SCHOOL OF
ENGINEERING
& APPLIED SCIENCE
DEPARTMENT OF NUCLEAR ENGINEERING
& ENGINEERING PHYSICS

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March 26, 1992

Mr. Marvin Mendonca
U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Non - Power Reactor, Decommissioning
and Environmental Project Directorate
Washington, D.C. 20555

Re: Docket No. 50-62
Docket No. 50-396

Dear Mr. Mendonca,

We hereby submit, as required by section 6.6.2 of the Technical Specifications, our annual report of the operations of the University of Virginia Reactor (UVAR), License No. R-66, Docket No. 50-62 and the CAVALIER Reactor, License No. R-123, Docket No. 50-396 during the period January 1, 1991 through December 31, 1991. This report has been reviewed and approved by the Reactor Safety Committee.

Sincerely,

J. P. Farrar

J. P. Farrar, Administrator
U.Va. Reactor Facility

cc: USNRC, Region II

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UNIVERSITY
OF
VIRGINIA

REACTOR FACILITY

1991
ANNUAL REPORT

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1991 ANNUAL REPORT

University of Virginia Reactor Facility

I. INTRODUCTION

A. Reactor Facility Reporting Requirements

1. Reporting Period

This report on Reactor Facility activities during 1991 covers the period January 1, 1991 through December 31, 1991.

2. Basis for Reporting

An annual report of reactor operations is required by the UVAR and CAVALIER Technical Specifications, section 6.6.2. Additionally, it is the desire of the facility management to document and publicize the most important results derived from reactor operations.

B. Reactor Facility Description

The Reactor Facility is located on the grounds of the University of Virginia at Charlottesville, Virginia and is operated by the Department of Nuclear Engineering and Engineering Physics. The Facility houses the UVAR 2 MW pool type research reactor and CAVALIER 100 watt training reactor (now shutdown, awaiting decommissioning). The Facility also has a 6,000 curie cobalt-60 gamma irradiation facility, a hot cell facility with remote manipulators, several radiochemistry laboratories with fume hoods, radiation detectors, counters and laboratory counting equipment, computerized data acquisition-analysis systems, and a fully equipped machine shop and electronic shop.

1. 2 MW UVAR Reactor

The UVAR reactor is a light water cooled, moderated and shielded type reactor that first went into operation at a licensed power level of one megawatt in June 1960, under facility license No. R-66. In 1971, the authorized power level was increased to two megawatts. In September of 1982, the operating license for the UVAR was extended for 20 years. Figure 1 shows a layout of the reactor and the various experimental facilities associated with it.

UVAR Experimental Facilities

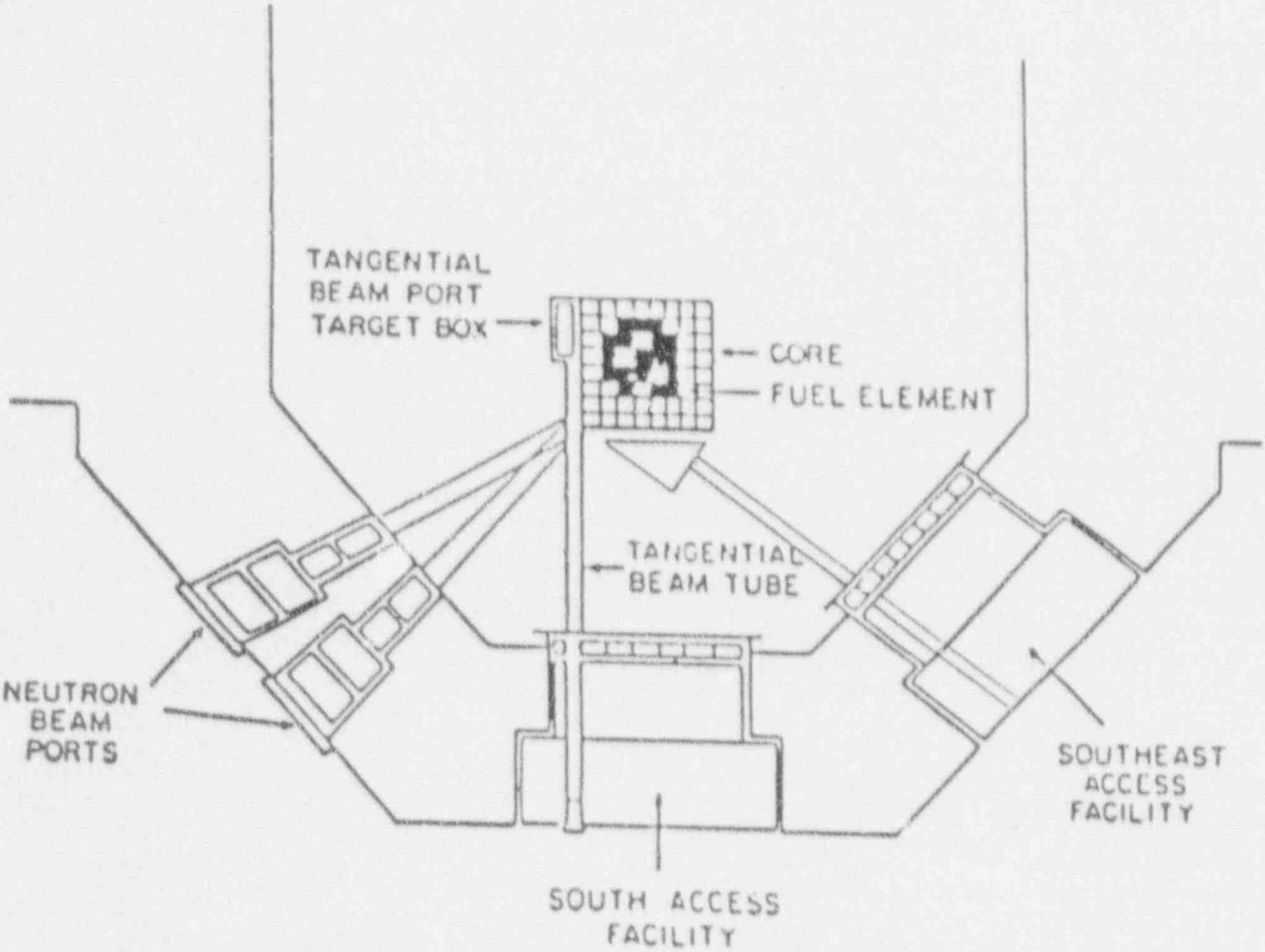


Figure 1

2. 100 W CAVALIER Reactor

The CAVALIER (Cooperatively Assembled Virginia Low Intensity Educational Reactor) first went into operation in October 1974, under facility license R-123, at a licensed power of 100 watts. The reactor was built to accommodate reactor operator training and perform experiments for undergraduate laboratory courses. The operating license was renewed in May 1985, for a period of 20 years. Figure 2 shows a layout of this reactor and its control room. A dismantlement plan was submitted in November, 1987 to the NRC. The NRC requested a decommissioning plan which was submitted early in 1990.

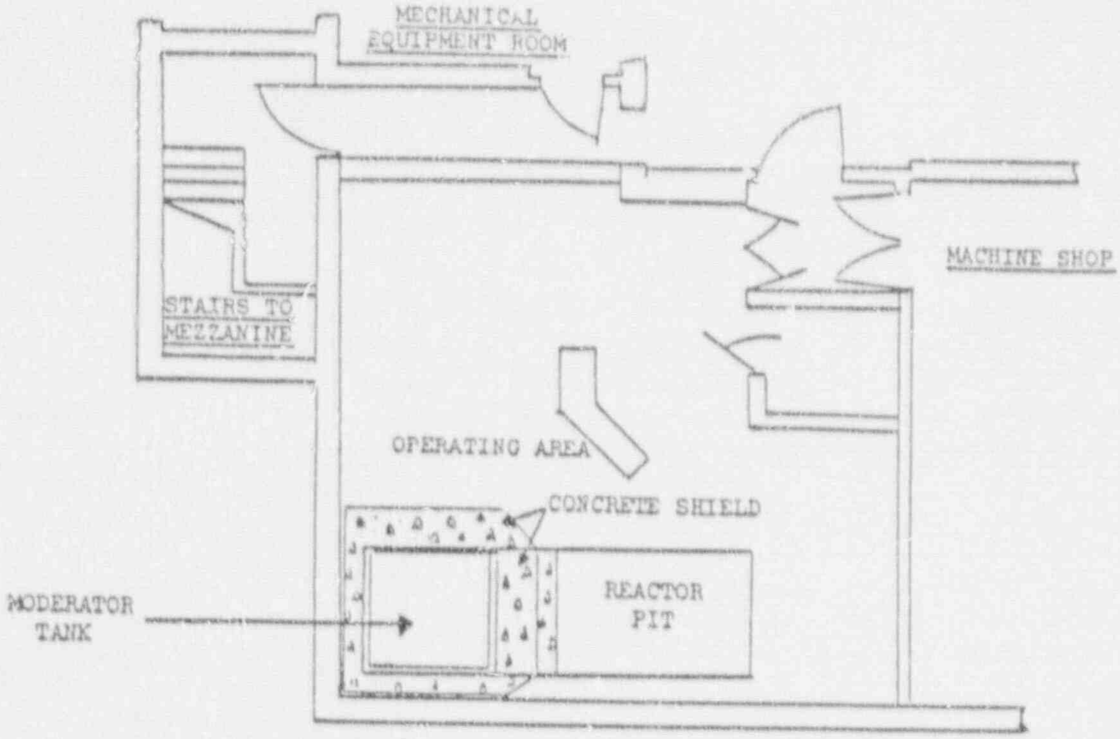
3. Past Operating History

a. UVAR Reactor

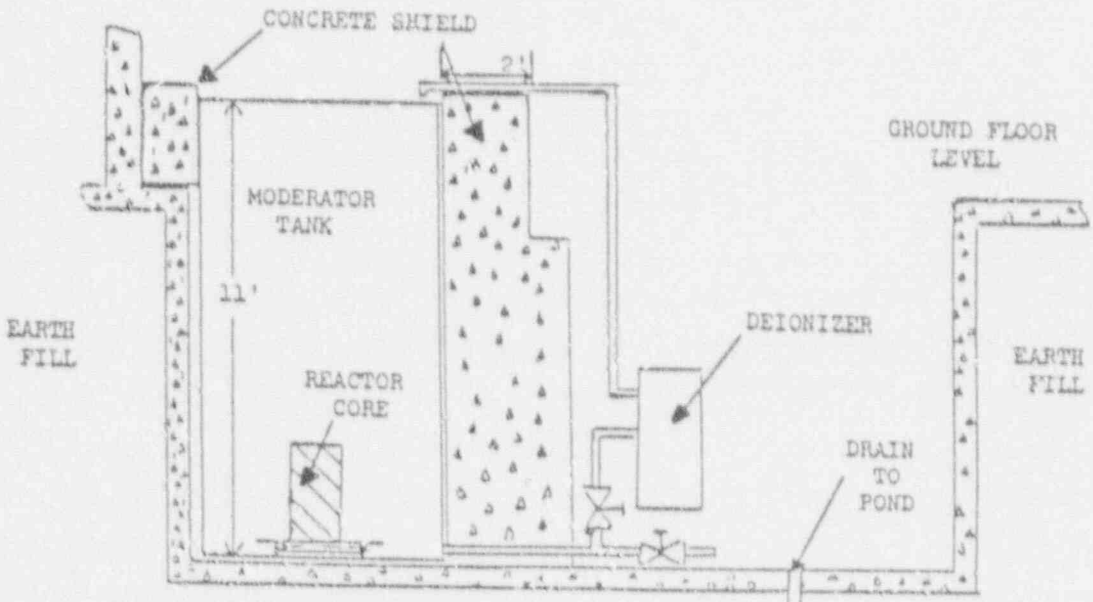
The UVAR reactor operating history is as follows:

Year(s)	MWhours	Hours Operated
1960-1965	1218	1500
1966-1970	2742	3000
1971-1975	1654	1800
1976-1978	1769	1480
1979	4426	2764
1980	4610	2863
1981	4988	3568
1982	5507	3024
1983	6079	3556
1984	5687	3166
1985	927	718
1986	1330	891
1987	1220	801
1988	910	621
1989	1378	869
1990	1837	1087
1991	2360	1365

During the years 1979 through 1984, the UVAR reactor was operated ~110 hours per week to irradiate metal specimens for radiation damage studies on pressure vessel steels. Since that time, the reactor has operated on a variable schedule up to 40 hours per week. The intent of the reactor management is to perform various on-going small and diverse irradiation projects, rather than a single large irradiation project.



Plan View of CAVALIER Operating Area



Vertical Section Through Reactor Pit

Figure 2

b. CAVALIER Reactor

The CAVALIER reactor operating history is as follows:

Year(s)	W-hours	Hours Operated
1974-1980	2128	758
1981-1985	1278	388
1986	147	37
1987	28	29
1988	Permanently Shutdown	

The CAVALIER reactor has been used primarily for reactor operator training and undergraduate lab experiments, although it has not been operated over the past three years. A dismantlement plan was submitted to the NRC in November, 1987 but the NRC decided the facility should submit a decommissioning plan. A complete decommissioning plan was submitted in January, 1990. The CAVALIER fuel and start-up source were unloaded on March 3, 1988.

4. Summary of 1991 Reactor Utilization

a. UVAR Reactor

During 1991, the UVAR was operated for 1365 hours and a total integrated power of 2360 Megawatt-hours. The following experiments were performed utilizing the UVAR reactor.

* 521 NAA samples were run in the pneumatic rabbit system
* No NAA samples were run in the hydraulic rabbit system
* 13 sets of samples were run in the Mineral Irradiation Facility
* 11 separate runs were made in the Rotating Irradiation Facility
* 278 hours of reactor operations were dedicated to Neutron Radiography
* 49 hours of reactor operations were dedicated to beamport work

b. CAVALIER Reactor

The CAVALIER reactor was permanently shut down in 1988 and will no longer be operated.

5. Special Facilities

The following facilities are operated in connection with the UVAR:

* Two neutron beam ports, of eight inch diameter entrance, stepped to 10 inches at the exit, are available. One beam port is currently dedicated to neutron radiography.

* Two access ports (6 ft x 4 ft). One port is currently configured for a high energy photon beam, and the other port for a neutron beam.

* Hydraulic rabbit, for activation analysis, permitting samples with less than 0.69 inch diameter and 6 inch length.

* Pneumatic rabbit, for activation analysis, permitting sample diameters of 1 inch and length not exceeding 2.3 inches, accessing either a thermal or an epithermal irradiation facility.

* Epithermal neutron irradiation facility, for trace element analysis with reduced thermal neutron flux.

* Solid gel irradiator for electrophoresis.

* Epithermal neutron mineral irradiation facility.

* A rotating irradiation facility currently used for activation of iridium seeds for cancer implantation therapy.

* Irradiation facilities with environmental control.

* Cobalt-60 gamma irradiation facility with 6,000 Ci permitting exposures at rates up to 200,000 R/hr.

* Depleted uranium subcritical facility.

* Small hot cell, with remote manipulators.

* Machine and Electronic Shops, well equipped.

* Several radiochemistry labs with fume hoods, counters and standard lab equipment.

* Low-background counting room with shielded, solid state germanium and silicon detectors and computerized data acquisition/analysis system.

C. Reactor Staff Organization

1. Operations Staff

A Reactor Facility organization chart is shown in Figure 3. Personnel on the reactor staff as of the end of 1991 were:

R.U. Mulder .... Reactor Director
J.P. Farrar ...... Reactor Administrator
P.E. Benneche ... Services Supervisor
B. Hosticka ..... Research Scientist
D.R. Krause .... Senior Reactor Operator
L.L. Scheid ..... Reactor Operator
W.E. Brown ..... Operator Trainee Under DOE Grant
W.N. Wilson .... Operator Trainee Under DOE Grant
V.G. Hampton ... Electronic Shop Supervisor
J.S. Baber ...... Machine Shop Supervisor
V.S. Thomas .... Reactor Facility Secretary

2. Health Physics Staff at the Facility

D. Steva .... Reactor Health Physicist
C. Glennie ..... Radiation Safety Technician
S. Garver ...... Radiation Safety Technician

The Health Physicist is assisted by a Reactor staff member paid from reactor services income. Other health physicists and technicians employed by the University are on call with the Office of Environmental Health and Safety.

3. Reactor Safety Committee

The Reactor Safety Committee is composed of the following individuals:

A.B. Reynolds ... Professor, Nuclear Engr. - Chairman
R.A. Rydin ..... Associate Professor - Nuclear Engr.
J.S. Brenizer .... Associate Professor - Nuclear Engr.
J.R. Gilchrist .... Assistant Director, EH&S
K.R. Lawless .... Professor - Material Science
R.U. Mulder .... Reactor Director and Asst. Prof., Nuclear Engr.
R.G. Piccolo .... Radiation Safety Officer

As of July 1, 1991 Dr. Reynolds resigned from the committee due to his appointment as department chairman and Dr. Rydin assumed the position of acting chairman of the committee.

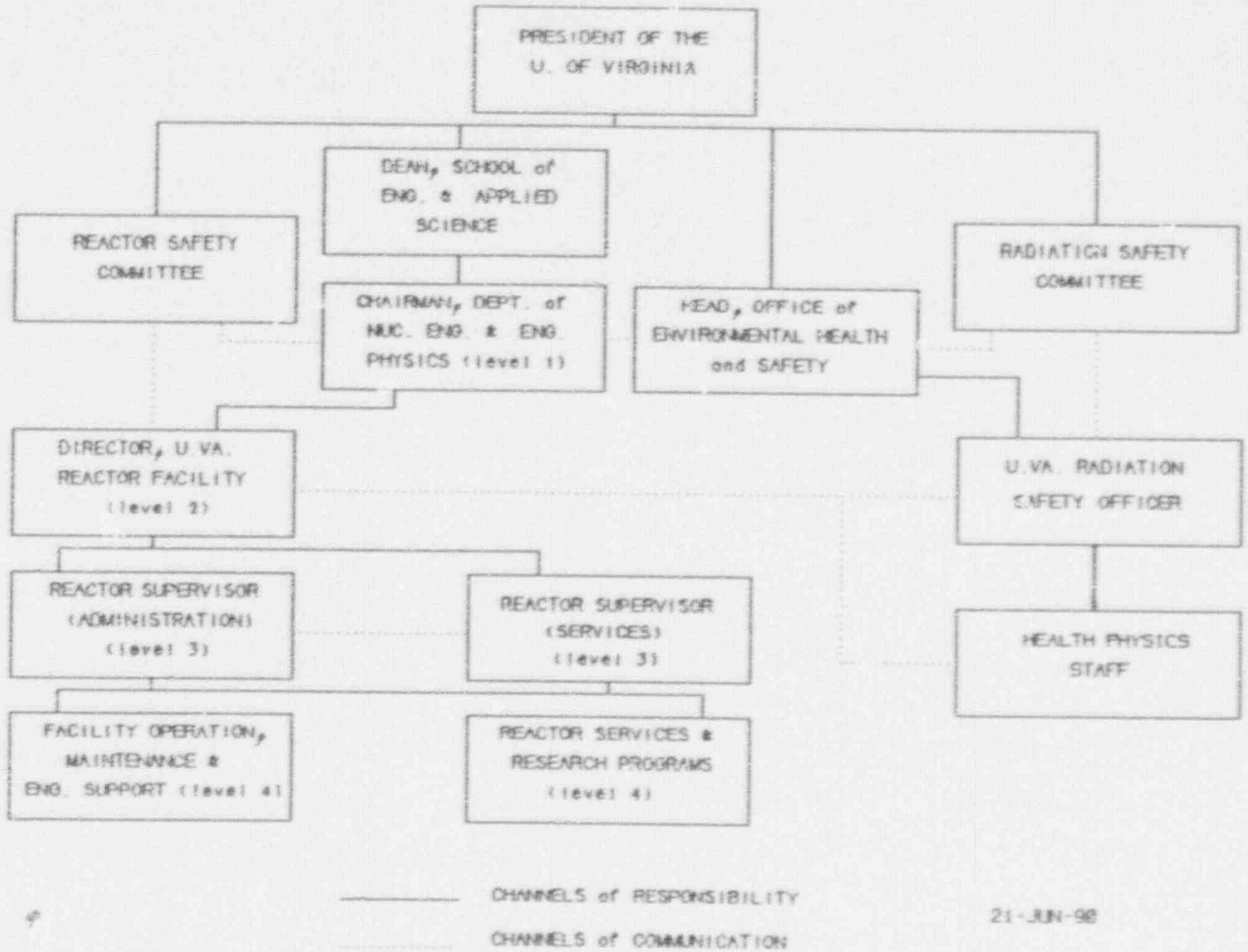


Figure 3 Organizational Structure of U.Va. Reactor Facility

II. REACTOR OPERATIONS

A. UVAR Reactor

1. Core Configurations

A typical UVAR core configuration is shown in Figure 4. The reactor employs three boron-stainless steel safety rods and one stainless steel regulating rod for fine power control. The fuel elements are of the MTR curved plate-type elements, utilizing a U-AL alloy. The fuel is approximately 93% enriched. The elements have 18 fuel plates per element, with a loading of approximately 195 grams/element. The control rod elements have 9 fuel plates with a loading of approximately 97.5 grams/element. A plan view of these elements is shown in Figure 5.

2. Standard Operating Procedures

Three sections of the UVAR standard operating procedures were changed during the year in the areas of: operating conditions checklist, irradiation request forms and waste release to the sanitary sewer system. The Reactor Safety Committee reviewed and approved these changes.

3. Surveillance Requirements

The following surveillance items were completed during the year as required by Section 4.0 of the Technical Specifications:

a. Rod Drop Tests and Visual Inspection

Technical Specification Requirements

Rod drop times are measured at least semi-annually, or whenever rods are moved or maintenance is performed.

Magnet release time should be less than 50 milliseconds and free drop time less than 700 milliseconds.

Rods are visually inspected at least annually.

UNIVERSITY OF VIRGINIA REACTOR CORE LOADING DIAGRAM

CORE LOADING 28-A SHUTDOWN MARGIN 0.82 % delta k/k

DATE July 25, 1991 EXCESS REACTIVITY 3.81 % delta k/k

U-235 3653 GRAMS EXPERIMENT WORTH 0.57% delta k/k

F = Normal Fuel Element
PF = Partial Fuel Element
CR = Control Rod Fuel Element
G = Graphite Element
S = Graphite Source Element
RMG - Control Rod Fuel Element with Regulating Rod

P = Grid Plate Plug
HYD RAB = Hydraulic Rabbit
THER RAB = Thermal Pneumatic Rabbit
EPI RAB = Epithermal Pneumatic Rabbit
RB = Radiation Basket

Rod Worths #1 -2.91 % #2 -3.31 % #3 -1.72 % Reg -0.282 %

MINERAL IRRADIATION FACILITY

G 11	F V-05 12	F V-04 13	F V-03 14	F V-02 15	F V-01 16	ROTATING IRR. FAC. 17	P 18
G 21	F V-06 22	F V-14 23	F-CR1 V-18 24	F V-27 25	F T-07 26	27	P 28
G 31	F V-08 32	F-CR2 V-19 33	F T-09 34	F T-10 35	F T-18 36	37	P 38
G 41	F V-09 42	F V-11 43	F V-10 44	F-CR3 T-31 45	F T-30 46	47	P 48
G 51	G 52	F T-13 53	F-REG T-32 54	F T-14 55	PF T-3P 56	57	P 58
G 61	G 62	G 63	RB 64	EPI RAB 65	S 66	P 67	P 68
G 71	THER RAB 72	G 73	G 74	G 75	G 76	HYD RAB 77	P 78
G 81	G 82	G 83	G 84	G 85	G 86	P 87	G 88

Loading Approved By:________________ Date:____________

Figure 4

FUEL ELEMENTS

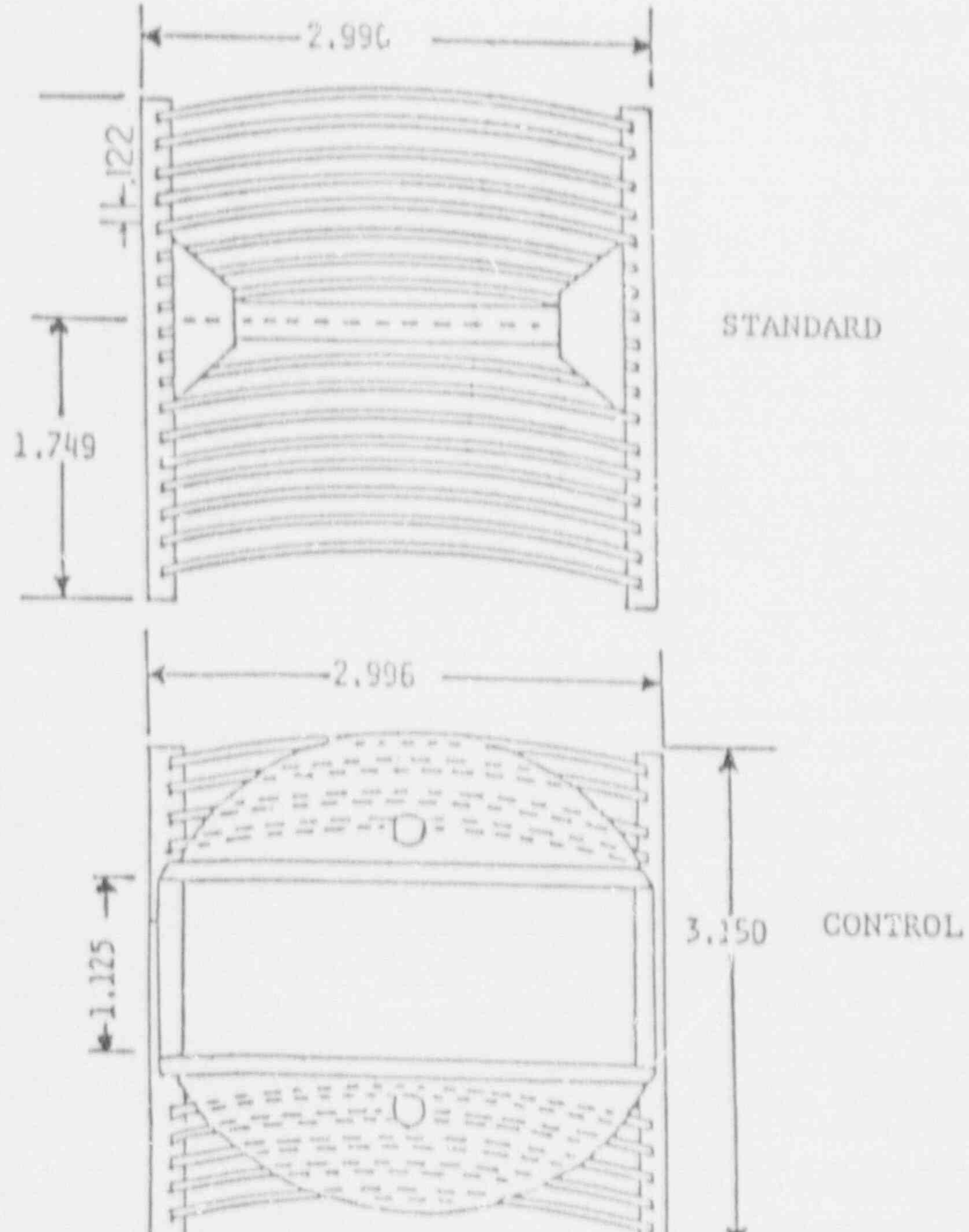


Figure 5

Rod drop times were measured on the UVAR reactor as follows:

After visual inspection of the rods on 1-07-91

Rod	Magnet Current (ma)	Rod Position (in)	Magnet Release (ms)	Free Drop (ms)	Total Drop (ms)
1	160	26	21	471	492
2	160	26	29	454	483
3	75	26	31.5	454	485.5

Semi-annual surveillance on 7-02-91

1	160	26	17	483	500
2	160	26	34	447	481
3	75	26	31	452	483

After rod inspection on 12-02-91

1	160	26	20	495	515
2	160	26	25	463	488
3	75	26	23	591	614

The rod drop times continue to be within the limits required by Technical Specifications.

The UVAR control rods were visually inspected on 1-07-91. The following is abstracted from the reactor log book and the surveillance files:

Rod #1 - Inspected rod under ~4 feet of water. Dose rate at surface of water was ~10 mr/hr. Rod looks good. No sign of cracking or rub marks. Rod passed 0.95 inch gauge easily.

Rod #2 - Inspected rod under ~4 feet of water. Dose rate at surface of water was ~10 mr/hr. No evidence of cracking. A few rub marks noted. Rod passed 0.95 inch gauge easily.

Rod #3 - Inspected rod under ~4 feet of water. Dose rate at surface of water was ~12 mr/hr. No evidence of cracking or rub marks. Passes 0.95 inch gauge easily.

The rods were inspected again on 12-02-91

Rod #1 - Inspected rod under ~4 feet of water. Dose rate at surface of water was ~42 mr/hr. No evidence of rubbing or cracking. Passes 0.95 inch gage easily.

Rod #2 - Inspected rod under ~4 feet of water. Dose rate at surface of water was ~25 mr/hr. No evidence of rubbing or cracking. Passes 0.95 inch gage easily.

Rod #3 - Inspected rod under ~4 feet of water. Dose rate at surface of water was ~44 mr/hr. No evidence of rubbing or cracking. Passes 0.95 inch gage easily.

b. Tests and Calibrations

Data on these tests and calibrations are on file at the Facility.

1) Monthly

Operational checks of the ventilation duct, personnel door, truck door and emergency exit cover were performed as required.

2) Semi-Annually

Visual inspection of gaskets on personnel door, ventilation duct and truck door was completed.

Calibration checks of source range channel, linear power channel, core gamma monitor, bridge radiation monitor, reactor face monitor, duct argon monitor, constant air monitor, pool level monitors, pool temperature monitors, core differential pool temperature monitors, and primary flow were done.

3) Annually

The emergency cooling system was tested during the month of September, 1991. The results are as follows:

	S.E. Tank (gal/min)	S.W. Tank (gal/min)
minimum required flow	11.0	11.5
9-19-91 actual flow	12.2	12.1
last five year range	11.3-12.1	12.2-12.9

No pattern was observed in the variation of the test results for the last five years.

4) Daily Checklist

The daily checklist, which is completed when the reactor is to be operated, provided for checks on all the significant automatic shutdown systems associated with the reactor.

5) Reactor Pool Water Quality

The Technical Specifications require that the pH and conductivity of the pool water be measured at least once every two weeks. These measurements were actually made on a daily basis when the reactor was operating and at least once each week. These measurements have indicated that the water quality was maintained well within the Technical Specification Limits of pH between 5.0 and 7.5 with conductivity $\leq$ 5 micromhos/cm.

6) Core Configuration Changes

The control rods were re-calibrated in January, 1991 after the existing core had accumulated ~1029 MW-hrs of operation. The rods were visually inspected and the reactivity worth of all experiments and experimental facilities were remeasured. In July, two elements with the highest burnup were removed from the core and replaced with new elements to compensate for burnup over the last year. The rods were again recalibrated and the worth of experiments and experimental facilities remeasured. In December, a partial element was removed from the core and replaced with a full element to compensate for burnup. The rods were visually inspected and recalibrated and the worth of all experiments and experimental facilities were remeasured.

7) Communication Checks

The security system and emergency communications with the University Police were checked on a weekly basis throughout the year.

8) Alarm System Checks

The fire alarm system was checked during the month of December for proper alarm functions, both in the Facility and at the University Police Department.

Data on all of these tests and calibrations are on file at the facility.

4. Maintenance

The following maintenance was performed on the UVAR reactor system during the calendar year 1991:

1-28-91 Waste Tank Level Indication. Light in Demineralizer Room not on when float switch contact closed. Corrective action: Replaced bad bulb.

2-14-91 Bridge Scram Relay. Relay was actuated whenever secondary console was bumped. Corrective action: Replaced relay.

3-11-91 Reg Rod Drive System. Rod sounded as if it were laboring during travel. Corrective action: Lubricated lead screw and aligned mechanism.

3-18-91 Rod #3 Magnet Current Rheostat. Switch shaft stuck. Unable to adjust current. Corrective action: Cleaned and lubricated shaft. Works smoothly.

4-08-91 N-16 Monitor. Would not respond to external source. Found bad pen in connector. Corrective action: Replaced connector.

4-11-91 Demineralizer System. Seal cooling line leaking several drops per second through copper fittings. Corrective action: Replaced copper fittings with stainless steel Swagelok fittings.

5-16-91 Solid State Relays. Intermittent. Found dirty contacts and overheating. Corrective action: Replaced connectors, three resistors and cross-over relay.

6-25-91 Linear Power Recorder. Seemed to have dead spot in slide wire. Corrective action: Cleaned both the pen slide wire and the transmit slide wire (to rod drive servo). Checked and replaced 3 vacuum tubes in servo unit.

6-21-91 Cooling Tower. Annual cleaning and inspection. Drained and cleaned.

7-11-91 Bridge Radiation Monitor. Response was erratic, probably due to high humidity in reactor room. Corrective action: Switched detector with hot cell detector. Recalibrated both detectors. Responds correctly.

7-17-91 Room Argon Monitor. No response. Found range switch wafer broken and input preamp(OP AMP) bad. Corrective action: Replaced range switch wafer and OP AMP in preamp. Cleaned system and lubricated range switch.

7-22-91 Reactor Face Monitor. Detector reading upscale in the absence of a radiation field. No response from Cs-137 source. Corrective action: Replaced detector and calibrated system.

8-01-91 Linear Power Recorder. Step changes in recorder indication while maintaining steady state power. Irregular signal from recorder feedback slide wire. Corrective action: Replaced entire slide wire.

8-08-91 Rod #3 Position Indication. Did not track rod motion. Updated position when switch was released. Corrective action: Found and replaced bad IC chip.

10-07-91 Yellow Springs #3 Temperature Probe. Reads down-scale. Found probe open. Corrective action: Replaced probe - relocated downstream of primary pump in isolatable section of primary pipe.

10-21-91 Power Range #2. Detector responding O.K., but just in specs with High Voltage at 100%. Low megger readings. Corrective action: Replaced detector and cable connectors at detector. High megger readings and responded well on next startup.

11-07-91 Rod #1. Rod kept dropping while attempting to withdraw. Corrective action: Removed drive unit and cleaned magnet face and extension rod face. Reassembled and performed rod drop test.

11-20-91 Delta T System. Delta T malfunctioning. Erratic. Corrective action: Removed RTD probe from pool, found insulation badly deteriorated. Replaced probe and calibrated. Functioning normally.

12-03-91 Scram Logic Drawer. Several scrams unaccompanied by any annunciator indication. Corrective action: Found power supply #P025200 reading low on voltage and found insulation bad on wire and an unsoldered connection. Replaced wire and resoldered bad connection. Checked voltage, 25 volts solid.

12-11-91 Power Range #2. Maximum reading of 90 % at 2 MW with detector inserted as far as it would go. Corrective action: Checked detector with megger. Read low. Removed and replaced detector. Checked out at 2 MW, adjusted to read 100 %.

No significant trends were noted in the maintenance.

5. Unplanned Shutdowns

The following unplanned shutdowns occurred on the UVAR reactor during the calendar year 1991:

1-09-91 Rod #1 and #3 dropped during manipulation of rods for rod calibration measurements. Magnet current was low. Adjusted current.

1-11-91 Reactor scram - loss of building power

2-13-91 Scram - noise in secondary console relay when replacing Argon monitor cover. Relay found to be unstable. Replaced relay K-3.

3-07-91 Scram - Noise in Power Range #2 while moving Fission Chamber.

3-08-91 Scram - Noise in Period Meter while moving rods.

3-20-91 Scram - Noise in Bridge Monitor.

5-01-91 Scram - Low flow in gas flow system in MIF experiment.

5-09-91 Scram - Spurious spikes in Intermediate Channel.

5-16-91 Scram - Relay chatter while moving rods. Started up again but had second scram from relay chatter. Found dirty contacts on SSR units and SSR resistors had over-heated. Cleaned SSR contacts, replaced resistors and crossover relay.

5-17-91 Scram - Loss of building power during thunderstorm.

5-22-91 Scram - Noise in Bridge Monitor.

6-17-91 Scram - Noise in secondary console when replacing duct monitor cover.

7-10-91 Scram - Noise in Bridge Monitor. Switched detector with Hot Cell monitor and recalibrated system.

7-16-91 Scram - North Neutron Beamport Monitor. Suspect air bubble in sight glass.

7-22-91 Scram - Period on intermediate scram when loading "hot" fuel with its "high" gamma ray emission rate.

7-30-91 Scram - Noise in low-flow relay when moving secondary console.

8-16-91	Scram - North Neutron Beamport Monitor. Suspect air bubble in sight glass.
9-06-91	Scram - Momentary loss of building power.
10-02-91	Scram - Noise in Reactor Face Monitor.
10-16-91	Scram - Noise in period channel.
10-22-91	Scram - Noise spike on Intermediate Channel.
10-24-91	Scram - Intermediate Period. Gamma noise from channel being overcompensated.
11-06-91	Scram - Electronic noise in console. Annunciator indicated ground floor manual, reactor room manual, escape hatch, air to header, truck door and range switch. Investigation revealed nothing wrong. Assumed to be spurious noise. Reset scrams and restarted reactor.
11-22-91	Scram - Building power failure.
12-04-91	Scram - Intermediate period due to compensating voltage spike.
12-05-91	Scram - Header down, pump on indication. Spurious signal. Was operating in natural circulation mode and in the process of shutting down.
12-17-91	2 scrams - Power Range #1 - unstable meter reading.
12-18-91	Scram - Power Range #1 while adjusting detector position.
12-20-91	Scram - Momentary building power failure.

No significant trends were noted in the unplanned shutdowns.

6. Pool Water Make-up

During the calendar year 1991, make-up water to the UVAR pool averaged approximately 28 gallons per day. Over the past 14 years, the pool water make-up has varied from a minimum of 16 gallons per day to a maximum of 85 gallons per day, depending on reactor operation. The loss of water is mostly due to evaporation from the pool while operating at full power.

7. Fuel Shipments

a. Fresh Fuel

No fresh fuel was received at the facility during 1991.

b. Spent Fuel

No spent fuel was shipped from the facility during 1991.

8. Training and Instruction

a. Reactor Facility Staff

At the end of 1991 the staff had four senior reactor operators and one reactor operator. Two new staff members joined the facility in December as part of a D.O.E. sponsored training program and are presently training for an NRC Operator License. All licensed operators participated in the Facility's operator requalification program, which was carried out during the year. The program consisted of periodic lectures, participation in the daily operation of the facility (including performing check-lists and start-ups of the UVAR reactor) and taking an annual written examination administered by the Facility management.

b. Disadvantaged American Reactor Operator Training

U.Va. has, since 1984, administered a reactor operator training program for disadvantaged americans sponsored by the Department of Energy. The program involved four other universities, but at the beginning of 1990 only UVa remained active in the program. The program was scheduled to terminate at the end of 1990 but sufficient funds remain in the program to justify its continuation. UVa requested and was granted a no cost extension of the program. The female trainee hired in November, 1990 applied for admission to the U.Va. medical school and was accepted. She left the training program in July, 1991. Two trainees were hired in December, 1991. The DOE grant will not support the two trainees for the entire year, but the Reactor Facility will supplement this through local funds. The program is due to terminate in December, 1992.

c. Reactor Security and Health Physics Orientation

Security and health physics orientation was provided to new students and staff members during the year. The existing faculty, staff and students attend a re-orientation lecture at the beginning of the academic year.

9. Reactor Tours

During the calendar year 1991, the staff guided 57 groups on tours of the Facility, for a total of 766 visitors.

B. CAVALIER Reactor

1. Core Configuration

The reactor was completely and permanently unloaded during the first week of March, 1988. A management decision has been made to shut down the CAVALIER reactor and a Dismantlement Plan was submitted to the NRC, however, the NRC requested that a complete decommissioning plan be submitted. This was accomplished in early 1990.

III. REGULATORY COMPLIANCE

A. Reactor Safety Committee

1. Meetings

During 1991, the Reactor Safety Committee met six times, on the following dates:

January 18, 1991	June 7, 1991
February 4, 1991	September 24, 1991
March 18, 1991	December 19, 1991

2. Audits

During the year sub-committees of the Reactor Safety Committee performed two audits of the facility in the areas of: reactor operations log book, the irradiation log book, the QA/QC program, experimental procedures and operator training.

3. Approvals

The Reactor Safety Committee approved three changes to the UVAR Standard Operating Procedures during the year concerning the operating conditions checklist, irradiation request forms and waste release to the sanitary sewer system.

4. 10 CFR 50.59 Reviews

The following 10 CFR 50.59 analyses were performed during the year and were reviewed by the Reactor Safety Committee:

a. Installation of plexiglass cover over escape hatch in UVAR reactor room.

b. Changes to Mineral Irradiation Facility (MIF) cooling.

c. Gamma Shielding Tank for Neutron Beamport.

d. Installation and operation of SE Beamport Facility.

e. Design and Testing of a new MINIRIF (Rotating Irradiation Facility).

B. Changes to the Reactor Facility

1. Low Enriched Uranium Conversion Plans

The NRC mandated in 1986 a change from High Enriched Uranium (HEU) fuel to Low Enriched Uranium (LEU) fuel, with the date of conversion to depend on several factors. The U.Va. Facility will be among the initial group of research reactor facilities to convert to LEU fuel. A study funded by DOE was begun in the spring of 1986 to accomplish this. A management decision has been made to shut down the CAVALIER reactor and a Dismantlement Plan was submitted to the NRC, however, the NRC has requested that a complete decommissioning plan be submitted. This was accomplished in early 1990. The present plans call for the conversion of the UVAR reactor in 1992, but will depend on the availability of new LEU fuel and a cask for spent fuel transport. A Safety Analysis Report on the LEU fuel and revised Technical Specifications were submitted to the NRC in November, 1989.

C. Inspections

During 1991 the Facility underwent four NRC compliance inspections, at the following times and in the areas of:

7-23-91	Security and Material Accountability
8-20-91	Reactor Operations
9-12-91	Health Physics
11-06-91	Emergency Preparedness

D. Licensing Action

No licensing changes were initiated during 1991.

E. Emergency Preparedness

1. On Tuesday, January 29, 1991, at 2:05 P.M. the evacuation alarm for the criticality monitoring system located in the CAVALIER room was initiated by a staff member as part of an annual drill. The drill was unannounced. Everyone in the building evacuated in an orderly manner.

2. On Monday, October 7, 1991, at 3:32 P.M. the public address system was used to announce an evacuation of the building. All personnel evacuated the building in ~3 minutes.

3. On Wednesday, November 7, 1991, the facility held an annual drill that did not involve outside support agencies. Two NRC personnel were present to observe the drill. The scenario involved severe weather conditions with heavy rains and winds up to 70 mph. The telephone lines and all power to

the building were assumed lost. The emergency team was assembled and all personnel in the building were evacuated to a room without windows near the front entrance of the facility in case windows were shattered by the high winds. Personnel were assigned to monitor the pool level in the reactor room. Communication with the U.Va. police department was established through the use of two-way radios. The police could have notified outside agencies if deemed necessary. The NRC personnel felt the drill was conducted appropriately, however they indicated that they would like to have seen more "action" items included in the scenario and we should always have communication capabilities included so these can be practiced in a drill.

4. On Friday, December 20, 1991, a communications drill was held with the emergency team. Each member of the team was given a scenario involving a small lab fire with personnel injury and radioactive contamination. Each person was asked to use the Emergency Plan Implementing Procedures (EPIP) to work through the steps necessary to respond to the emergency, and in particular those items requiring communications with off-site agencies. At least one off-site agency was called by each person to confirm the phone number listed in the EPIP. All phone numbers were confirmed to be correct. Each person's competency with the use of the telephones and radios was also checked.

IV. HEALTH PHYSICS

A. Personnel Doses

1. Visitor Exposure Data For 1991

Visitors to the UVAR primarily consist of students, maintenance personnel and vendors. Visitor exposure at the UVAR is monitored through the use of gamma and X-ray sensitive direct reading pocket dosimeters. During 1991, there were 2,098 visitor entries into the Reactor Facility. Of these entries, 1332 were individual visitor entries and 766 were visitors as part of 57 tour groups. No visitor's dosimeter registered more than five milliroentgens in any one visit.

2. Reactor Facility Personnel Dosimetry Data For 1991

a. Monthly Whole Body Badge Data

Radiation doses received by Reactor Facility personnel were measured using Landauer film badges. The film badge dosimeters measured exposure from beta, X, gamma and thermal neutron radiation. In 1991, all personnel working with the neutron beamports at the Facility were issued neutron dosimeters in addition to their whole body film badges. The neutron dosimeters used were Landauer Neutrak ER badges which allowed detection of an extended range of neutron energies. All dosimeters were changed out on a monthly basis.

The dose distribution for personnel badged at the Reactor Facility during the period January 1 through December 31, 1991 was as follows:

Table I

WHOLE BODY DOSES RECORDED FOR BADGED INDIVIDUALS AT THE REACTOR FACILITY IN 1991

Measured Dose * (mrem)	Number of Occurrences in 1991	
Less than 10	83	
11 - 20	12	
21 - 30	0	
31 - 40	0	
41 - 50	1	
51 - 60	0	
61 - 70	0	
71 - 80	1	
81 - 90	0	
91 - 100	0	
> 100	1	(190 mRem)

* whole body deep dose only as measured by film badge dosimeters

Number of badged personnel: 98 persons

Total dose in 1991 for this group: 0.47 person-rem

NOTE: The dosimeters used by the Reactor Facility had a detection minimum of 10 mrem for gamma, X and thermal neutrons and 40 mrem for energetic beta particles.

The individual with the highest exposure (190 mrem) was a Reactor Facility staff member routinely assigned to the handling of radioactive materials for neutron activation analysis.

b. Neutron Exposures

Seven Facility personnel were issued Neutrak ER neutron badges in 1991. The neutron dose distribution for this group is as follows:

Measured * Neutron Dose (mrem)	Number of Occurrences in 1991
Less than 20	7
21 - 30	0
> 100	0

NOTE: These dosimeters have a minimum reporting dose of 20 mrem

c. Extremity Exposures

During 1991, 21 Facility personnel wore TLD ring badges in addition to their whole body badges. The following is a summary of the extremity doses received by Reactor Facility personnel who wore ring badges during the period January 1, 1991 through December 31, 1991.

Measured Extremity Dose (mrem)	Number of Occurrences in 1991	
Less than 100	16	
101-500	3	
501-1000	1	
> 1000	1	(1170 mrem)

The individual with the highest extremity exposure (1170 mrem) was a Reactor Facility staff member routinely assigned to the handling of radioactive materials for neutron activation analysis

d. Direct-reading Dosimeter Exposures

Direct-reading dosimeters are worn by UVAR personnel when they are handling irradiated material which has a calculated or measured exposure rate of greater than 100 mR per hour, measured at one foot from the source. If the exposure totals more than 5 mR in one day, the exposure is logged in an exposure log kept in the control room. This information is helpful in assessing the amount of exposure received during specific operations. The total of all exposures recorded in the log book during 1991 was 83 mR.

B. Effluents Released During 1991

1. Airborne Effluents

Argon-41 gaseous release concentrations are calculated using a methodology described in a June, 1977 memorandum entitled: "Memo to Senior Operators - argon 41 production in UVAR." The methodology described in this memorandum assumes:

a. a maximum production rate for Ar-41 (given the present UVAR core loading)

b. immediate evolution of Ar-41 from the pool water into the UVAR confinement atmosphere

c. no decay

d. air saturating the UVAR pool water at 68°F.

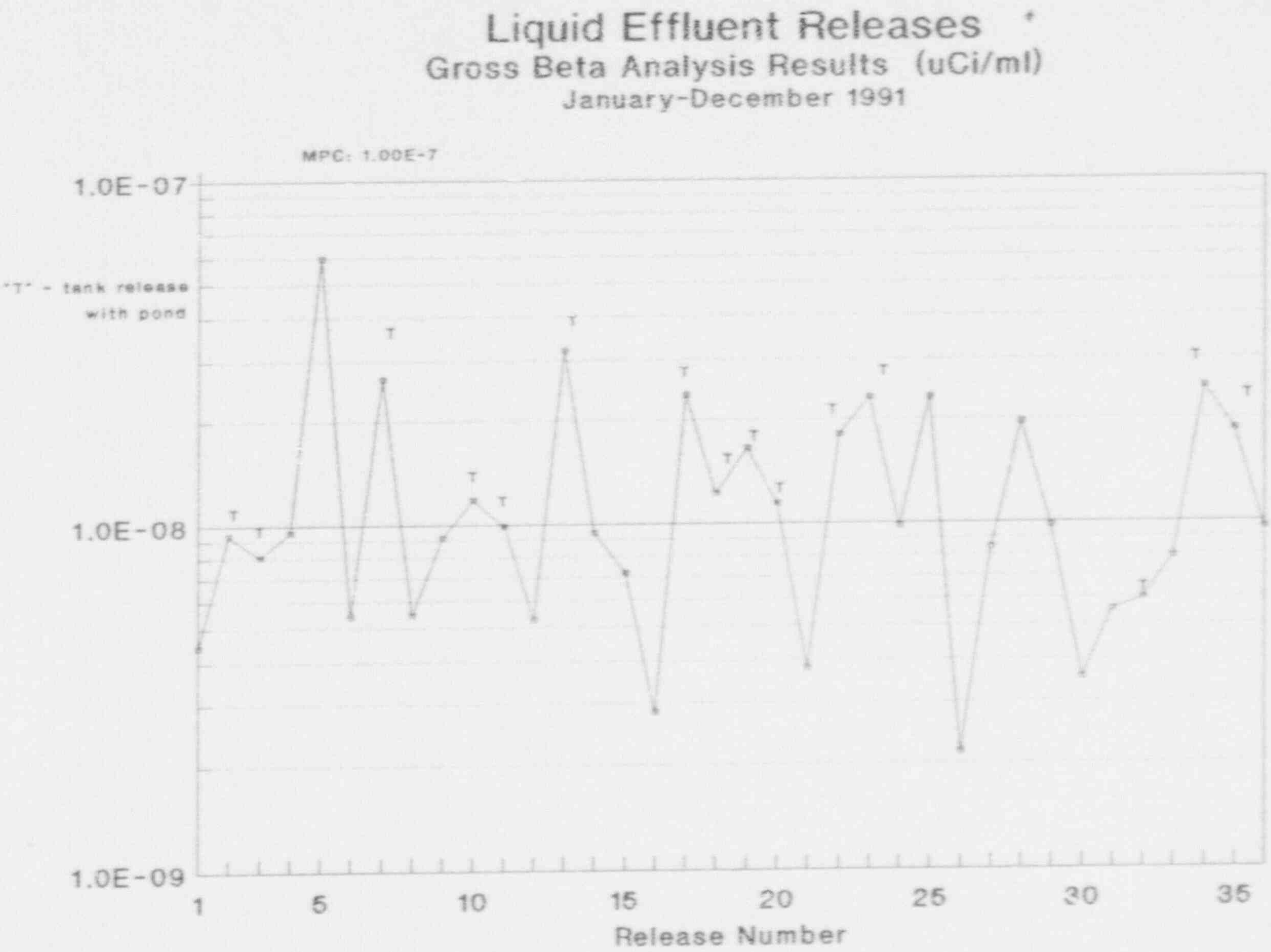
Based on this method, and using the known amount of time the reactor was at power during 1991 (2 MW for 1180 hours), the calculated total activity of Ar-41 released was 3.4 Curies.

2. Liquid Effluents

Liquid radioactive waste generated at the UVAR is disposed of by one of two means. Liquid waste generated in the student laboratories is poured into approved containers which are collected and disposed of by the Environmental Health and Safety Office. Other liquid wastes generated by the UVAR operation are released off-site in accordance with 10 CFR 20 release limits. The majority of liquid released off-site is from an on-site pond. This pond receives surface runoff and water from a creek which flows into it. In unusual situations, it may receive a direct discharge from the facility (e.g. draining of the reactor pool). Regeneration of the UVAR demineralizer system is the major source of radioactivity in the effluent from the Facility. Prior to release, the regeneration liquid is stored in two 5,000 gallon underground tanks where it is circulated through Cuno filters. The liquid in these tanks is analyzed for radioactivity content and then released through the pond spillway where it is diluted with pond water. Prior to, and during all liquid releases, water samples are collected and analyzed for radioactivity content. During 1991 there were 36 releases of liquid effluent to the environment (See Fig. 6).

In 1991 it was verified that leakage was occurring through the pond spillway to the release standpipe at an average rate of three gallons per minute. As this was considered release of pond water, it was sampled on a monthly basis and analyzed for gross beta activity. Consequently, the volume and activity released via this pathway is included in the 1991 liquid

Figure 6



Apriori LLD: 3.0 E-9 uCi/ml

release totals. The total volume of liquid released offsite in 1991 was 30,000,000 liters (7,900,000 gallons).

The average concentration of radioactive material (as measured by gross beta analysis) released in effluent from the UVAR site was 1.3 x 10^{-8} uCi/ml. This concentration was 13% of the applicable MPC. The total activity (excluding tritium activity) released in this effluent was 383 uCi. This activity includes naturally occurring radionuclides contributed to the pond from sources described above.

The average tritium concentration in effluent from the site was 5.0 x 10^{-7} uCi/ml. This concentration was 0.016% of the applicable MPC. The total tritium activity released during 1991 was 11 mCi. In previous years, the calculation of total tritium activity included sample results which were less than or equal to the LLD and which were averaged into the release summation at the corresponding LLD concentration. It was decided that this method was overly conservative. Consequently, the calculation for total tritium in 1991 did not include activities based on concentrations which were less than the LLD.

3. Solid Waste Shipments

During 1991, 28 fifty-five gallon drums of dry solid waste were shipped from the reactor facility to the EHS waste storage facility for consolidation with other waste being prepared for shipment for disposal.

C. Environmental Surveillance

1. Air Sampling

Environmental air samples are collected on a monthly basis at the following locations:

A-1 Roof of reactor building
A-2 Indicator - approximately 0.13 mi. E of UVAR
A-3 Control - approximately 3.1 mi. NW of UVAR

Fixed sampling locations are utilized to collect air samples at locations A-2 and A-3. Sampling time is approximately 96 hours. Air samples are collected at location A-1 using a portable air sampler which is run for 2 hours. All air samples collected at these locations were particulate air samples and were analyzed for gross beta activity. Results are provided in Table 3.

2. Water Sampling

Environmental water samples are collected on a monthly basis from the locations indicated in Table 2.

Gross beta analysis was performed on all water samples collected. The results of the analysis are provided in Table 4. The average gross beta concentration measured at each location was less than the applicable MPC.

Table 2

LOCATIONS OF ENVIRONMENTAL WATER SAMPLES TAKEN FROM AROUND THE REACTOR FACILITY IN 1991

Location	Description	Distance/Direction from UVAR
W-1	Creek upstream of on-site pond	on-site
W-2	University water filtration plant	0.26 mi. SE
W-3	Meadow Creek near Barracks Road, downstream of main University water discharge point (2 samples taken short distance apart on creek, results are averaged)	1.8 mi. NE

Table 3

ENVIRONMENTAL AIR SAMPLING RESULTS

Gross Beta Analyses Results

	ROOF OF UVAR FACILITY	0.13 MI. EAST OF UVAR	3.1 MI. NW OF UVAR
	uCi/ml ± 2 sigma error		
JAN	1.1 ± 2.0 E-13	8.0 ± .63 E-14	9.0 ± .65 E-14
FEB	1.2 ± .26 E-12	1.4 ± .08 E-13	1.9 ± .09 E-13
MAR	1.6 ± 2.1 E-13	1.3 ± .08 E-13	1.4 ± .08 E-13
APR	2.4 ± 2.5 E-13	1.5 ± .08 E-13	1.2 ± .07 E-13
MAY	1.5 ± .32 E-12	1.5 ± .07 E-13	1.4 ± .07 E-13
JUNE	2.5 ± .39 E-12 *	1.8 ± .09 E-13	2.2 ± .10 E-13
JULY	8.5 ± 3.1 E-13	2.0 ± .09 E-13	2.0 ± .09 E-13
AUG	7.2 ± 2.6 E-13	2.2 ± .10 E-13	2.7 ± .11 E-13
SEP	2.5 ± .37 E-12	2.5 ± .11 E-13	2.5 ± .11 E-13
OCT	1.6 ± .38 E-12	6.9 ± .21 E-13 **	6.4 ± .17 E-13
NOV	2.5 ± .39 E-12	1.1 ± .08 E-13	1.1 ± .08 E-13
DEC	5.1 ± 2.6 E-13	2.7 ± .11 E-13	2.8 ± .11 E-13

* filter paper counted before 24 hour waiting period

** running time meter indicated sampler ran for 20 hrs. less than usual. If running time meter malfunctioned, then true concentration should be 5.4 E-13.

Table 4

ENVIRONMENTAL WATER SAMPLING RESULTS

	UPSTREAM OF POND W-1	FILTRATION PLANT W-2	MEADOW CREEK W-3
	μCi/ml $\pm$ (1 sigma error %)		
JAN	4.1×10^{-9} (21)	3.6×10^{-9} (22)	4.9×10^{-9} (15)
FEB	1.7×10^{-8} (8)	8.1×10^{-10} (92)	6.0×10^{-9} (13)
MAR	3.4×10^{-9} (31)	-1.9×10^{-9} (-37)	3.0×10^{-9} (24)
APR	2.1×10^{-8} (8)	1.1×10^{-9} (72)	5.3×10^{-9} (15)
MAY	1.6×10^{-8} (9)	2.7×10^{-9} (31)	9.7×10^{-9} (10)
JUN	8.6×10^{-9} (16)	5.5×10^{-11} (1761)	5.2×10^{-9} (18)
JUL	5.4×10^{-9} (26)	5.5×10^{-9} (19)	9.6×10^{-9} (12)
AUG	9.3×10^{-9} (14)	1.4×10^{-9} (54)	4.6×10^{-9} (17)
SEP	1.2×10^{-8} (11)	4.2×10^{-9} (22)	8.7×10^{-9} (10)
OCT	7.0×10^{-9} (17)	3.9×10^{-9} (23)	9.8×10^{-9} (9)
NOV	6.6×10^{-9} (18)	4.6×10^{-9} (21)	8.2×10^{-9} (11)
DEC	9.9×10^{-9} (13)	3.6×10^{-9} (25)	1.1×10^{-8} (8)
AVG.	1.0×10^{-8}	2.5×10^{-9}	7.2×10^{-9}

D. UVAR Facility Surveys

1. Radiation and Contamination Surveys

Daily, weekly and monthly surveys are performed throughout the Facility to monitor radiation and contamination levels. All required area radiation and contamination surveys were performed during 1991.

The levels of contamination detected in the Facility during 1991 were generally very low (typically less than 100 dpm/100 cm^2). Although the procedural definition of "contamination" is an activity of 2200 dpm per 100 cm^2 or greater, most areas are decontaminated if found to have greater than 50 dpm/100 cm^2. This is in keeping with the philosophy of ALARA. Area radiation level surveys revealed no overall increase in background or systems-related radiation levels.

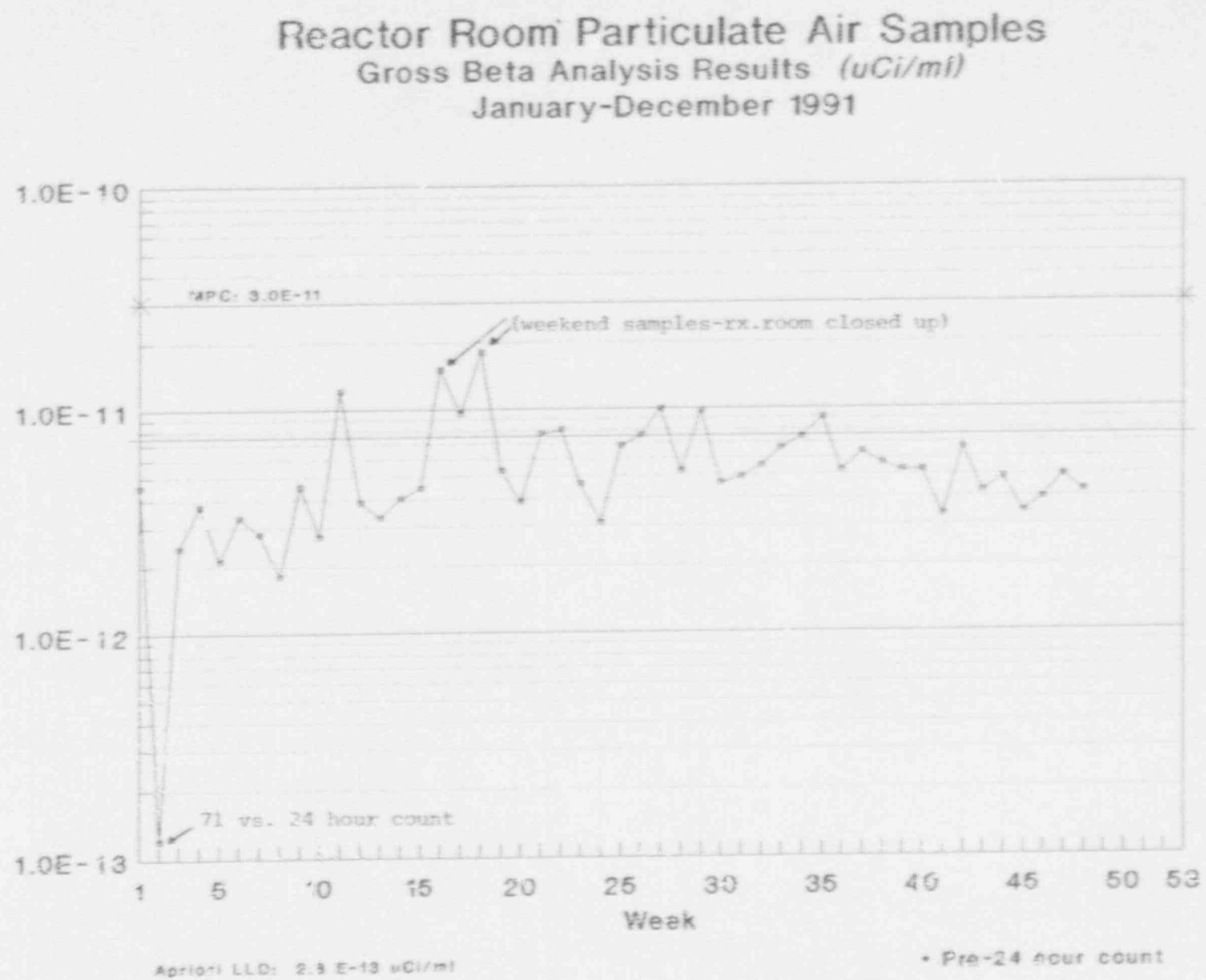
2. Airborne Radioactivity

A particulate air sample is collected in the reactor room as part of the weekly survey of the Reactor Facility. The average concentration of radioactive material detected in the air in the reactor room (as measured by gross beta analysis of the particulate samples) was 5.6×10^{-12} uCi/ml. The airborne radioactivity detected was primarily due to radon and thoron daughters. None of the measured concentrations exceeded the applicable MPC. (See Fig. 7).

E. Spills

No reportable spills occurred at the UVAR Facility during 1991.

Figure 7


Reactor Room Particulate Air Samples
Gross Beta Analysis Results (uCi/ml)
January-December 1991
1.0E-10
1.0E-11
1.0E-12
1.0E-13
MPC: 3.0E-11
(weekend samples-rx.room closed up)
71 vs. 24 hour count
1
5
10
15
20
25
30
35
40
45
50
53
Week
Apriori LLD: 2.8 E-13 uCi/ml
• Pre-24 hour count

F. Quality Assurance

The UVAR Facility participates in the U.S. Environmental Protection Agency (EPA) Laboratory Intercomparison Studies Program as part of its quality control program for radiation measurement of air and water samples. The UVAR Facility participates in the following studies:

Gamma In Water on a triannual basis
Gross Alpha, Gross Beta in Water on a triannual basis
Tritium in Water on a semiannual basis
Gross Beta on Air Filter on a semiannual basis

Three independent determinations for each radionuclide included in a study are made and analysis results are reported to the EPA. A report of all participating laboratories results is generated by the EPA. This report contains analytical precision values which are used as a basis for judging a laboratory's performance.

Table 5 gives the results of the UVAR's performance in the above mentioned studies. The fifth column in Table 5 (normalized deviation) is a measure of the UVAR's analytical accuracy. It is the difference of the UVAR's results from the known values.

G. Summary

During 1991, no State or Federal limit for exposure to personnel or the general public was exceeded.

Table 5

Date	Study		Known Value	UVAR average value	Normalized Deviation*
3-29-91	Air Filter Gross Beta		124.0 pCi/F	133.67	2.79
8-30-91	Air Filter Gross Beta		92.0 pCi/F	108.00	2.77
2-22-91	Tritium in Water		4418.0 pCi/l	4774.33	1.40
6-21-91	Tritium in Water		12480.0 pCi/l	12755.33	0.38
2-08-91	Gamma in Water	Co-60	40.0 pCi/l	35.33	-1.62
		Zn-65	149.[illegible] pCi/l	148.67	-0.04
		Ru-106	186.0 pCi/l	183.67	-0.21
		Cs-134	8.0 pCi/l	7.33	-0.23
		Cs-137	8.0 pCi/l	7.67	-0.12
		Ba-133	75.0 pCi/l	68.67	-1.37
6-07-91	Gamma in Water	Co-60	10.0 pCi/l	NRR	
		Zn-65	108.0 pCi/l	124.33	2.57
		Ru-106	149.0 pCi/l	129.33	-2.27
		Cs-134	15.0 pCi/l	14.0	-0.35
		Cs-137	14.0 pCi/l	16.67	0.92
		Ba-133	62.0 pCi/l	63.33	0.38
10-04-91	Gamma in Water			NRR	

KEY: NRR: No results reported by UVAR Facility
F: Filter

* If this value is between 2.00 and 3.00; analytical process precision is in the warning zone; if it exceeds 3.00 it is out of control.

V. RESEARCH, EDUCATION AND SERVICE ACTIVITIES

A. Available Research Facilities

A summary description of the experimental facilities available at the UVA Reactor is listed in section I.B.5. During 1991, no substantial changes were made to any existing experimental facilities but one new facility was added. The hot cell Facility for a number of years has been used only for the temporary storage of low level radioactive waste prior to combined shipments. A professor currently doing research at the Reactor obtained an X-ray machine to complement other research utilizing neutrons. This X-ray machine was installed in the hot cell.

One minor experiment involving the gamma irradiation of some fiber optics like material was carried out in a facility in the reactor pool using a lead shield and eight cobalt-60 rods in a linear array. The lead shield reduced the dose to one end of the fibers by a factor of 100.

B. Research Activities

1. A continuing program of research was pursued on behalf of the Philip Morris Company. This work was supervised by Dr. Jack Brenizer and conducted primarily by graduate students with Reactor Facility staff assistance. The major projects were neutron radiographic examinations of burning cigarettes, neutron activation analysis of various tobacco products and other substances used in the tobacco industry and the analysis of the distribution of smoke from a smoked cigarette through spiking of tobacco with radioactive isotopes.

2. Staff assistance was provided for one major project and several minor projects utilizing the cobalt-60 irradiation facility. The major project is on behalf of sponsors related to the nuclear power industry. It involves the gamma irradiation of radiation sensitive components from nuclear power plants. Dr. Albert Reynolds is the principal investigator for this project which should last several more years.

   One of the other projects was sponsored by the Continuous Electron Beam Accelerator Facility (CEBAF) in Newport News, Virginia. The researchers there are investigating the possible radiation degradation of fiber-optic type radiation scintillation detectors that are scheduled for use with the accelerator. Additional work related to this project is anticipated in 1992.

   A local firm, Biotage, is also using the cobalt facility. A large number of samples have been irradiated to test polymer coated stationary phases for liquid chromatography.

Several researchers at both UVA and other universities provided a number of different kinds of samples to be sterilized in the cobalt facility.

3. A nuclear engineering faculty member, Dr. W.R. Johnson, and several students used reactor produced radioisotopes to perform sponsored research investigating methods of early detection of corrosion inside steel pipes.

4. The Ciba-Geigy pharmaceutical company continued sponsoring work involving NAA and production of samarium and erbium radioactive tracers. The interest is to develop methods to measure and control drug delivery and release mechanisms which employ hydrogel bead technology.

5. A student in the UVA Chemistry Department utilized the services and equipment at the Reactor Facility to perform neutron activation analysis on a number of geologic samples as part of his PhD research.

6. A professor from Yugoslavia, Dr. P. Vukotic, who had received a Fulbright fellowship, spent about nine months at the Reactor Facility working with the Reactor Facility Director and the reactor staff using neutron activation analysis of special foil to assist the development of a neutron self-shielding correction PC program.

7. A professor from Egypt, Dr. H. Hamroush, also on a Fulbright fellowship, spent about three months at the Reactor Facility working with an UVA chemistry department professor and the reactor staff performing neutron activation analysis on Nile River sediments to determine their source and thus infer the climatic conditions which existed when the sediments were laid down.

8. A student in the UVA Engineering Physics program utilized the neutron activation analysis services and the assistance of a reactor staff member to determine the ratio of iodine to thallium in sodium iodide crystals he made.

C. Service Projects

1. Iodine determinations by epithermal neutron activation analysis (ENAA) were performed on behalf of several sponsors. The substances analyzed were infant formula, liquid diet supplements, surgical diets, pet foods and various chemical compounds.

2. Rhodium determinations by neutron activation analysis (NAA) were performed on a number of chemical mixtures for a major chemical manufacturer.

3. The project involving the color enhancement of various gemstone grade minerals by fast neutron irradiation was pursued by the reactor staff on behalf on several sponsors involved in the commercial gem trade.

4. Researchers from two local historical sites sought the assistance of the Reactor Facility in determining the trace element composition of various building materials in order to determine their place of manufacture.

5. A number of small gold pellets were irradiated for use by the Department of Radiological Physics at the University of Virginia Health Sciences Center in the treatment of inoperable cancerous tumors.

6. A company which supplies various radioactive sources to industry had the Reactor Facility irradiate and ship numerous sources for use by companies performing oil well drilling.

7. A number of small radioactive sources were produced for use in graduate and undergraduate nuclear engineering laboratories.

8. Silicon wafers from a major electronics manufacturer were analyzed by a member of the Reactor Staff in order to determine the composition of thin films on the wafers.

D. Reactor Sharing Program

The Department of Energy has for funded a program at the University entitled Reactor Sharing for the past thirteen years. The purpose of this program is to make available the UVAR facilities to faculty and students at universities and other educational institutions which do not have nuclear science facilities. Over the years, hundreds of students and dozens of professors have used this arrangement to enhance both their educational and research opportunities. This past year a number of tours, laboratories and research projects were conducted under this program.

The following is a list of both the directly and indirectly funded activities completed in 1991.

School tours:

Ten tours from eight high schools, middle schools and elementary schools involving 214 students and teachers.

Nine tours by special groups of junior high school and elementary school-aged students involving 190 students.

College tours:

Twelve tours from five colleges involving 171 students and professors.

Special tours in conjunction with UVA programs:

Thirteen tours involving 196 individuals.

College labs:

Two of the college student tours involved laboratories which were participated in by 19 individuals.

Research projects:

Several research projects utilizing neutron activation analysis or cobalt-60 gamma ray irradiation were conducted by students and faculty from other schools during the year.

E. Reactor Facility Supported Courses and Laboratories

1. Academic Courses and Laboratories

The following courses and laboratories were taught by professors in the Department of Nuclear Engineering and Engineering Physics during 1991 utilizing in part services provided by the Reactor Facility.

NE 488 - Nuclear Power Plant Operations
NE 382 - Nuclear Engineering Laboratory

During June 1992, 32 high school teachers from the state of Virginia attended a one week special course at the Reactor Facility. The title of the course was "Science of Nuclear Energy and Radiation: Environmental Issues and Safety." It consisted of lectures by University of Virginia nuclear engineering faculty, laboratory experiments using the reactor and a tour of the North Anna Nuclear Power Station.

F. Degrees Granted by the Dept. of Nuclear Engineering and Engineering Physics

The following number of degrees were awarded during 1991 by the Department of Nuclear Engineering and Engineering Physics.

Bachelor of Science, Nuclear Engineering	7
Bachelor of Science, Engineering Science	4
Master, Nuclear Engineering	3
Master, Engineering Physics	5
Doctor of Philosophy, Nuclear Engineering	2
Doctor of Philosophy, Engineering Physics	0
TOTAL	21

The following theses by students in the Department of Nuclear Engineering and Engineering Physics were completed during 1991 in part using services or facilities provided at the UVA reactor.

Instrumental Neutron Activation Analysis: Resolving Interferences in (n,γ) Reactions Due to (n,p) and/or (n,α) Reactions, MS thesis in Nuclear Engineering by Michael C. Morrison.

Degradation of EDTA (Ethylenediaminetetraacetic Acid), MS thesis in Nuclear Engineering by Matthew J. Mueller.

Radiation Aging Effects on Electric Cable Insulation, MS thesis in Nuclear Engineering by Laurent Quintric.

The research work for several other theses is in progress utilizing Reactor Facility support.

VI. FINANCES

A. Expenditures

Expenditures for 1991 were as follows:

	Direct State Support	Reactor Service Income Received
Salaries:	$213,760	$92,070
Operations:	44,350	33,210
Subtotals:	$258,110	$125,280
TOTAL:	$383,390	

B. State Support / Research and Service Income

The University of Virginia is supported by allocations from the State of Virginia. Of these monies, a portion is allocated to the Department of Nuclear and Engineering Physics for the operation of the Nuclear Reactor Facility. These funds cover many of the expenses directly related to the operation of the reactor but additional monies are necessary to provide for remaining services provided to the university community by the Facility. Additional income is in the form of fees received for research and service work support. This amount billed for these services totaled about $200,000 in 1991. The income is "not business related income" because it is primarily used to pay the salaries of those professional staff members at the Facility who are not state supported. Currently, there are two staff members receiving the majority of their salaries from local funds and two other individuals who receive partial support.

Many staff members take courses and receive degrees at the University while their salaries are paid from monies generated by service work. In effect, this is another method by which the Reactor Facility supports science education at the Department of Nuclear Engineering and Engineering Physics.