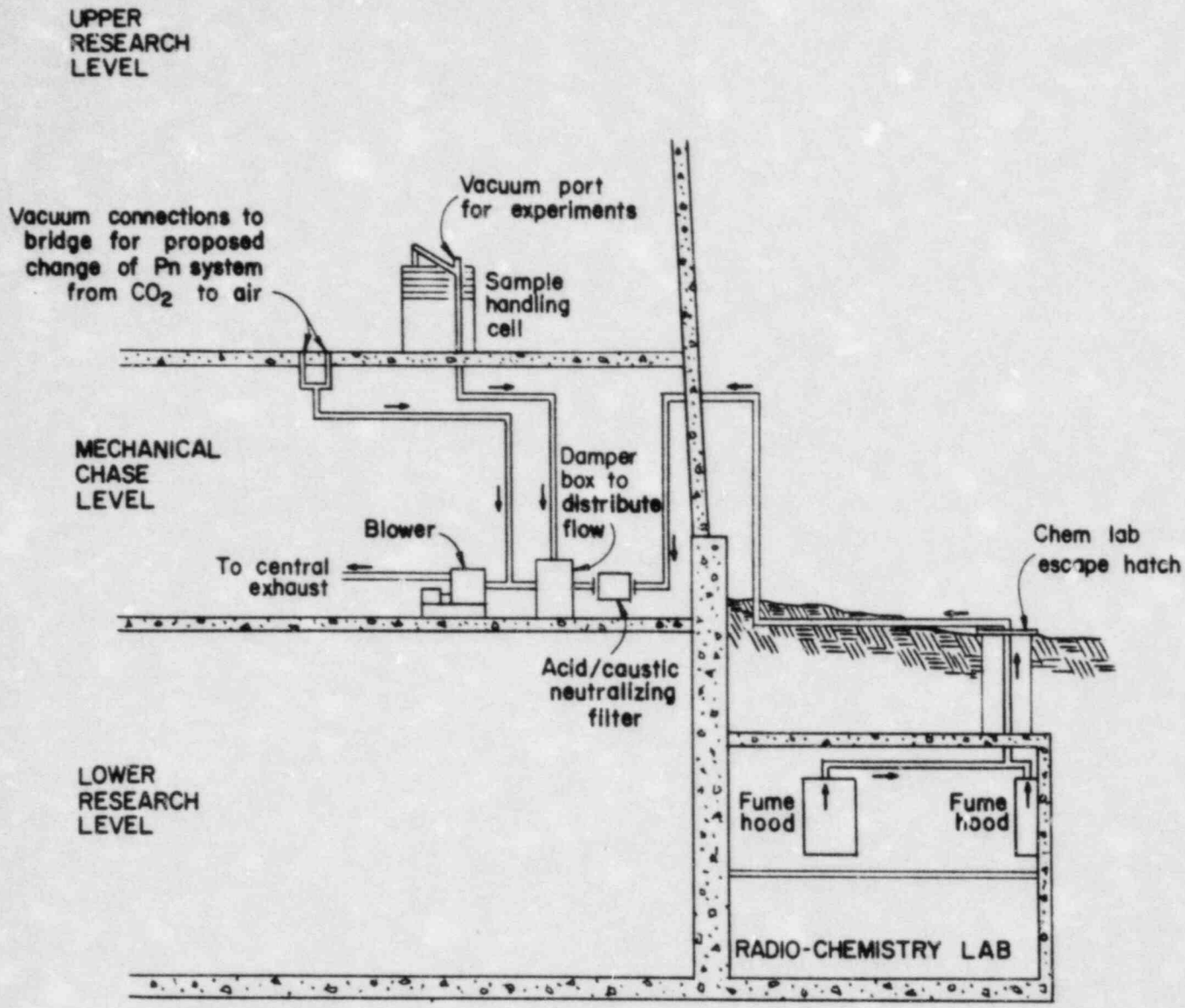

Figure 6. Modification of the Chemistry Lab and Sample Handling Cell Exhaust System

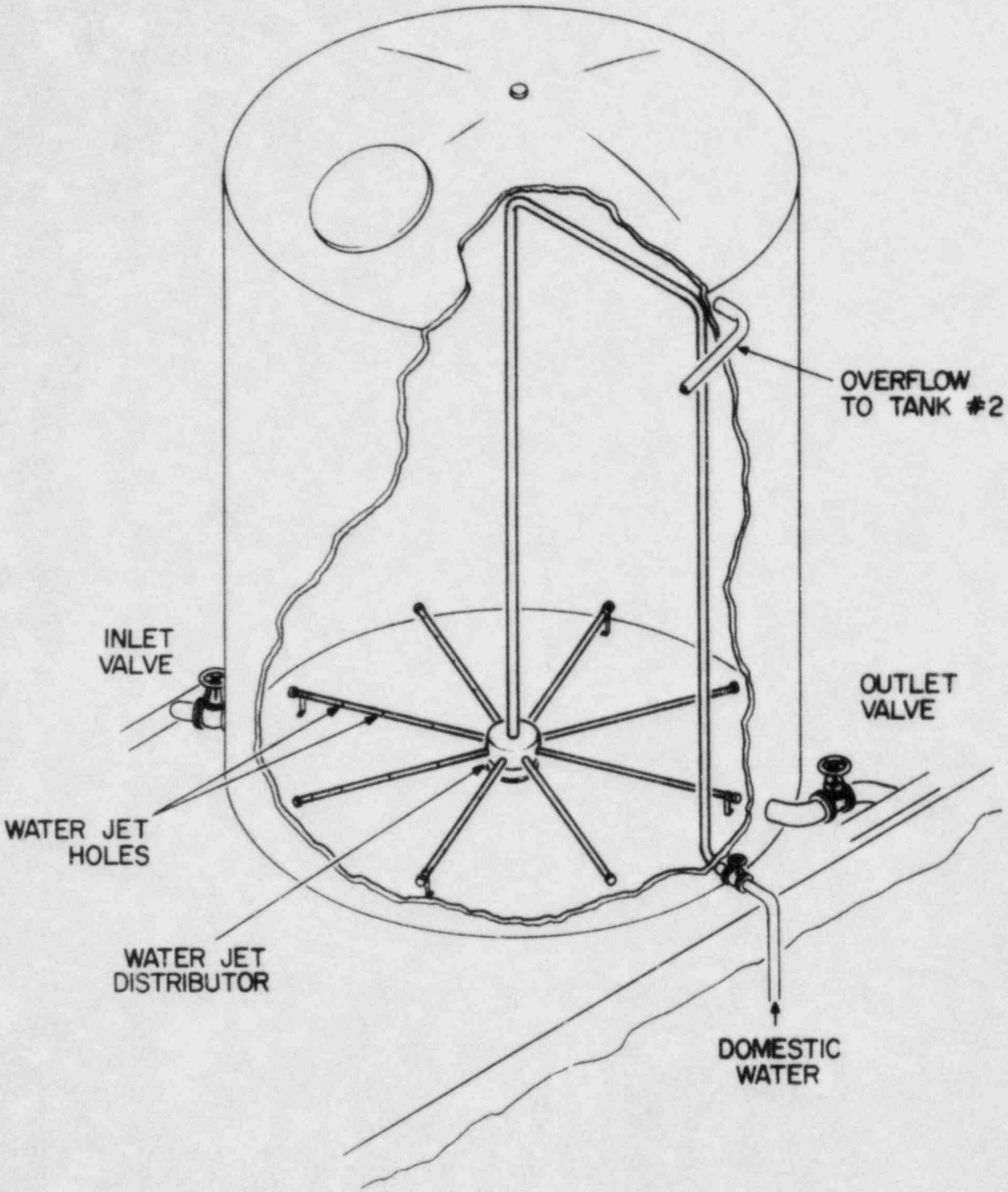

Figure 7. High Velocity Raw Water Stirrer System for Waste Storage Tanks

Reportable Occurrences

Failure of the Linear Power Channel to Respond During Reactor Startup

On February 5, 1982 during the initial reactor startup of the day, it was noticed that the linear power channel was not responding. Rod withdrawal was terminated with the shim safety control rods at approximately 40% and reactor power less than 1 watt. The detector high voltage switch was found to be in the off position, and a reactor shutdown was initiated. The reactor supervisor restored power to the detector, and the reactor was started up to 1 Mw with no further problems. Although the operator observed proper detector voltage during the prestartup check, the switch was apparently inadvertently turned off prior to startup. Normal subcritical multiplication was observed on the Log Power Channel but it was not until the reactor approached 1 watt that the operator noted no response on the linear channel.

Failure of the Log Channel Rate Meter During a Reactor Startup

On July 22, 1982 during the initial reactor startup of the day it was noticed that the log power channel rate meter was no longer responding. The reactor was shutdown, and following a cleaning and inspection of various switch contacts normal meter response was observed. However, the meter failed a second time during the subsequent reactor startup. A further cleaning of amplifier boards restored normal operation, and a third reactor startup was performed with no further problems noted. The intermittent nature of the problem made it difficult to pinpoint the exact cause of failure. However, the instrument has since been observed closely and no further failures have occurred.

Failure of a Fuel Temperature Thermocouple During Reactor Operation

On September 28, 1982 erratic readings were noted of the fuel temperature indicator while the reactor was operating at power. The reactor was shutdown, and on Setember 29, 1982 a different instrumented fuel element (IF) was connected to the Fuel Temperature Channel. After approximately twelve hours of operation erratic readings were once again observed and the reactor was shutdown. A new IF was prepared and installed in the core on October 1, 1982 and has operated satisfactorily since that time.

Reactor Operation in Excess of Licensed Power Level

On December 4, 1982 following a core change to establish Core VIII a power calorimetric was performed and indicated the reactor was operating lower than the indicated power. Since all procedural requirements and initial conditions had been adhered to and the data appeared to be correct, the reactor power detectors

were repositioned such that the calculated actual power and indicated power agreed. A second calorimetric performed on December 10, 1982 indicated that reactor power was actually much higher than indicated, and a series of additional calorimetrics were completed during the following week to confirm the results. Based on these results, NRC Region IV was notified on December 17, 1982, and it was later decided that reactor power may have been as high as 1.37 Mw on December 6, 1982 and 1.23 Mw from December 7, 1982 to December 9, 1982. A thorough investigation into the calorimetric of December 4 indicated that an improper ice bath for the reference temperature had been prepared causing the large error obtained. The ice bath prepared with too little water experienced a temperature change of approximately .5°F over a two hour period resulting in a 30% error. Operators have now been trained in the proper method for ice bath preparation, and until the calorimetric procedure is thoroughly reviewed an interim procedure limits the amount of reactor power increase by detector adjustment at any one time to no greater than 10% of the measured power.

Security Incidents

There were two incidents pertaining to security requirements at the NSC during 1982. However, due to public disclosure restrictions these will not be addressed in this report. It should be noted, however, that neither case involved an item of noncompliance.

D. Changes in Operating Procedures

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

SOP Number	Subject
I-A	Definitions and Abbreviations
I-H	Reactor Safety Board
II-B	Operations Records
II-C	Reactor Startup
II-F	Reactor Shutdown
III-C	Linear Power Measuring Channel Maintenance and Surveillance
III-E	Safety Power Measuring Channel Maintenance and Surveillance
III-Q	SNM Accountability
IV-D	Beam Port Experiments
IV-E	Irradiation Cell Experiments
IV-F	Neutron Radiography Beam Port No. 4
VI-A	Maintenance and Surveillance of Support Systems - General

Changes in Operating Procedures (Cont'd)

SOP Number	Subject
VI-B	Ventillation System Maintenance and Surveillance
VI-C	Electrical Power Failure Testing and Maintenance
VII	Health Physics Procedures
VIII-A	Security Plan - Introduction
VIII-A, B, E	Security Plan
VIII-E	Testing and Maintenance of Security Systems
IX-B	Emergency Procedures and Plans

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

SOP Number	Subject
III-A	General
III-R	Evacuation Horn System Surveillance
VI-C	Electrical Power Failure
VI-D	Red Tag Procedures

E. Unscheduled Shutdowns

A total of nineteen unscheduled shutdowns occurred during 1982. As can be seen a large number were electronic in nature due to equipment age. The unscheduled shutdowns can be arranged in the following categories:

Cause of Shutdowns	Number of Shutdowns
Building power loss	6
Operator error	3
Electronics	10

F. Reactor Maintenance and Surveillance

1. A calibration of the fuel temperature measuring channel was performed on 1-7-82. The LSSS was set at 525°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 as follows:

Core VII-A (1-8-82)

Control Rod	Rod Worth
SS #1	$2.77
SS #2	1.68
SS #3	2.45
SS #4	4.49
RR	.78
Shutdown Margin	$1.01

Core VIII (12-3-82)

Control Rod	Rod Worth
SS #1	$2.64
SS #2	1.64
SS #3	2.21
SS #4	4.23
RR	.85
TR	2.92
Shutdown Margin	$4.70

4. The reactivity worth of all experiments was either estimated or measured, as appropriate before reactor operation with the experiment. The most reactive experiment irradiated had a worth of $.65.

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 rods. However, there are plans to pulse in 1983 and the transient rod was installed in December with the establishment of Core VIII.

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

Date	Control Rod	Time in Seconds
1-6-82	SS #2	.635
1-7-82	SS #3	.739
1-8-82	SS #1	.718
	SS #2	.638
	SS #4	.718

Date	Control Rod	Time in Seconds
2-3-82	SS #2	.624
8-19-82	SS #1	.56
	SS #2	.58
	SS #3	.65
	SS #4	.64
10-28-82	SS #1	.656
	SS #2	.676
12-3-82	TR	.826

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:

Date	Indicated Power (Kw)	Actual Power (Kw)	% Error	Core Loading
1-11-82	400	394.84	-1.29	VII-A
12-4-82	400	277.22	-30.6	VIII
12-10-82	400	626.4	+56.6	VIII
12-13-83	400	369.7	-7.6	VIII
12-16-82	400	393	-1.6	VIII
12-20-82	400	370.6	-7.0	VIII

It should be noted that the series of calorimetrics completed in December 1982 were performed in an effort to determine the large error obtained on 4 December 1982 following the establishment of Core VIII. See Section III-C for details.

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 4-2-82 and 9-24-82.

11. Weekly checks were performed throughout the year to verify that the NSC security alarm system was operable.

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

Monitoring System	Date of Calibration
Ch #1 - Stack Particulate	11-1-82
Ch #2 - Fission Product	5-5-82
Ch #3 - Stack Gas	9-1-82
Ch #4 - Building Particulate	5-7-82
Ch #6 - Building Gas	12-16-82
Area Radiation Monitors	9-24-82

13. A review of the NSC security plan was conducted by the NSC staff and the Reactor Safety Board on January 28, 1982.

IV. FACILITY ADMINISTRATION

A. Organization

The organization chart for reactor operations at the Nuclear Science Center is presented in Figure 8. During this reporting year the Director, Dr. John Randall, was reassigned to the Nuclear Engineering Department at Texas A&M University and Donald E. Feltz assumed his duties as Acting Director. The position of Associate Director has remained vacant since that time. Gary Waldrep was reassigned to Manager of Technical Services and was replaced as Reactor Supervisor by Dan Rodgers. Mr. Waldrep later resigned his position and was not replaced during this reporting period. Jim Petesch, Bill Sims, and Terry Rolon all received senior reactor operator licenses during 1982. Also during this same year Karen McKinley, Jerald Head, and Ron Land received reactor operator licenses. Melody Geer resigned as Health Physicist and was replaced by Yenny Contreras. The NSC continues to employ students on a part-time basis when full-time help is not available.

B. Personnel

The following is a list of personnel at the Nuclear Science Center for the period January 1, 1982 - December 31, 1982.

Facility Administration and Reactor Operations Staff

+Feltz, D. E.	- Associate Director, January 1982 - 31 May 1982. Acting Director, 1 June 1982 - 31 December 1982
+Petesch, J. E.	- Reactor Supervisor
+Randall, J. D.	- Director, 1 January 1982 - 31 May 1982 (Terminated). Professional Engineer (1 June 1982 - 31 December 1982)
+Rodgers, D. J.	- Reactor Supervisor

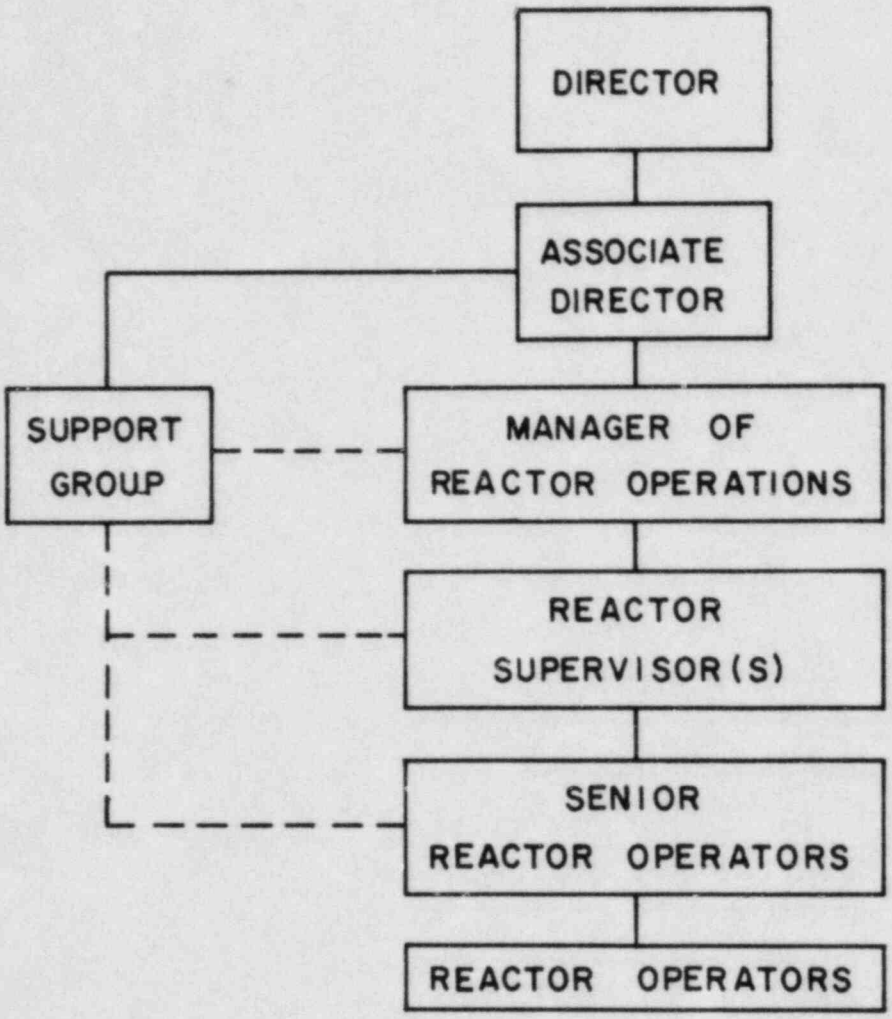

Figure 8. Nuclear Science Center Reactor Operations Organization Chart

Facility Administration and Reactor Operations Staff (Cont'd)

+Rogers, R. D.	- Manager of Reactor Operations
+Rolon, T. R.	- Reactor Operator
+Sims, W. W.	- Reactor Operator
+Theis, J. W.	- Reactor Supervisor

Technical Service and Maintenance

Brown, D.	- Student Worker I (Terminated)
Deigl, C.	- Draftsman (Terminated)
Fisher, T.	- Scientific Instrument Maker II
Goodman, D.	- Student Worker I
*Head, J. G.	- Engineering Research Associate
Horn, C. R.	- Mechanical Equipment Foreman
Johnson, G.	- Student Worker I
Khalil, N.	- Co-op Research Aide
*Land, R.	- Engineering Research Associate
Lee, D.	- Student Worker I (Terminated)
*McKinley, K. M.	- Engineering Research Associate
Meyer, C.	- Research Assistant (Terminated)
Miller, P.	- Draftsman (Terminated)
Otte, M. G.	- Engineering Research Associate (Terminated)
Parlos, A.	- Student Worker I (Terminated)
Powell, R.	- Student Worker I (Terminated)
Restivo, A. L.	- Engineering Research Associate
Schneider, L.	- Student Worker I
Thompson, J.	- Mechanical Maintenance Technician
Thompson, L.	- Reactor Maintenance Supervisor
+Waldrep, G. W.	- Manager of Technical Services (Terminated)
Yupari, R.	- Student Technician

*Licensed Reactor Operator
+Licensed Senior Reactor Operator

Clerical

Huss, K.	- Receptionist
Kunz, B.	- Receptionist (Terminated)
Mitchell, Y.	- Secretary
Ribardo, J.	- Bookkeeper

Health Physics Staff

Contreras, Y.	- Health Physicist
Deigl, H. J.	- Senior Health Physicist
Geer, M.	- Health Physicist (Terminated)
Rodriguez, L.	- Health Physicist
Stehle, W.	- Health Physicist

Texas Engineering Extension Service

Benson, C. A.	- Instructor (Terminated)
Dr. Buchanan, R.J.	- Training Specialist
Dunn, R. F.	- Instructor
Hassell, C. A.	- Instructor (Terminated)
Holste, C.	- Instructor
Keith, D.	- Instructor (Terminated)
Kolar, F.	- Instructor (Terminated)

C. Reactor Safety Board

Committee Composition

Chairman

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

(January 1, 1982 - August 31, 1982)

F. Jennings, Director, Office of University Research

(September 1, 1982 - December 31, 1982)

Voting Members

Dr. F. Sicilio, Professor of Chemistry

(January 1, 1982 - December 31, 1982)

Dr. R. L. Watson, Professor of Chemistry and Associate Dean of Science

(January 1, 1982 - December 31, 1982)

Dr. R. R. Hart, Professor of Nuclear Engineering

(January 1, 1982 - December 31, 1982)

Dr. Dan Hightower, Professor of Veterinary Physiology and Pharmacology

(January 1, 1982 - August 31, 1982)

Voting Members (Cont'd)

R. Green, Assistant Professor, Small Animal Clinic
(September 1, 1982 - December 31, 1982)
Dr. R. A. Kenefick, Professor of Physics
(September 1, 1982 - December 31, 1982)

Ex-Officio Members

Dr. C. A. Erdman, Professor and Head of Nuclear Engineering
(January 1, 1982 - December 31, 1982)
Dr. J. D. Randall, Professor Nuclear Engineering and Director of Nuclear Science Center
(January 1, 1982 - May 31, 1982)
D. E. Feltz, Acting Director of Nuclear Science Center
(June 1, 1982 - December 31, 1982)
Dr. R. D. Neff, Professor and University Radiological Safety Officer
(January 1, 1982 - December 31, 1982)

Meeting Frequency

The Reactor Safety Board (RSB) met on the following dates during the calendar year 1982: 3/5/82, 8/31/82, 9/24/82.

RSB Audits

During the reporting period RSB audits of NSC activities were conducted on the following dates: 2/12/82, 5/14/82, 7/21/82, 10/15/82.

APPENDIX I

Description of Projects Utilizing the NSCR

DESCRIPTION OF PROJECTS UTILIZING THE NSCR

A. Texas A&M University

Nuclear Engineering

NEUTRON TRANSMUTATION DOPING OF SILICON

Personnel

Dr. Ron R. Hart -- Professor
Cary Waldrep -- Reactor Supervisor

Personnel completed all phases of testing of a multi-tube irradiation device for neutron doping of solid silicon ingots. This device is presently in commercial use for production of silicon semiconductor material.

NEUTRON TRANSMUTATION DOPING OF GALLIUM ARSENIDE

Personnel

Dr. Ron R. Hart -- Professor
Edward Parma -- Graduate Assistant

Past work demonstrated the value of neutron transmutation doping of silicon to produce semiconductor material. Tests were conducted to determine the feasibility of applying this process to Gallium Arsenide to produce a semiconductor material.

MEASURE OF IRON IMPURITY CONCENTRATIONS IN SEMICONDUCTOR MATERIALS

Personnel

Dr. Ron R. Hart -- Professor
Steve Lee -- Graduate Assistant

Neutron and charged particle activation techniques were used to measure the concentrations of iron impurities in semiconductor materials.

RADIATION FIELD MEASUREMENTS IN THE TAMU NUCLEAR SCIENCE CENTER IRRADIATION CELL

Personnel

Dr. Carl A. Erdman -- Professor
Michaele C. Brady -- Graduate Assistant

This study was performed to determine the feasibility of using the NSC irradiation cell for LMFBR safety analysis experiments using neutronic heating. The test involved modifying the irradiation cell for experiments using thermal neutrons.

THE DEVELOPMENT AND EVALUATION OF A NEUTRON WINDOW FILTER FACILITY

Personnel

Dr. Gerald Schlapper -- Professor
Patricia Harding -- Graduate Assistant

A study was performed to determine the feasibility of a neutron window filter facility at the NSC. A facility of this type would have application in neutron dosimetry and radiography.

MEASUREMENT OF FLUORIDE CONCENTRATION IN LITHIUM FLUORIDE

Personnel

Dr. Theodore Parish -- Associate Professor
Mike Schuller -- Graduate Assistant

Fluorine concentrations were measured in LiF using neutron activation analysis. These concentrations are of interest in Fusion Reactor Blanket Research.

AIRBORNE RADIOACTIVE MATERIAL COLLECTION, MEASUREMENT, AND DATA STORAGE FOR THE NSC

Personnel

Dr. R. D. Neff -- Professor
Melody Jones -- Graduate Student

The sampling program and data evaluation for airborne radioactive effluents from the NSC was reviewed and updated to include a minicomputer for data storage. The computer receives its information directly from the air monitors and computes an average release rate. This project greatly improved the efficiency of the air monitoring equipment.

Animal Science

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

Personnel

Dr. W. C. Ellis -- Professor
Kevin Pond -- Graduate Assistant

An experiment was conducted to determine the passage of ingested forage particles through the gastrointestinal tract of cattle using rare earth radioisotopes as tracers.

PREPARATION OF AN AUTOMATED SAMPLE ANALYSIS SYSTEM FOR NAA STUDIES

Personnel

Dr. W. C. Ellis -- Professor
NSC Technical Services Staff

An automatic sample changer supplied by the Animal Science Department was modified for use with a Ge(Li) detector and interfaced with a multichannel analyzer system. This system allows the automatic analysis of up to 100 samples at a time with no operator intervention. This system will be used extensively in further studies of the G.I. tract of cattle.

Oceanography

DETERMINATION OF TRACE METAL CONCENTRATIONS IN SURFICIAL SEDIMENTS, MACRONEKTON AND SPINY OYSTERS FROM THE SOUTH TEXAS TOPOGRAPHIC FEATURES STUDY

Personnel

Dr. B. J. Presley -- Associate Professor
Dr. P. N. Boothe -- Research Associate
Fred Fenner -- Graduate Assistant

The NSC facilities were used to determine the levels of vanadium (V), barium (Ba) and other trace elements (when possible) in various sample types by neutron activation analysis. These samples included spiny oyster tissue (Spondylus Americanus) and both leaches and total digests of marine sediments. These samples were collected as part of the Bureau of Land Management's Gulf of Mexico Topographic Features Study. Most came from the vicinity of the East Flower Gardens Bank. The primary purpose of these analyses is to determine baseline levels of trace metals in the biota and sediments from these biologically important fishing banks on the outer continental shelf. These data will be used to evaluate the impact which present and future oil and gas exploration and production may have on these potentially sensitive reef communities. The expected level of V in Spondylus samples is about 10 ppm. The levels of Ba and V in the sediment samples should be $\leq$ 300 ppm and $\leq$ 100 ppm respectively.

Chemistry

COMPLEXES AND CATIONS SUPPORTED ON THE SURFACE AND BETWEEN LAYERS OF ZIRCONIUM PHOSPHATE I. COPPER (II) AND ITS AMMONIA COMPLEXES

Personnel

Dr. A. Clearfield -- Professor
Laura Quayle -- Graduate Assistant
Bharati Menta -- Post Doctorate

Neutron activation analysis was used to determine cation content of complexes placed on the surface of Zirconium Phosphate and to determine the ion exchange of alkali metals cations.

TRITIUM AND SILICON-31 PRODUCTION PROJECT

Personnel

Dr. Yi-Noo Tang -- Professor
Dr. E. E. Siefert -- Post Doctorate

Recoil tritium atoms, generated from $^{3}He(n,p)^{3}H$ process with thermal neutrons from the reactor, reacted with organic compounds such as C_2H_5F, C_2H_5Cl and $C\text{-}C_4H_8$ to yield products either from abstraction or substitution. The substituted products that formed carried a large amount of residual 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 aluminum 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 stabilized) varied as a linear function of log P_{eff}. The effective pressure P_{eff}, was calculated by taking into consideration the relative collisional coefficient 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 silykenes, $^{31}SiH_2$ 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 silacy-clopent-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.

Center for Energy and Mineral Resources - Chemistry Department

TRACE ELEMENTS IN LIGNITES

Personnel

Dr. Ralph Zingaro -- Professor
Wayne Ilger -- Graduate Assistant

The results of the continuing study of the modes of occurrence of uranium in Texas lignites indicate that a significant amount of the element may be associated with the humic acids. In the present and perhaps, the final phase of the project, the lignite humic acids were fractionated according to molecular size on a sephadex cclumn. The fractions obtained were analyzed for uranium content using NSC facilities and an attempt made to correlate the uranium distribution with the molecular weights of the humic acids.

Geology

Personnel

Dr. Thomas Tieh -- Professor
Wendy Schaftenaar -- Graduate Assistant

Studies were performed to determine the distribution, abundance, and nature of occurrence of uranium in igneous rocks of the Davis Mountains of West Texas. Uranium content was determined using the delayed neutron counting system at the NSC.

Radiological Safety Office

DETERMINATION OF URANIUM CONTENT IN LIGNITE

Personnel

Dr. R. D. Neff -- Professor
John O'Donnell -- Graduate Student

The NSC delayed neutron counting system was used to determine uranium content of lignite samples. These results were then compared to other methods of uranium detection.

CALIBRATION OF HIGH LEVEL GAMMA SURVEY INSTRUMENTS

Personnel

John Simek
Phil Sandel

The NSC chemistry lab was used as a site for calibration of high level gamma measuring instruments using Xenon gas as a source.

B. Other Universities

Reactor Demonstrations

Groups from the following institutions visited the NSC in 1982 for detailed facility tours and demonstration of activation analysis capabilities. In some cases, this included forensic analysis of specialized samples with detailed explanation of techniques involved.

Institution	No. Students
McLennan Community College	119
Baylor University	6
Blinn College	21

Baylor College of Medicine

Personnel

Dr. McLauren -- Assistant Professor, Biology

The project consists of determining the amounts of transition (and other) metals found in the complex enzyme RuBP Case. This enzyme is of great importance in the food chain since it is primarily responsible for fixation of carbon in plants.

Sam Houston State University

Personnel

Dr. B. Covington -- Assistant Professor, Physics
Dr. C. K. Manka -- Assistant Professor, Physics

In the first of these two projects, the transmutation doping of semi-conductor materials by use of the NSC reactor. The properties of highly doped materials are then determined and practical applications identified. The second project involves the determination by neutron activation analysis of the amount of aluminum deposited inside an experimental laser. The purpose of this project is to ultimately improve the performance of high output lasers.

Texas State Technical Institute (Harlingen, Texas)

Personnel

Mr. Pedro R. Jimenez -- Chairman, Nuclear Technology

Twenty-two first and second year nuclear technology students performed a one-day lab class covering neutron activation analysis, pool water chemistry, and area radiation survey.

Texas State Technical Institute (Waco, Texas)

Personnel

Mr. Carl Kee -- Chairman, Nuclear Systems Technology

During the year, approximately 40 students from the first and second years of the Nuclear Technology Program came to the NSC for

laboratory classes in a number of areas pertaining to radiation safety. The following laboratories were performed during 1982:

1. Neutron Activation Analysis
2. Neutron Flux Determination
3. Reactor Operator Experience and Instrumentation Study
4. Pool Water Chemistry Analysis
5. Radioactive Waste Analysis
6. Contamination Control
7. Personnel Dosimetry
8. Instrument Calibration and Survey
9. Air Monitoring System Study
10. Fixed Area Monitoring System Study

McNeese State University

Personnel

Dr. Jim Beck -- Professor

Using the NSC for irradiation services, neutron activation analysis projects were performed on geothermal brines. Saltwater from deep gas wells in Louisiana which has a potential use as a thermal energy source were analyzed for trace metal content to determine possible harmful constituents. Another project was done for metal levels in home air conditioning filters to determine normal exposures to pollutants.

Louisiana State University

Personnel

Dr. R. Knaus -- Assistant Professor

The project involves the fate of dredge spoil materials as determined by neutron activation analysis. Lake bottom sediment will be laced with the stable elements indium and dysprosium. The tagged lake sediments will be pumped to a spoil site. The stable trancers will be used to follow the ultimate fate of fine erosional materials which are naturally washed from the dredge spoil banks.

Sul Ross State University

Personnel

Dr. Dennis O. Nelson -- Assistant Professor, Geology

The project consists of trace elements geochemistry of Davis Mountain Syenites, Precambrian Aphibolites of the Van Horn region, rocks from the Paisano Volcanic area, and volcanic rocks and ultramasix xenoliths from Big Bend National Park region. The purpose of the project is to use the trace element concentrations of these igneous and metamorphic rocks to determine their origin and the geological history of the corresponding areas.

C. Industrial Training Programs

In addition to the activities described above, the NSC through the Texas Engineering Extension Service has embarked on a program to develop a number of training courses for industrial organizations. These are primarily oriented toward nuclear power plant and medical research personnel. A description of the courses is presented below.

RADIATION SAFETY TRAINING

Instructors

Mr. H. J. Deigl, NSC
Ms. M. L. Jones, NSC
Dr. R. D. Neff, RSO
Mr. P. Sandel, RSO
Mr. J. Simek, RSO

These courses are taught in conjunction with the Radiological Safety Office (RSO). Depending on the program, instruction is conducted both at the NSC and other campus facilities. Courses taught in 1982 are:

Advanced Health Physics Technicians Training

This course is designed for technicians who perform daily health physics tasks under professional supervision. Nine individuals from the U.S. Army participated in 1982 for the 1 week course.

Health Physics and Radiochemistry Training

Instructors

Mr. J. G. Head, NSC
Dr. R. J. Buchanan, TEEX
Mr. A. Hassel, Chemistry
Mr. C. Meyer, NSC
Mr. R. F. Dunn
Ms. C. Holste
Mr. F. Kolar

This 12 week course was given to five individuals from Kansas Gas and Electric. The training consisted of 6 weeks in Applied Health Physics Training and 6 weeks of chemistry (including radiochemistry). Instruction in both the classroom and laboratory.

APPENDIX II

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

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 Congestive 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, "Factors 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. Fishman, P.H., "Mineralogical Analysis and Uranium Distribution of the Sediments from the Upper Jackson Formation Karnes County, Texas", Masters' Thesis in Geology, December 1978.

14. Prasse, E.M., "Uranium and Its Relationship to Host Rock Minerology in an Unoxidized Roll Front in the Jackson Group, South Texas", Masters' Thesis in Geology, December 1978.

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

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

17. 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.

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

19. 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".

20. 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.

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

22. Clearfield, A., and L. Kullberg, "On the Mechanism of Ion-Exchange in Zirconium Phosphates: An Equilibrium Study of Sodium-Potassium-Hydrogen Exchange on Crystalline Zirconium Phosphates", Jour. of Inorganic and Nuclear Chem., 1979.

23. O.F. Zeck, R.A. Ferrieri, C.A. Copp, G.P. Gennaro and Y. -N. Tang, "Gas Phase Recoil Phosphorus Reactions IV-Effect of Moderators on Abstraction Reactions", J. Inorg. Nucl. Chem., 41, 785 (1979).

24. Chatham, J.R., "A Study of Uranium Distribution in an Upper Jackson Lignite - Sandstone Ore Body, South Texas", Masters' Thesis in Geology, May 1979.

25. Parks, S.L., "Distribution and Possible Mechanism of Uranium Accumulation in the Catahoula Tuff, Live Oak County, Texas", Masters' Thesis in Geology, May 1979.

26. Miller, M.E., "Uranium Roll Front Study in the Upper Jackson Group Alascosa County, Texas", Masters' Thesis in Geology, December 1979.

27. Ellis, W.C., J.H. Matis, and Carlos Lascano, "A Method for Determining In-Vivo Rates of Particle Size Degradation, Genesis, and Passage from the Rumen", Proc. of 15th Conference on Rumen Function, 1979.

28. Ellis, W.C., J.H. Matis, and Carlos Lascano, "Sites Contributing to Compartmental Flow for Forage Residues", Ann. Res. Vet, 1979.

29. Lescano, Carlos, "Determination of Grazed Forage Voluntary Intake", Ph.D. Dissertation in Animal Nutrition, December 1979.

30. Pond, Kevin, "Effect of Monensin on Intake Digestibility, Gastrointestinal Fill and Flow in Cattle Grazing Coastal Bermuda Pasture", Masters' Thesis in Animal Nutrition, August 1979.

31. Loza, Hector, "Effect of Protein Defficiency on Forage Intake and Digestibility", Masters' Thesis in Animal Nutrition, May 1979.

32. Tenhet, Vicki L., "Penetration Mechanism and Distribution Gradients of Sodium-Tripoly-Phosphate in Peeled and Deveined Shrimp", Masters' Thesis in Animal Science, December 1979.

33. E.E. Siefert, K-L. Loh, R.A. Ferrieri, and Y.-N. Tang, "Formation of 1-Silacyclopenta-2,4-eiene through Recoil Silicon Atom Reactions", J. Am. Chem. Soc., 102, 2285 (1980).

34. Rowe, M.W., E.W. Filberth, and H.J. Shaeffer, "Uranium in Huero and Guadalupe Mountain Indian Ceramics", Archaeometry Great Britain, 1980.

35. Ledger, E.B., T.T. Tieh, and M.W. Rowe, "Delayed Neutron Activation Determination of Uranium in Thirteen French Rock Reference Samples", Geostandards Newsletters, 1980.

36. Tieh, T.T., E.B. Ledger, M.W. Rowe, "Release of Uranium from Granitic Rocks During In Situ Weathering and Initial Erosion (Central Texas)", Chemical Geology, 1980.

37. "Core Modification of the Texas A&M Nuclear Science Center Reactor for Improved Commercial Utilization", J.P. Taft with John D. Randall and K. Walker, (March 1980).

38. "Organization and Management of Health Physics Support for a Research Reactor", E.F. Bates with R.D. Neff and J.D. Randall, (March 1980).

39. "Analysis of Uranium in Ore Samples by Delayed Neutron Activation Analysis", Radiochemical and Radioanalytical Letters, by K.L. Walker, October 1980.

40. "Formation of 1-Silacyclopenta-2,4diene Through Recoil Silicon Atom Reactions", E.E. Siefert, K.-L. Loh, R.A. Ferrieri, and Y.-N. Tang, J. Am. Chem. Soc., 102, 2285, (1980).

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Appendix III

Summaries

of

Health Physics Support

Effluent Releases

Environmental Survey Program

Radiation and Contamination Control Program

and

Personnel Exposures

Summary of Health Physics Support for the Operation of the Nuclear Science Center Reactor 1982

_____ Provided health physics monitoring support for processing 980 irradiations containing over 14,925 samples and approximately 2135 curies of radioactivity.

_____ Certified 467 shipments of radioactive materials to off-site industry.

_____ Certified 157 shipments of radioactive materials to other campus laboratories.

_____ Provided monitoring support for processing and handling over 7559 experimental samples retained at the Nuclear Science Center laboratories.

_____ Conducted environmental survey program in cooperation with the Texas State Department of Health. This program consists of in-situ TLD monitors and the collection, analyses and evaluation of over 41 soil, water, vegetation, and milk samples.

_____ Provided personnel monitoring support for ~ 47 persons on a daily basis and over 6280 visitors as required.

_____ Performed radionuclide analyses and packaged approximately 36.8 Ft^3 of dry solid radioactive waste for disposal.

_____ Performed radioisotope identification and determined radioactivity concentrations for 72 releases of radioactive liquid effluents totaling 2,200,000 gallons including fresh water diluent.

_____ Performed surveys of the Nuclear Science Center facilities for radiation levels and radioactive contamination including the collection, analyses, and evaluation of approximately 200 smear samples on a monthly basis.

_____ Conducted radiation safety training for 121 NSC employees and experimental personnel using NSC facilities.

EFFLUENT RELEASE SUMMARY

Introduction

Summaries of radioactive effluents released from the Nuclear Science Center for 1982 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 5.57 E-11 µCi/cc. Total radioactivity released for the year was 3.98 E-03 curies. There were 5 radioisotopes with > 8 day half-lives identified from isotopic analyses of the filter papers in addition to the < 8 day half-lives of 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 counting the Argon-41 photopeak in the gaseous discharges of the central exhaust stack. Total Argon-41 released during 1982 was 2.45 curies. This results in an annual average release rate of 3.99 E-08 µCi/cc as measured in the central exhaust stack with no dilution factors applied. Applying the dilution factor of 5.0 E-03 allowed at the site boundary (as determined, SAR, pages 117-119, June 1980) results in radioactivity concentrations of < 1% of the limits specified in 10CFR20, Appendix B, Table II, Column 1. 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 radioisotope identification and radioactivity concentrations were determined for each release. There were 72 liquid waste releases totaling 2.2 E 06 gallons including diluents from the Nuclear Science Center during 1982. The total radioactivity released for 1982 was 2.65×10^{-2} Ci with an average concentration of 3.11×10^{-6} µCi/ml. Summaries of the radioisotope data are presented in Tables 3 through 15. Radioactivity concentrations for each isotope were below the limits specified in 10CFR20 Appendix B.

Solid Radioactive Waste

There was a total of 36.8 ft^3 of dry solid waste material packaged in five (5) 55 gallon steel drums for disposal during 1982. These materials were transferred to the Radiological Safety Office, Texas License 6-448, for disposal. This material consisted of laboratory glassware, irradiation containers, decontamination materials, and expendable protective clothing and equipment, e.g., paper, shoe covers, plastic bags and gloves. This material contained Co-60, Ir-192, Cs-137, Zn-65, Ce-141, Mn-54, Cr-51, Br-82, Cd-109 and mixed fission products with the total radioactivity being 1.53 E-1 Ci. These data are in Table 16.

TABLE 1
PARTICULATE EFFLUENT RELEASES
ANNUAL SUMMARY
1982

Month	Exhaust Volume (cc)	Concentration (μCi/cc)	Total Radioactivity (μCi)	(Ci)
January	6.31 E 12	1.33 E-12	8.39	8.39 E-6
February	5.91 E 12	5.72 E-10	3380.52	3.38 E-3
March	6.31 E 12	1.83 E-11	115.47	1.15 E-4
April	6.12 E 12	2.03 E-11	124.24	1.24 E-4
May	6.31 E 12	1.24 E-12	7.82	7.82 E-6
June	6.12 E 12	6.53 E-12	39.96	4.0 E-5
July	6.31 E 12	6.31 E-12	39.82	3.99 E-5
August	6.31 E 12	5.78 E-12	36.48	3.65 E-5
September	6.12 E 12	1.50 E-12	9.18	9.18 E-6
October	6.31 E 12	2.25 E-12	14.20	1.42 E-5
November	6.12 E 12	8.3 E-12	50.80	5.08 E-5
December	6.31 E 12	2.42 E-11	152.70	1.53 E-4

Total Volume: 7.45 E 13 cc

Annual Average Release: 5.57 E-11 μCi/cc

Total Radioactivity Released: 3.98 E-03 Ci

TABLE 2
GASEOUS EFFLUENT RELEASES
ARGON-41
ANNUAL SUMMARY
1982

Month	Exhaust Volume(cc)	Concentration* (µCi/cc)	Concentration** (µCi/cc)	Percent MPC**	Total Radio-activity (Ci)*
January	6.31 E 12	3.0 E-10	1.50 E-12	3.75 E-05	1.89 E-03
February	5.91 E 12	1.80 E-8	9.00 E-10	2.25 E-02	1.06 E-01
March	6.31 E 12	3.00 E-10	1.50 E-11	3.75 E-04	1.89 E-03
April	6.12 E 12	2.32 E-8	1.16 E-09	2.90 E-02	1.42 E-01
May	6.31 E 12	9.42 E-8	4.71 E-09	1.18 E-01	5.94 E-01
June	6.12 E 12	9.24 E-9	4.71 E-10	1.18 E-02	5.65 E-02
July	6.31 E 12	1.67 E-8	8.35 E-10	2.09 E-02	1.05 E-01
August	6.31 E 12	1.58 E-8	7.90 E-10	1.98 E-02	1.00 E-01
September	6.12 E 12	9.09 E-8	4.55 E-9	1.14 E-01	5.56 E-01
October	6.31 E 12	1.67 E-8	8.35 E-10	2.09 E-02	1.05 E-01
November	6.12 E 12	9.4 E-8	4.7 E-09	1.18 E-01	5.75 E-01
December	6.31 E 12	1.67 E-8	8.85 E-10	2.09 E-02	1.05 E-01

Total Volume: 7.45 E 13 cc

Annual Average Release*: 3.99 E-08 µCi/cc

Total Radioactivity Released*: 2.45 Ci

*As measured in the central exhaust stack.

**As determined at 100 meters, approximate boundary of exclusion area, with 200/1 dilution factor (SAR, pp. 117-119, June 1979).

TABLE 3
RADIOACTIVE LIQUID EFFLUENT RELEASES
SUMMARY
1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Sb-124	1	1.51E+08	3.01987E-08	2E-05	.150993	4.56E-06
Ce-141	2	2.965E+08	7.9258E-09	9E-05	8.80645E-03	2.35E-06
Ce-144	1	1.51E+08	1.15894E-07	1E-05	1.15894	1.75E-05
Cs-137	18	2.577E+09	4.38417E-08	2E-05	.219208	1.1298E-04
Cr-51	19	2.906E+09	8.69752E-07	2E-03	.0434876	2.5275E-03
Sb-122	1	3.74E+08	1.58021E-08	3E-05	.0526738	5.91E-06
Br-82	2	5.74E+08	5.30836E-07	4E-05	1.32709	3.047E-04
Cd-115	6	7.76E+08	1.6482E-06	3E-05	5.49399	1.279E-03
Co-57	7	1.055E+09	2.16114E-08	4E-04	5.40285E-03	2.28E-05
Co-58	50	7.8005E+09	2.48879E-07	9E-05	.276532	1.94138E-03
Co-60	95	1.4416E+10	1.03655E-06	3E-05	3.45517	.0149429
Au-198	9	1.515E+09	1.45122E-07	5E-05	.290244	2.1986E-04
Ir-192	14	2.222E+09	1.40842E-07	4E-05	.352104	3.1295E-04
Mn-54	68	1.0088E+10	4.21832E-07	1E-04	.421832	4.25544E-03
Mn-56	3	3.43E+08	1.58018E-06	1E-04	1.58018	5.42E-04
Nb-95	1	1.52E+08	1.38158E-08	1E-04	.0138158	2.1E-06
Rb-86	1	1.53E+08	5.5817E-07	2E-05	2.79085	8.54E-05
Na-22	2	3.1E+08	1.57742E-06	3E-05	5.25806	4.89E-04
Na-24	13	1.925E+09	1.02622E-06	3E-05	3.42074	1.97548E-03
Sr-87M	2	3.04E+08	2.01316E-08	3E-06	.671053	6.12E-06
Zn-65	82	1.2118E+10	1.04516E-06	1E-04	1.04516	.0126652
U-NAT	1	2.73E+08	1.48718E-09	3E-05	4.95727E-03	4.06E-07
Zr-97	1	1.98E+08	6.31313E-09	2E-05	.0315657	1.25E-06
Re-186	1	1.53E+08	1.29412E+06	9E-05	1.43791E+12	1.98E+08
Ra-226	1	9.99E+07	1.53153E+06	3E-08	5.1051E+15	1.53E+08

Total Number of Releases: 72
Total Volume Including Dilution: 8.52E+09 ml
Total Activity: .02652 Curies
Average Concentration Including Dilution: 3.11268E-06 µCi/cc

TABLE 4
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

January 1982

Isotope	No. of Releases	Volume ml	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Zn-65	5	6.47E+08	1.3915E-06	1E-04	1.3915	9.003E-04
Co-60	6	7.109E+08	8.10663E-07	3E-05	2.70221	5.763E-04
Mn-54	5	6.069E+08	6.594E-07	1E-04	.6594	4.0019E-04
Na-24	1	1.76E+08	3.50568E-07	3E-05	1.16856	6.17E-05
Ir-192	2	2.59E+08	2.35135E-07	4E-05	.587838	6.09E-05
Co-58	3	3.68E+08	4.2962E-07	9E-05	.477355	1.581E-04
Cr-51	1	1.09E+08	4.27523E-07	2E-03	.0213762	4.66E-05
Co-57	1	1.06E+08	3.74528E-08	4E-04	9.36321E-03	3.97E-06

SUMMARY

Total Number of Releases: 6

Total Volume with dilution: 187309 Gallons or 7.099E+08 ml

Average Concentration with dilution: 3.11038E-06 µCi/cc

Total Radioactivity: 2.20806E-03 Curies

TABLE 5
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

February 1982

Isotope	No. of Releases	Volume ml	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Ir-192	1	1.54E+08	4.25325E-08	4E-05	.106331	6.55E-06
Zn-65	4	7.81E+08	1.43406E-07	1E-04	.143406	1.12E-04
Co-60	4	7.81E+08	7.66965E-08	3E-05	.255655	5.99E-05
Br-82	1	2.45E+08	1.13469E-06	4E-05	2.83674	2.78E-04
Sr-87M	1	1.52E+08	1.22368E-08	3E-06	.407895	1.86E-06
Cs-137	1	1.52E+08	1.47368E-08	2E-05	.0736842	2.24E-06
Mn-54	1	1.52E+08	1.84211E-08	1E-04	.0184211	2.8E-06

SUMMARY

Total Number of Releases: 4

Total Volume with dilution: 206069 Gallons or 7.81E+08 ml

Average Concentration with dilution: 5.93278E-07 µCi/cc

Total Radioactivity: 4.6335E-04 Curies

TABLE 6
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

March 1982

Isotope	No. of Releases	Volume ml	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Mn-54	5	6.63E+08	1.07394E-06	1E-04	1.07394	7.1202E-04
Zn-65	5	6.63E+08	2.53243E-06	1E-04	2.53243	1.679E-03
Co-60	6	8.09E+08	6.69963E-07	3E-05	2.23321	5.42E-04
Cr-51	3	4.53E+08	1.56711E-06	2E-03	.0783554	7.099E-04
Co-58	4	5.55E+08	5.68342E-07	9E-05	.631491	3.1543E-04
Ir-192	2	2.98E+08	2.48054E-07	4E-05	.620134	7.392E-05
Sr-87M	1	1.52E+08	2.80263E-08	3E-06	.934211	4.26E-06
Cs-137	1	1.52E+08	4.17105E-08	2E-05	.208553	6.34E-06

SUMMARY

Total Number of Releases: 6

Total Volume with dilution: 213456 Gallons or 8.09E+08 ml

Average Concentration with dilution: 4.99737E-06 µCi/cc

Total Radioactivity: 4.04287E-03 Curies

TABLE 7
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

April 1982

Isotope	No. of Releases	Volume ml	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Mn-54	3	4.08E+08	1.89706E-08	1E-04	.0189706	7.74E-06
Co-60	4	5.17E+08	5.80271E-08	3E-05	.193424	3E-05
Ce-141	1	9.95E+07	1.04523E-08	9E-05	.0116136	1.04E-06
Co-58	1	9.95E+07	8.82412E-09	9E-05	9.90458E-03	8.78E-07
Zn-65	3	3.18E+08	7.92453E-08	1E-04	.0792453	2.52E-05
Cs-137	2	2.18E+08	1.49083E-08	2E-05	.0745413	3.25E-06

SUMMARY

Total Number of Releases: 4

Total Volume with dilution: 136412 Gallons or 5.17E+08 ml

Average Concentration with dilution: 1.31737E-07 µCi/cc

Total Radioactivity: 6.8108E-05 Curies

TABLE 8
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

May 1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Cr-51	4	6.21E+08	1.49878E-06	2E-03	.0749388	9.3074E-04
Mn-54	5	7.67E+08	1.23289E-06	1E-04	1.23289	9.4563E-04
Zn-65	5	7.67E+08	3.24673E-06	1E-04	3.24673	2.49024E-03
Co-60	7	1.213E+09	7.99909E-07	3E-05	2.66636	9.7029E-04
Cd-115	3	3.43E+08	1.97376E-06	3E-05	6.5792	6.77E-04
Mn-56	3	3.43E+08	1.58018E-06	1E-04	1.58018	5.42E-04
Na-24	3	3.43E+08	3.93586E-06	3E-05	13.1195	1.35E-03
Ir-192	1	1.55E+08	5.35484E-07	4E-05	1.33871	8.3E-05
Co-58	3	4.57E+08	8.57156E-07	9E-05	.952395	3.9172E-04
Na-22	1	1.56E+08	2.3141E-06	3E-05	7.71368	3.61E-04
Au-198	2	4.46E+08	6.41256E-09	5E-05	.0128251	2.86E-06

SUMMARY

Total Number of Releases: 10

Total Volume with dilution: 410554 Gallons or 1.556E+09 mL

Average Concentration with dilution: 5.61985E-06 µCi/cc

Total Radioactivity: 8.74448E-03 Curies

TABLE 9
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

June 1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Sb-124	1	1.51E+08	3.01987E-08	2E-05	1.50993E-03	4.56E-06
Ce-141	1	1.97E+08	6.64975E-09	9E-05	7.38861E-05	1.31E-06
Ce-144	1	1.51E+08	1.15894E-07	1E-05	.0115894	1.75E-05
Cs-137	2	3.96E+08	1.47475E-08	2E-05	7.37374E-04	5.84E-06
Cr-51	4	6.57E+08	3.55251E-07	2E-03	1.77626E-04	2.334E-04
Cd-115	1	1.52E+08	9.4079E-07	3E-05	.0313597	1.43E-04
Co-57	2	2.7E+08	1.38519E-08	4E-04	3.46296E-05	3.74E-06
Co-58	8	1.283E+09	1.6118E-07	9E-05	1.79089E-03	2.06794E-04
Co-60	10	1.632E+09	3.10215E-07	3E-05	.0103405	5.0627E-04
Ir-192	3	5.02E+09	3.920323E-08	4E-05	9.8008E-04	1.968E-05
Mn-54	10	1.632E+09	2.96622E-07	1E-05	.0277056	4.84087E-04
Na-22	1	1.54E+08	8.31169E-07	3E-05	.0277056	1.28E-04
Na-24	1	1.52E+08	1.125E-06	3E-05	.0375	1.71E-04
Zn-65	9	1.513E+09	1.06173E-06	1E-04	.0106173	1.6064E-03
U-NAT	1	2.73E+08	1.48718E-09	3E-05	4.95727E-05	4.06E-07

SUMMARY

Total Number of Releases: 11

Total Volume Released with dilution: 1.905E+09 mL

Average Concentration with dilution: 1.85406E-06 µCi/cc

Total Radioactivity: 3.53199E-03 Curies

TABLE 10
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

July 1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Cs-137	3	3.075E+08	1.79187E-08	2E-05	.0895935	5.51E-06
Cr-51	1	1.53E+08	1.94118E-07	2E-03	9.70588E-03	2.97E-05
Co-58	5	7.14E+08	1.48263E-07	9E-05	.164737	1.0586E-04
Co-60	6	7.955E+08	7.09516E-07	3E-05	2.36505	5.6442E-04
Ir-192	1	1.53E+08	6.73203E-08	4E-05	.168301	1.03E-05
Mn-54	6	7.965E+08	2.93773E-07	1E-04	.293773	2.3399E-04
Rb-86	1	1.53E+08	5.5817E-07	2E-05	2.79085	8.54E-05
Zn-65	6	7.955E+08	1.20101E-06	1E-04	1.20101	9.554E-04
Zr-97	1	1.98E+08	6.31313E-09	2E-05	.0315657	1.25E-06

SUMMARY

Total Number of Releases: 7

Total Volume Released with dilution: 9.185E+08 mL

Average Concentration with dilution: 2.16981E-06 µCi/cc

Total Radioactivity: 1.99297E-03 Curies

TABLE 11
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY
August 1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Cs-137	5	6.985E+08	2.39084E-08	2E-05	.119542	1.67E-05
Cr-51	4	6.97E+08	7.32712E-07	2E-03	.0366356	5.107E-04
Co-57	3	5.47E+08	1.86289E-08	4E-04	4.65722E-03	1.019E-05
Co-58	5	8.48E+08	1.40236E-07	9E-05	.155818	1.1892E-04
Co-60	8	1.04965E+09	6.31629E-07	3E-05	2.10543	6.6299E-04
Au-198	1	1.51E+08	4.33113E-07	5E-05	.866225	6.54E-05
Ir-192	2	3.94E+08	1.01015E-07	4E-05	.252538	3.98E-05
Mn-54	7	9.53031E+08	3.14306E-07	1E-04	.314306	2.9955E-04
Na-24	1	1.5E+08	1.40667E-07	3E-05	.468889	2.11E-05
Zn-65	6	7.54051E+08	1.49483E-06	1E-04	1.49483	1.12718E-03

SUMMARY

Total Number of Releases: 8

Total Volume with dilution: 1.2005E+09 mL

Average Concentration with dilution: 1.87594E-06 µCi/cc

Total Radioactivity: 2.25206E Curies

TABLE 12
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

September 1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Cs-137	1	1.98E+08	1.71717E-08	2E-05	.0858586	3.4E-06
Cr-51	1	1.08E+08	3.06482E-07	2E-03	.0153241	3.31E-05
Co-58	3	6.3E+08	1.40635E-07	9E-05	.156261	8.86E-05
Co-60	10	1.724E+09	2.87355E-07	3E-05	.95785	4.954E-04
Au-198	3	4.59E+08	1.6512E-07	5E-05	.33024	7.579E-05
Mn-54	5	8.82E+08	2.08231E-07	1E-04	.208231	1.8366E-04
Na-24	1	2.36E+08	3.32203E-08	3E-05	.110734	7.84E-06
Zn-65	8	1.249E+09	5.17158E-07	1E-04	.517158	6.4593E-04

SUMMARY

Total Number of Releases: 10

Total Volume Released with dilution: 1.724E+09 mL

Average Concentration with dilution: 9.90957E-07 µCi/cc

Total Radioactive: 1.70841E-03 Curies

TABLE 13
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

October 1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Cs-137	2	2.57E+08	2.5786E-07	2E-05	1.2893	6.627E-05
Cd-115	1	1.52E+08	1.67763E-06	3E-05	5.59211	2.55E-04
Co-58	10	1.55196E+09	1.91706E-07	9E-05	.213007	2.9752E-04
Co-60	15	2.12546E+09	7.44691E-07	3E-05	2.4823	1.58281E-03
Ir-192	2	3.07E+08	6.13029E-08	4E-05	.153257	1.882E-05
Mn-54	10	1.55196E+09	3.17064E-07	1E-04	.317064	4.9207E-04
Nb-95	1	1.52E+08	1.38158E-08	1E-04	.0138158	2.1E-06
Na-24	4	5.03E+08	4.49781E-07	3E-05	1.49927	2.2624E-04
Zn-65	14	2.05246E+09	8.00678E-07	1E-04	.800678	1.64336E-03
Re-186	1	1.53E+08	1.14379E-07	9E-05	.127088	1.75E-05
Ra-226	1	9.996E+07	4.10164E-08	3E-08	136.721	4.1E-06

SUMMARY

Total Number of Releases: 17

Total Volume Released with dilution: 3.33196E+09 mL

Average Concentration with dilution: 1.37942E-06 µCi/cc

Total Radioactivity: 4.59616E-03 Curies

TABLE 14
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

November 1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Sb-122	1	1.29E+08	4.5814E-08	3E-05	.152713	5.91E-06
Cd-115	1	1.29E+08	1.5814E-06	3E-05	5.27132	2.04E-04
Co-58	3	3.63E+08	3.0854E-07	9E-05	.342822	1.12E-04
Co-60	5	6.91E+08	1.19027E-05	3E-05	39.6758	8.2248E-03
Mn-54	4	4.92E+08	4.4065E-07	1E-04	.44065	2.168E-04
Na-24	1	1.29E+08	1.00775E-06	3E-05	3.35917	1.3E-04
Zn-65	5	6.91E+08	6.52533E-07	1E-04	.652533	4.509E-04

SUMMARY

Total Number of Releases: 5

Total Volume Released with dilution: 6.91E+08 mL

Average Concentration with dilution: 2.30666E-06 µCi/cc

Total Radioactivity: 1.5939E-03 Curies

TABLE 15
NUCLEAR SCIENCE CENTER
RADIOACTIVE LIQUID EFFLUENT RELEASES
MONTHLY SUMMARY

December 1982

Isotope	No. of Releases	Volume mL	Conc. µCi/cc	MPC µCi/cc	MPC Percent	Activity Curies
Br-82	1	2E+08	1.335E-07	4E-05	.33375	2.67E-05
Co-57	1	1.32E+08	3.09849E-08	4E-04	7.74622E-03	4.09E-06
Co-58	2	3.06E+08	1.83987E-07	9E-05	.20443	5.63E-05
Co-60	4	6.51E+08	3.72412E-07	3E-05	1.24137	2.4244E-04
Mn-54	2	3.06E+08	3.00327E-07	1E-04	.300327	9.19E-05
Zn-65	4	6.51E+08	5.84639E-07	1E-04	.584639	3.806E-04

SUMMARY

Total Number of Releases: 4

Total Volume Released with dilution: 6.51E+08 mL

Average Concentration with dilution: 1.23318E-06 µCi/cc

Total Radioactivity: 8.028E-04 Curies

TABLE 16
SOLID RADIOACTIVE WASTE DISPOSAL
ANNUAL SUMMARY
1982

Radioisotope	Radioactivity (μCi)	(Ci)
Co-60	141883	1.42 E-01
Ir-192	5329.8	5.33 E-03
Cs-137	532.98	5.33 E-04
Zn-65	1776.6	1.78 E-03
Ce-141	355.32	3.55 E-04
Mn-54	355.32	3.55 E-04
Cr-51	355.32	3.55 E-04
Cd-109	177.66	1.77 E-04
Br-82	0.7	7.00 E-04
Mixed Fission Products	2617.5	2.62 E-03

Total Volume: 36.8 Ft^3 contained in five (5) 55 gallon steel drums

Total Radioactivity: 1.53 E-1 Ci

TABLE 20

ENVIRONMENTAL RADIATION MONITORING PROGRAM
INTEGRATED RADIATION EXPOSURE

11 December 1981 to 29 July 1982

Station Number	Location	Calculated Exposure (Dose Rate mR)	Exposure (Net mR)	Average Exposure Rate (μR/hr)
1	NW corner - Firemans Training School	35	21	4.
2	Fence corner west of TLD Station #4	106	67	12.1
3	Back fence south of TLD Station #2	108	68	12.3
4	West corner NSC & calibration fence	121	77	13.8
5	Fence NSC front gate	117	74	13.3
6	East corner NSC & calibration fence	390	247	44.5
7	Easterwood Airport fence north of stock tank	762	48	8.7
8	Evergreen tree in open field west of calibration fence	63	40	7.3
9	Fence by trailers next to NSC	73	46	8.3
10	Fence 50' from TLD Station #9	77	49	8.8
11	Fence by aluminum gate by Easterwood Airport	67	42	7.6

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 exposures of radioactive materials detected during 1982. These surveys revealed only background radiations at the site perimeter fence.

Contamination Survey

The Nuclear Science Center is routinely surveyed for radioactive contamination every month. 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.

PERSONNEL EXPOSURES

Radiation exposures to personnel at the Nuclear Science Center for 1982 were within the limits of 10CFR20. The maximum exposure received by an individual for the year was ∿ 1320 mrem. A total of approximately 7.91 MANREM was received for 1982. 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, over 14,000 samples containing approximately 21.35 curies of radioactivity were produced and processed at the Nuclear Science Center in 1982.

The whole-body exposure data for NSC employees and experimental personnel are presented in Table 21. These data are presented in graded divisions as required under 10CFR20.202(a).

The access control procedures for visiting personnel were effective in preventing exposure to radiation. There were 6,580 visitors to the Nuclear Science Center during 1982. The maximum exposure to any visitor as determined by film badges 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.

TABLE 19

ENVIRONMENTAL SURVEY PROGRAM
FIRST QUARTER SUMMARY

1982

V E G E T A T I O N

Radioactivity (ρci/gm)

Location	Number Samples	Activity
HWY-6 and Rock Prairie	1	23 ± 2.3
Wick's Lumber	1	48 ± 3.1
Former Neinast Dairy	1	99 ± 6.6
TAMU Dairy	1	17 ± 1.3
Cyclotron	1	14 ± 9.2
White Creek	1	47 ± 5.4
NSC Creek	1	
NSC Outside	1	36 ± 3.9
NSC Inside	1	27 ± 3.3
TAMU Landfill	1	46 ± 5

M I L K

Radioactivity (ρci/l)

Location	Number Samples	Average
TAMU Dairy	2	500

W A T E R

Radioactivity (ρCi/ml)

Location	Number Samples	Average
NSC Creek	1	.026 ± 0.015
White Creek	2	.005 ± 0.004
Upper Brazos	2	.004
Sanitary Outflow	2	.004
Airport Fish Pond	2	.004 ± .0039
Lower Brazos	2	.017 ± .005

TABLE 20

ENVIRONMENTAL SURVEY PROGRAM
SECOND QUARTER SUMMARY

1982

V E G E T A T I O N

Radioactivity (pci/gm)

Location	Number Samples	Average
White Creek	3	31.5 ± 2.9
NSC Creek	3	27 ± 3.9
NSC Inside	1	21.3 ± 2.7
TAMU Landfill	1	24.3 ± 2.4

W A T E R

Radioactivity (pci/ml)

Location	Number Samples	(pCi/ml)
Sanitary Outflow	1	0.004
Easterwood Airport	1	0.006
White Creek	3	0.007
NSC Creek	3	0.009
Lower Brazos River	1	0.014
Upper Brazos River	1	0.016

TABLE 21

PERSONNEL WHOLE-BODY EXPOSURES

1982

Annual Whole-Body Dose Ranges (Rems)	Number of Individuals in Each Range
No Measurable Exposure	4
Less than 0.100	21
0.100 - 0.249	11
0.250 - 0.499	6
0.500 - 0.749	3
0.750 - 1.990	1
1.000 - 2.000	1
Greater than 2.000	0
Total Number of Individuals Reported:	47

APPENDIX IV

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

Other Universities and Colleges

Baylor University
Baylor, College of Medicine
University of Texas
Texas Women's University
University California, Los Angeles
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
Bluefield 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
Grove City College
Louisiana Tech.
Abraham Baldwin College
Kent St. University

Other Universities and Colleges (Cont'd)

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

Moody College

Sul Ross University

East Texas State University

University of Nebraska

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

Chemtrol Inc.

Jet Research

Resource Engineering

Ranger Engineering

Turbine Lab

Gulf Nuclear

Industrial Organizations (Cont'd)

Westinghouse Electric

Avery Oil Company

Bell Helicopter

Spectronics

LGL, LTD.

E-Systems

Monsanto, Inc.

Radian Corp.

Nuclear Laboratory Services

Core Laboratories

Pacific Gas and Electric

Houston Lighting and Power

Broz Labs

Balcones Research

General Electric Company

Gulf States Utilities

Kansas Gas and Electric

Teledyne

Bendix

Research Concepts

American Hoechst

Gulf Nuclear

Engineers/Designers, Inc.

Tracerco

TRIAD

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

Osage County Oklahoma, District Attorney

Bureau of Economic Geology

Amarillo District Attorney

Orange Police Department

Fort Worth Police Department

Austin Police Department

APPENDIX V

Texas A&M University Departments Served by the NSC During Twenty Years of Operation

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

TAMU Departments (Cont'd)

Department of Health and Physical Education

Department of Architecture

Department of Building Construction

Department of Industrial Engineering

Department of Industrial Education

Department of Aerospace Engineering

Department of Engineering Technology

Department of Civil Engineering

Fireman's Training School

Department of Archaeology

Department of Entomology