DOE/ER/01953

OREGON STATE UNIVERSITY TRIGA REACTOR
ANNUAL REPORT

To satisfy the requirements of:

A. U.S. Nuclear Regulatory Commission License R-106 (Docket No. 50-234), Section 6.7(e) of the Technical Specifications, for the period July 1, 1978 through June 30, 1979.

B. U.S. Department of Energy Fuel Fabrication Contract No. EY-76-C-06-1953, for the period July 1, 1978 through June 30, 1979.

C. Oregon Department of Energy, DOE Rule No. 30-010, for the period July 1, 1978 through June 30, 1979.

Written by:

T.V. Anderson, Reactor Supervisor
A.G. Johnson, Health Physicist
S.L. Bennett, Radiation Specialist
J.C. Ringle, Assistant Reactor Administrator

Submitted by:

C.H. Wang, Reactor Administrator

Radiation Center
Oregon State University
Corvallis, Oregon 97331
Telephone: 503-754-2341

August 31, 1979

DISCLAIMER

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

I. Introduction and Summary

I. INTRODUCTION AND SUMMARY

A. INTRODUCTION TO OREGON STATE TRIGA REACTOR ANNUAL REPORT

1. This year's annual report will use the format that was introduced in the 1976-77 report.
2. The reporting period will be for one year: 1 July 78 to 30 June 79.
3. All of the information included in this annual report may not be of interest to all recipients and will require selected perusal. A comprehensive Table of Contents has been included to aid in such a selection.
4. This year's report will not attempt to review in detail the past operating years for the original 20% enriched core. A table showing the important operational data for this period (1967-1976) is included as Table III-2, however. This year's report will review the operating history of the 70% enriched FLIP core (1976-present). The 70% enriched FLIP core is established as the historical base for subsequent reports.
5. The 1976-77 report is a good source of detailed information for readers interested in the OSTR's 20% enriched core history.

B. SUMMARY OF OSTR USE DURING REPORTING PERIOD

During the year July 1, 1978 to June 30, 1979 the Oregon State TRIGA Reactor:

1. Generated 10.6 MWD of energy.
2. Consumed 13.3 grams of ^{235}U.

3. Pulsed 130 times.
4. Two fuel elements were added to the core during the reporting period.
5. Accommodated 10 courses in nuclear engineering and nuclear engineering technology; six courses in nuclear chemistry; and provided demonstrations for classes in lower division chemistry and general science. Also, 29 hours of reactor time was used to furnish special training in reactor operation for four Taiwan Power Company students. (Reactor use time for teaching and instruction totaled 202 hours.)
6. Two reactor operators are starting their training and preparing for reactor operator licensing. These trainees are from Malaysia* participating in a special research reactor operator training program. A total of three hours of reactor time has been used in the training during this reporting period.
7. Accommodated 52 research projects. (Reactor use time for research programs totaled 303 hours.)
8. During a typical week, operated about 22 hours/week.
9. Accommodated 1,095 scheduled visitors and several hundred unscheduled visitors during university open house events. (Reactor use time for visitor demonstration totaled 31 hours.)
10. Reactor use time averaged 55%, based on a 40-hour week (eight hours a day, five days a week).

*Research technicians from Tun Ismail Atomic Research Centre.

C. SUMMARY OF OSTR ENVIRONMENTAL AND RADIATION PROTECTION DATA

	Year July 1, 1978 Through June 30, 1979
1. Liquid Waste Data (See Table V-1):	
a. Total estimated quantity of radioactivity released (in curies)*	2.30×10^{-5}
b. Detectable radionuclides in liquid waste	^{51}Cr, ^{54}Mn. ^{58}Co, ^{60}Co ^{3}H
c. Estimated average concentration of released radioactive material at the point of release (in microcuries per cubic centimeter)	2.32×10^{-6}
d. Percent of applicable MPC for released liquid radioactive material at the point of release (%)	0.174
e. Total volume of liquid effluent released, including diluent, (in gallons)**	2620

*The OSU operational policy is to subtract only detector background from our water analysis data and not background radioactivity in Corvallis city water.

**Total volume of effluent plus diluent does not take into consideration the additional mixing with approximately 95,000 to 115,000 gallons per year of liquids and sewage normally discharged by the Radiation Center complex into the same sanitary sewer system.

	Year July 1, 1978 Through June 30, 1979
2. Gaseous Waste Data (See Table V-2):	
a. Total estimated quantity of radioactivity released (in curies)	10.62
b. Detectable radionuclides in gaseous waste*	^{41}Ar ($t_{1/2}$ = 1.83 hr)
c. Estimated average atmospheric diluted concentration of Argon-41 at the point of release (in micro-curies per cubic centimeter)	5.97×10^{-8}
d. Percent of applicable MPC for diluted concentration of Argon-41 at the point of release (%)	1.49
e. Total estimated release of radioactivity in particulate form with half-lives greater than 8 days (in curies)**	NONE
3. Solid Waste (See Table V-3):	
a. Total amount of solid waste packaged and disposed of (in cubic feet)	9.50
b. Detectable radionuclides in solid waste	^{60}Co, ^{59}Fe, ^{24}Na, ^{56}Mn, ^{51}Cr, ^{75}Se
c. Total radioactivity in solid waste (in curies)	6.51×10^{-4}

*Routine gamma spectroscopy evaluation of the gaseous radioactivity in the stack discharge indicated that it was virtually all Argon-41.

**Evaluation of the particulate radioactivity in the stack discharge confirmed its origin as naturally occurring radon daughter products, predominantly lead-214 and bismuth-214, not associated with reactor operations.

	Year July 1, 1978 Through June 30, 1979
4. Radiation Exposure Received by Facility Personnel and Visitors (in mRem)(See Table V-4):	
a. Facility operating personnel (mRem)	
(1) Average whole body	8.00
(2) Average extremities	208.00
(3) Maximum whole body	30.00
(4) Maximum extremities	680.00
b. Facility research personnel (mRem)	
(1) Average whole body	0.00
(2) Average extremities	82.00
(3) Maximum whole body	0.00
(4) Maximum extremities	450.00
c. Visitors (mRem)	
(1) Average whole body	1.00
(2) Maximum whole body	25.00
5. Number of Area and Offsite Environmental Monitoring Samples Evaluated:	
a. Area film badges inside the TRIGA facility	96
b. Vendor supplied TLD monitors on the reactor facility fence	36
c. OSU TLD monitors on the reactor facility fence	108
d. Integrating ionization chambers on the reactor facility fence	468
e. μR/hr measurements around the perimeter of the reactor facility fence	234
f. Offsite environmental soil samples	16
g. Offsite environmental water samples	14
h. Offsite environmental vegetation samples	56

	Year July 1, 1978 Through June 30, 1979
i. Offsite vendor supplied TLD monitors	44
j. Offsite OSU TLD monitors	228
k. Offsite integrating ionization chambers	572
l. μR/hr measurements at the offsite airborne gamma monitoring stations	494

II. General Information

II. General Information

A. Radiation Center

The Oregon State TRIGA Reactor (OSTR) is housed in the Radiation Center at Oregon State University. The Radiation Center was designed and established to: (1) accommodate internal and off-campus instructional programs; (2) support research and development programs involving nuclear science and engineering; (3) provide a place for the use of radioisotopes and ionizing radiation; and (4) provide fast and thermal neutrons for applicable programs. Construction of the Radiation Center was divided into two phases. The first phase was completed in June 1964 and consisted of 32,397 square feet of office and laboratory space. The second phase was completed in March 1967, and consisted of a nuclear research reactor housed in a 9,956 square foot building adjacent to the existing Radiation Center. In 1975, temporary space of 1,600 square feet was added for interim accommodation of the fast expanding nuclear engineering program. In 1977, additional temporary space of 1,600 square feet was added. The Radiation Center complex at present totals 45,553 square feet.

Housed in the Center are various types of laboratories and equipment designed to furnish:

1. Instruction programs in nuclear engineering, radiation biology, and nuclear and radiation chemistry.
2. Instrumental and radiochemical neutron activation analysis.

3. Neutron radiography and neutron diffraction.
4. Irradiation experiments involving x-ray, gamma-ray, or neutrons.
5. Measurement of various types of ionizing radiation.
6. Consultation in the application of radioisotopes and radiation research.
7. Exploratory programs on the novel uses of radioisotopes and radiation.

B. FACULTY MEMBERS HOUSED AT THE RADIATION CENTER

*Wang, Chih H. (Professor)
Director, OSU Radiation Center
Reactor Administrator
Head, Department of Nuclear Engineering

*Bennett, Casey W. (Instructor)
Chemistry (nuclear chemistry)

*Binney, Stephen E. (Associate Professor)
Nuclear Engineering (nuclear instrumentation)

Daniels, Malcolm (Professor)
Chemistry (radiation chemistry)

*Dodd, Brian (Assistant Professor)
Nuclear Engineering (health physics)
Health Physicist, OSU Radiation Center

Fairchild, Clifford E. (Professor)
Physics (radiation chemistry)

*Hornyik, Karl (Associate Professor)
Nuclear Engineering (safety analysis and reactor kinetics)

Jansen, George (Visiting Professor)
Nuclear Engineering (nuclear fuel cycle)

*Johnson, Arthur G. (Associate Professor)
Nuclear Engineering (health physics)
Senior Health Physicist, OSU Radiation Center

Kimeldorf, Donald J. (Professor)
General Science (radiation biology)

*Reactor users for research and/or teaching.

*Loveland, Walter D. (Associate Professor)
Chemistry (nuclear chemistry)

*Peddicord, K. Lee (Assistant Professor)
Nuclear Engineering (thermohydraulics)

Popovich, Milosh (Vice President Emeritus)

*Ringle, John C. (Associate Professor)
Nuclear Engineering (shielding and safety analysis)
Assistant Reactor Administrator, OSU Radiation Center

*Robinson, Alan H. (Professor)
Nuclear Engineering (neutron radiography and fuel management)

*Schmitt, Roman A. (Professor)
Chemistry (neutron activation analysis-Lunar geology)

Spinrad, Bernard I. (Professor)
Nuclear Engineering (reactor design and nuclear fuel cycles)

Thomas, T. Darrah (Professor)
Chemistry (photoelectron spectroscopy)

*Woods, W. Kelly (Visiting Professor)
Nuclear Engineering (energy systems analysis)

*Reactor users for research and/or teaching.

C. RESEARCH PERSONNEL HOUSED AT THE RADIATION CENTER

1. Post-Doctorate Research Associates

Name	Field	Advisor
Bahl, Mahinder K.	Chemistry	T.D. Thomas
Gimzewski, James	Chemistry	T.D. Thomas
*Ma, Maw-Suen	Chemistry	R.A. Schmitt

2. Graduate Students

Name	Degree	Field	Advisor
Ades, Maurice	PhD	Nuclear Engr	K.L. Peddicord
Bomben, Ken	PhD	Chemistry	T.D. Thomas

*Reactor users for research and/or thesis work.

Graduate Students (continued)

Name	Degree	Field	Advisor
*Chick, Steve	PhD	Chemistry	W.D. Loveland
*Conard, Roberta	MS	Chemistry	R.A. Schmitt
*Dzata, Francis K.A.	MS	Chemistry	R.A. Schmitt
Fyke, David R.	MS	Anal Chem	S.E. Binney
Guidotti, Timothy E.	MS	Nuclear Engr	K.L. Peddicord
*Ghannam, Lina M.	MS	Chemistry	W.D. Loveland
Hedberg, Thomas	MS	Rad Biology	D.J. Kimeldorf
Hindagolla, Suraj	PhD	Chemistry	R.A. Schmitt
Huang, K.Y.	MS	Nuclear Engr	A.H. Robinson
Jackson, John T.	MS	Physics	A.H. Robinson
Joo, Han Sem	MS	Nuclear Engr	B.I. Spinrad
Kazerouni, Mohd	MS	Chemistry	W.D. Loveland
*Keasler, Ken	PhD	Chemistry	W.D. Loveland
Kraus, Robert H.	PhD	Chemistry	W.D. Loveland
*LaTouche, Y. David	MS	Biol Science	D.J. Kimeldorf
Lopez, Ricardo	MS	Nuclear Engr	K. Hornyik
*Narccor-Tsey, Winfred	MS	Nuclear Engr	J.C. Ringle
*Nelsen, Janet	MS	Nuclear Engr	A.H. Robinson
*Nielsen, Larry	MS	Nuclear Engr	K.L. Peddicord
*Oylear, Joan M.	MS	Nuclear Engr	K.L. Peddicord
Ozaki, Calvin	MS	Rad Biology	D.J. Kimeldorf
*Poeton, Richard	MS	Gen Science	A.G. Johnson
Polkinghorne, Steve	MS	Nuclear Engr	S.E. Binney
Prichard, Andrew	MS	Nuclear Engr	B.I. Spinrad
*Priest, George	PhD	Geology	R.A. Schmitt
Reardon, Patrick T.	MS	Nuclear Engr	B.I. Spinrad
Reid, Bruce	MS	Nuclear Engr	K. Hornyik
*Rivera, Ma Rita	MS	Chemistry	R.A. Schmitt
Robinson, Cheryl A.	MS	Nuclear Engr	K.L. Peddicord
*Scherpelz, Robert I.	MS	Nuclear Engr	S.E. Binney
*Schofield, Paul	MS	Nuclear Engr	A.H. Robinson
Scott, James D.	MS	Rad Biology	D.J. Kimeldorf
Sittner, Valerie J.	MS	Rad Biol	D.J. Kimeldorf
*Smith, Monty	PhD	Nuclear Chem	R.A. Schmitt
Snowhill, Elaine	MS	Pharmacy	V. Smith
*Sterbentz, James	MS	Nuclear Engr	K.L. Peddicord
*Taylor, Cynthia	MS	Geology	R.A. Schmitt
*Tollefson, Dennis A.	MS	Nuclear Engr	A.H. Robinson
Tripathi, Amitabh	MS	Nuclear Engr	B.I. Spinrad
*Ungerer, C. Andy	MS	Chemistry	W.D. Loveland
Van, Phuong Dong	MS	Nuclear Engr	A.H. Robinson
*Wang, Lancelot S.K.	MS	Nuclear Engr	A.H. Robinson
Wong, Bright M.K.	MS	Nuclear Engr	B.I. Spinrad
Wu, Chi-Hung	PhD	Nuclear Engr	B.I. Spinrad
Yoshihara, Grant M.	MS	Nuclear Engr	K. Hornyik
Youssefnia, Mohammad H.	MS	Nuclear Engr	J.C. Ringle

*Reactor users for research and/or thesis work.

3. Visiting Scientists and Trainees

Name	Field (Affiliation)	Advisor
*Abu, M.P.H.	Reactor Operations (Malaysia)	J.C. Ringle
*Ali, Yusof	Reactor Operations (Malaysia)	J.C. Ringle
*Barton, John P.	Neutron Radiography (IRT Corp.)	C.H. Wang
Besar, Idris	Health Physics (Malaysia)	A.G. Johnson
*Fawaris, A.H.	Radioecology (Louisiana St. U.)	W.D. Loveland
*Fukuoka, Takaaki	Meteorite Studies (Japan)	R.A. Schmitt
*Gooding, James	Geology (Univ. of New Mexico)	R.A. Schmitt
*Hamzah, Razali	Reactor Operations (Malaysia)	J.C. Ringle
*Kamat, Kasbun	Reactor Operations (Malaysia)	J.C. Ringle
*Khair, Nahrul	Reactor Operations (Malaysia)	J.C. Ringle
*Knaus, Ronald M.	Nuclear Chemistry (Louisiana St)	W.D. Loveland
*Laul, J.C.	Neutron Act. Anal. (BNWL)	R.A. Schmitt
*Leeman, William	Geology (Rice University)	R.A. Schmitt
*Nunnelley, Lewis	Nuclear Chemistry	T.D. Thomas
Pilus, A. Rahman	Health Physics (Malaysia)	A.G. Johnson
*Yunus, Yaziz	Reactor Operations (Malaysia)	J.C. Ringle

D. CLASSIFIED STAFF AT THE RADIATION CENTER

Name	Title
Anderson, Terrance V.	Reactor Supervisor
Bauman, Mary L.	Clerical Specialist
Bennett, Stephen L.	Radiation Specialist
Busby, Harold	Scientific Instrument Technician
Campbell, Ken	Custodian
Carpenter, William T.	Reactor Operator
Clark, Judith A.	Business Manager
Doak, Sandra	Clerical Assistant
Flickinger, Evelyn	Secretary
Keen, Robin Ann	Administrative Assistant
Moeller, Wanda	Clerical Specialist
Schneider, Mary K.	Clerical Assistant
Smith, Vernon N.	Chemist
Woodrow, Doyle	Scientific Instrument Technician
Ungier, Leon	Research Assistant-Unclassified

*Reactor users for research and/or thesis work.

E. REACTOR OPERATIONS STAFF

Title	Name
Reactor Administrator	C.H. Wang
Assistant Reactor Administrator	J.C. Ringle
Reactor Supervisor	T.V. Anderson

REACTOR OPERATIONS STAFF (continued)

Title	Name
Senior Reactor Operators	J.C. Ringle S.E. Binney T.V. Anderson J.M. Oylear (student)
Reactor Operators	W.T. Carpenter
Senior Health Physicist	A.G. Johnson
Health Physicist	B. Dodd
Radiation Specialist	S.L. Bennett

F. REACTOR OPERATIONS COMMITTEE

Name	Affiliation
J.C. Ringle (chairman)	Nuclear Engineering
T.V. Anderson	Radiation Center
S.E. Binney	Nuclear Engineering
A.G. Johnson	Radiation Center
G.M. Reistad	Mechanical Engineering
A.H. Robinson	Nuclear Engineering
R.A. Schmitt	Nuclear Chemistry
D.L. Willis	General Science (Rad. Biol.)

G. RADIATION SAFETY COMMITTEE

Name	Affiliation
S.E. Binney (chairman)	Nuclear Engineering
A.G. Johnson	Radiation Center
John Kelley	Radiation Safety Office
J.E. Nixon	Food Science & Technology
C.C. Calligan	Computer Center
S.C. Fang	Agricultural Chemistry
D.J. Reed	Biochemistry-Biophysics
R.C. Worrest	General Science

III. Operational Data

III. OPERATIONAL DATA

A. REVIEW

1. The OSTR has operated for more than 12 years.
2. From March 1967 to August 1969, the maximum reactor power level was restricted to 250 kW.
3. In August 1969 the reactor was licensed to operate at a maximum reactor power level of 1 MW. From then until June 1971 the OSTR could operate at 1 MW for only short periods of time, due to the lack of sufficient cooling capacity.
4. In June 1971 the cooling capacity was upgraded to allow continuous operation at 1 MW.
5. In July 1976 the reactor was shut down (for a month) and a new FLIP core (70% enriched fuel) installed.
6. See Table III-1 for a tabular review of the OSTR's three year statistics with the FLIP core.
7. See Figure III-1 for a graphical review of the OSTR's three year energy production with the FLIP core.
8. See Table III-2 for a summary of the OSTR nine year statistics with a standard (20% enriched) core.
9. This year's Annual Report will not attempt to review the past 12 years, but will only report and review the FLIP core. It will, however, establish the new 70% enriched fuel as the historical base for subsequent reports. More detailed information concerning the 20% enriched standard core can be obtained from the 1976-77 Annual Report dated 31 August 77.

Table III-1

THREE YEAR OSTR STATISTICS

FLIP Core	1 Aug 76 to 30 Jun 77*	1 Jul 77 to 30 Jun 78	1 Jul 78 to 30 Jun 79
Operating Hours (critical)	875	819	458
Megawatt Hours	451	496	255
Megawatt Days	19	20.6	10.6
Grams ^{235}U Used	24	25.9	13.4
Hours at Full Power (1 MW)	401	481	218
Number of Fuel Elements Added to Core	85 (initial loading)	0	2
Number of Irradiation Requests	443	375	329

*Reactor shutdown July 26, 1976 for one month for refueling reactor with new full FLIP core.

Figure III-1

OSTR ANNUAL ENERGY PRODUCTION VS. TIME (FISCAL YEAR)

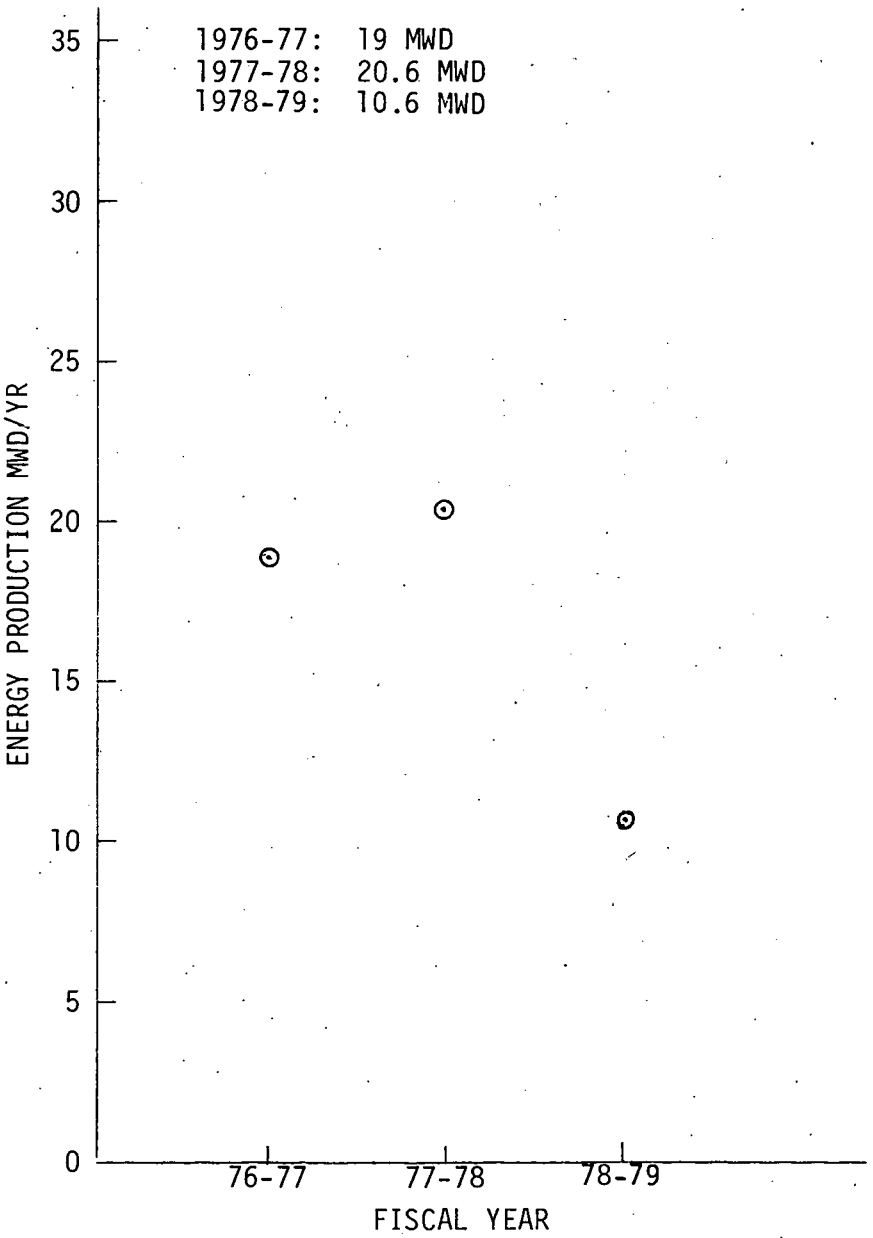


Table III-2

OSTR STATISTICS WITH 20% ENRICHED CORE

	8 MAR 67 to 30 JUN 68	1 JUL 68 to 30 JUN 69	1 JUL 69 to 31 MAR 70	1 APR 70 to 31 MAR 71	1 APR 71 to 31 MAR 72	1 APR 72 to 31 MAR 73	1 APR 73 to 31 MAR 74	1 APR 74 to 31 MAR 75	1 APR 75 to 31 MAR 76	1 APR 76 to 26 JUL 76	TOTAL MAR 67 to JUL 76
	*		**	***						****	
Operating Hours (critical)	904	610	567	855	598	954	705	563	794	353	6903
Megawatt Hours	117.24	102.47	138.05	223.77	195.11	497.82	335.94	321.45	408	213	2553
Megawatt Days	4.88	4.27	5.75	9.3	8.1	20.74	13.99	13.39	17	9	106.4
Grams ^{235}U Used	6.13	5.36	7.21	11.7	10.2	26.031	17.57	16.81	21.35	10.7	133
Hours at Full Power (250 KW)	429	369	58	--	--	--	--	--	--	--	856
Hours at Full Power (1 MW)	--	--	20	23	100	401	200	291	460	205	1700
Number of Fuel Elements Added to Core	70 (initial)	2	13	1	1	1	2	2	2	0	94
Number of Irradiation Requests	429	433	391	528	347	550	452	396	357	217	4100
Number of Pulses	202	236	299	102	98	249	109	183	43	39	1560

*Reactor became critical on March 8, 1967 (70 element core; 250 KW). Note: This period length is 1.33 years as initial critical occurred out of phase with the reporting period.

**Reactor shutdown August 22, 1969 for one month for upgrading to 1 MW (did not upgrade cooling system). Note: This period length is only .75 years as there was a change in the reporting period from July-June to April-March.

***Reactor shutdown June 1, 1971 for one month for cooling system upgrading.

****Reactor shutdown July 26, 1976 for one month for refueling reactor with new full FLIP core. Note: This period length is .33 years.

B. OPERATING STATISTICS

The utilization of the OSTR for the reporting period declined to some extent compared to that of the previous year (see Table III-1).

The thermal energy generated in the reactor during the reporting period was 10.64 MWD. (The cumulative thermal energy generated by the FLIP core now totals 50.2 MWD for Aug. 1, 1976 to June 30, 1979). See Tables III-1 and III-3 through III-5 for this reporting period's statistics. Reactor use time averaged ~55% of our 8-hour day, 5-day week schedule.

Our present rate of excess reactivity decrease with the FLIP core is about 3¢/MWD. Our present core excess (after the addition of two FLIP fuel elements) is approximately $6.70. The initial FLIP core excess was $7.17.

So far the reactivity loss per MWD with the FLIP core is about the same as with the 20% fuel. The fuel manufacturer (General Atomic) reports that with the FLIP fuel we should initially expect a decrease in reactivity and then eventually (at about 120 MWD)see a net gain in reactivity. This net gain should peak in about 4.5 MW years and is a result of the burnable poison in the fuel.

Table III-3

PRESENT OSTR OPERATION STATISTICS

Reactor Operations	1 July 78 to 30 Jun 79	FLIP Cumulative 1 Aug 76 to date
1. MWH of energy produced	255	1202
2. MWD of energy produced	10.6	50.2
3. Grams ^{235}U used	13.4	63.3
4. Number of fuel elements added to core	2	84 + 3 FFCR**
5. Number of pulses	130	316
6. Hours reactor critical	458	2152
7. Hours at full power (1 MW)	218	1100
8. Number of startup and shutdown checks	246	725
9. Number of irradiation requests processed*	329	1147
10. Number of samples irradiated	4526	16,300

*Each request authorized from 1 to 120 samples to be irradiated (the number of samples per irradiation request averaged about 14)

**Fuel Follower Control Rod

Table III-4A

OSTR USE TIME

Overall Reactor Operation Time Statistics	1 July 78 to 30 Jun 79 (hours)	FLIP Cumulative 1 Aug 76 to date (hours)
1. Checkout, core excess and shutdown	358	1033
2. Load and unload samples	91	306
3. Reactor in operation*	699	2657
4. Total reactor use time	1148	3996

*Includes preclude time. (Preclude is the time the reactor is not available for use due to inspections and maintenance, such as fuel element inspections, transient rod lubrication, control rod calibration, power calibration, etc.)

Table III-4B

OSTR USE TIME

Teaching, Research, Inspection and Demonstration Time Statistics	1 July 78 to 30 Jun 79 (hours)	FLIP Cumulative 1 Aug 76 to date (hours)
1. Training (departmental) and others)[1,2]	202	627
2. OSU research[1,3]	289	1374
3. Off-campus research[1,3]	74	257
4. Reactor preclude time	552	1666
5. Visitor demonstration	31	72
6. Total reactor use time	1148	3996

[1]Includes sample loading and unloading.
[2]See Tables IV-1 and IV-2 for teaching statistics.
[3]See Table IV-5 for research statistics.

Table III-5

OSTR MULTIPLE[1] USE TIME

Number of Users	1 Jul 78 to 30 Jun 79 (hours)	FLIP Cumulative 1 Aug 76 to date (hours)
1. Two users	37	220
2. Three users	10	49
3. Four users	0.2	1.7
4. Total multiple use time	47.2[2]	270.7[3]

[1]Multiple use time is that time when more than one experimenter had samples in the reactor during critical operations.

[2]10% of total hours the reactor was critical this year.

[3]12% of total hours the reactor was critical since startup with FLIP fuel August 1976.

C. EXPERIMENTS PERFORMED

There are at the present time 12 approved experiments on the active list that can be utilized in reactor-related programs. These experiments are listed below:

NOTE: Missing numbers identify those experiments that are in the inactive file and are not being used.

A-1 Reactor operation in any of its modes with no sample irradiation.

B-3 Irradiation of materials in assorted matrices for elements H to Bi inclusive plus natural Th and U for neutron activation analysis.

B-8 Isotope production for elements 1 thru 83 (H to Bi) excluding Cd.

B-11 Nuclear reaction studies by irradiating stable elements to produce any nuclide formed during the neutron irradiation of natural uranium.

B-12 Exploratory experiments to investigate the TRIGA capability to achieve certain experimental goals. If the TRIGA can achieve the desired goals, a regular experiment is drafted.

B-21 Advanced Neutron Radiography using beam port #3. (Radiography of all conventional items plus ordinance materials.)

B-23 Measure γ decay via γ detector in thermal column for nuclear engineering labs.

B-24 General neutron radiography using beam port #1. (Ordinance items excluded from radiography in this experiment.)

B-25 Neutron flux monitors to be used to measure relative fluxes at various locations in the reactor core and other irradiation facilities. (Fission probes and self-powered neutron detectors.)

B-29 Reactivity measurements for fuel worth.

B-30 Irradiation of jet, diesel, and furnace fuels. Irradiation of various fuel oils for NAA required a new experiment to satisfy the needs of various environmental agencies.

B-31 TRIGA flux mapping using all irradiation facilities and foils for determining neutron fluxes.

There are 25 experiments in the inactive file that would require re-approval of the Reactor Operations Committee before using.

Of the 12 approved experiments, 10 were used during the reporting period.

See Table III-6 for a tabulation of the experiments performed during the reporting period. (This table shows the experiments used, how often each was used, and in which particular area the use occurred.)

Table III-6*

EXPERIMENT USAGE VS. PROJECT

Experiment	Research	Research Thesis	Lab Classes	Forensic	Special Projects	Total
A-1	--	--	43	--	17	60
B-3	148	15	42	10	1	216
B-8	4	1	25	--	6	36
B-21	28	3	--	--	--	31
B-23	--	--	7	--	--	7
B-24	4	--	--	--	--	4
B-25	--	--	4	--	--	4
B-29	--	--	3	--	--	3
B-30	--	--	2	--	--	2
B-31	--	1	--	--	--	1
TOTAL	184	20	126	10	24	364

*Table displays the number of times a specific experiment was used in a particular area.

D. UNPLANNED SHUTDOWNS

There was a total of three unplanned shutdowns that occurred during the reporting period. See Table III-7 for tabulation.

Table III-7

UNPLANNED SCRAMS

Type Scram	Occurrences	Cause
Linear Scram	2	Reactor power range switch turned the wrong way--usually by students--during power increases.
External Scram	1	Beam port #1 has a series of interlocks associated with beam closure and access to target area. One lead shutter was not closed far enough to trip the micro switch when the access door was starting to roll open caus- a scram.

E. CHANGES IN FACILITY

1. 10 CFR 50.59 Changes

There were no 10 CFR 50.59 changes in our facility and no new experiments added to the approved list during the reporting period.

2. Other Changes

a. In August of 1978, the annunciator panel was moved from its temporary location, on top of the left console side cabinet, to a position in front of and above the operator. This change was made in anticipation of

adding a future instrument rack to the top of the left side cabinet. The annunciator panel position is an improvement over the old location.

b. In June of 1979, the core fuel elements were re-arranged to favor an increased neutron flux to beam port #4, and to increase the transient rod worth. The core configuration was changed from a symmetrical to an asymmetrical arrangement. See Figure III-2 for the symmetrical configuration and Figure III-3 for the asymmetrical arrangement. The transient rod worth increased from $2.25 to $2.78. Mechanical and electrical stops are now used to restrict the transient rod worth to $2.35, as required by our Technical Specifications.

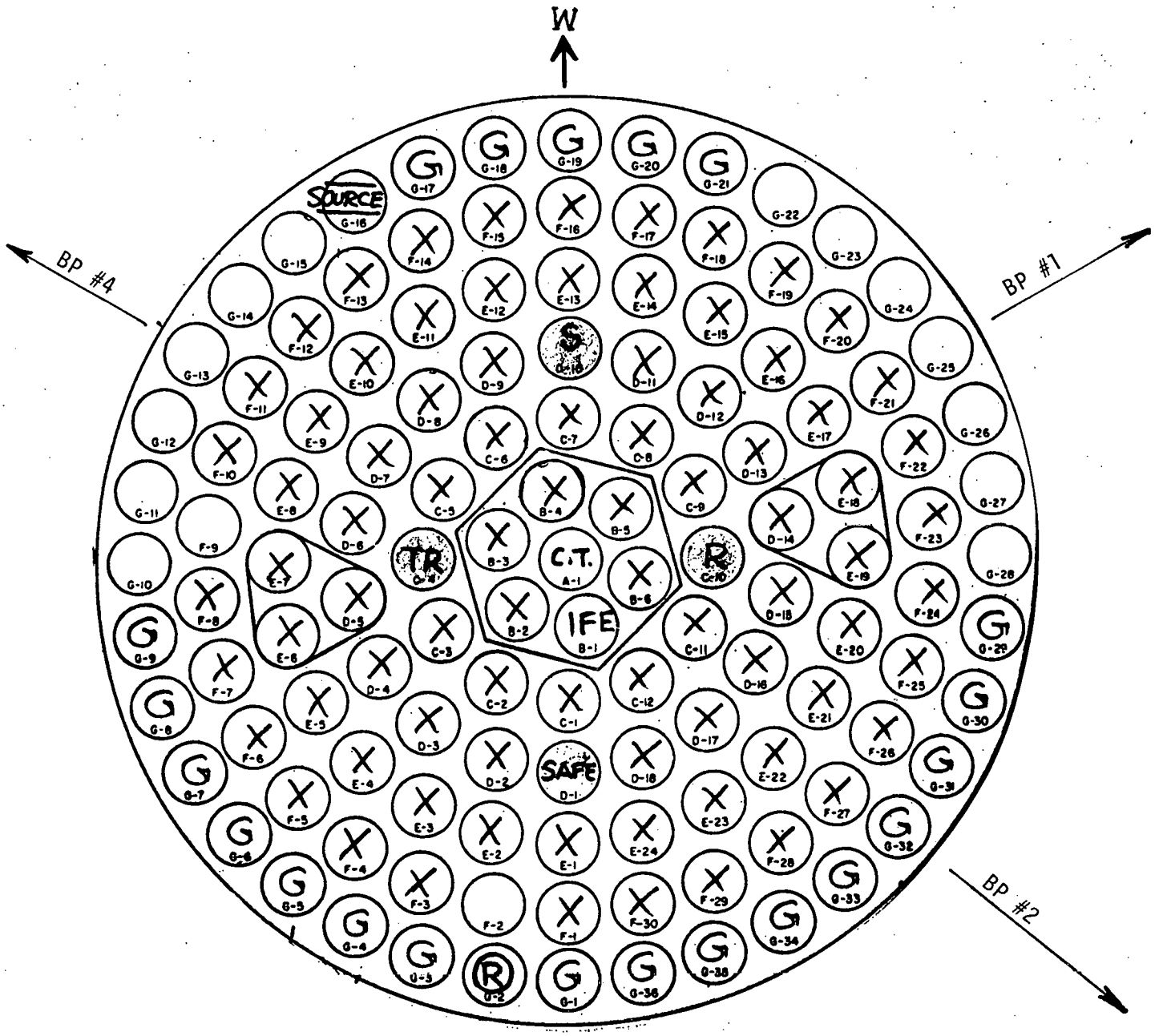
c. In June of 1979, a graphite filler plug was removed from beam port #4. This graphite plug was inserted into the reflector about six years ago to enhance the neutron in the tangential beam port (BP #3). A water-filled aluminum plug was inserted into BP #4 to replace the graphite plug in hopes the neutron beam would be increased for the neutron radiography program. The core excess decreased 23¢ with this change of plugs.

3. Planned Changes

a. We plan, in the very near future, to upgrade about half of our existing console electronics. A

Symmetrical Core Before June 1979

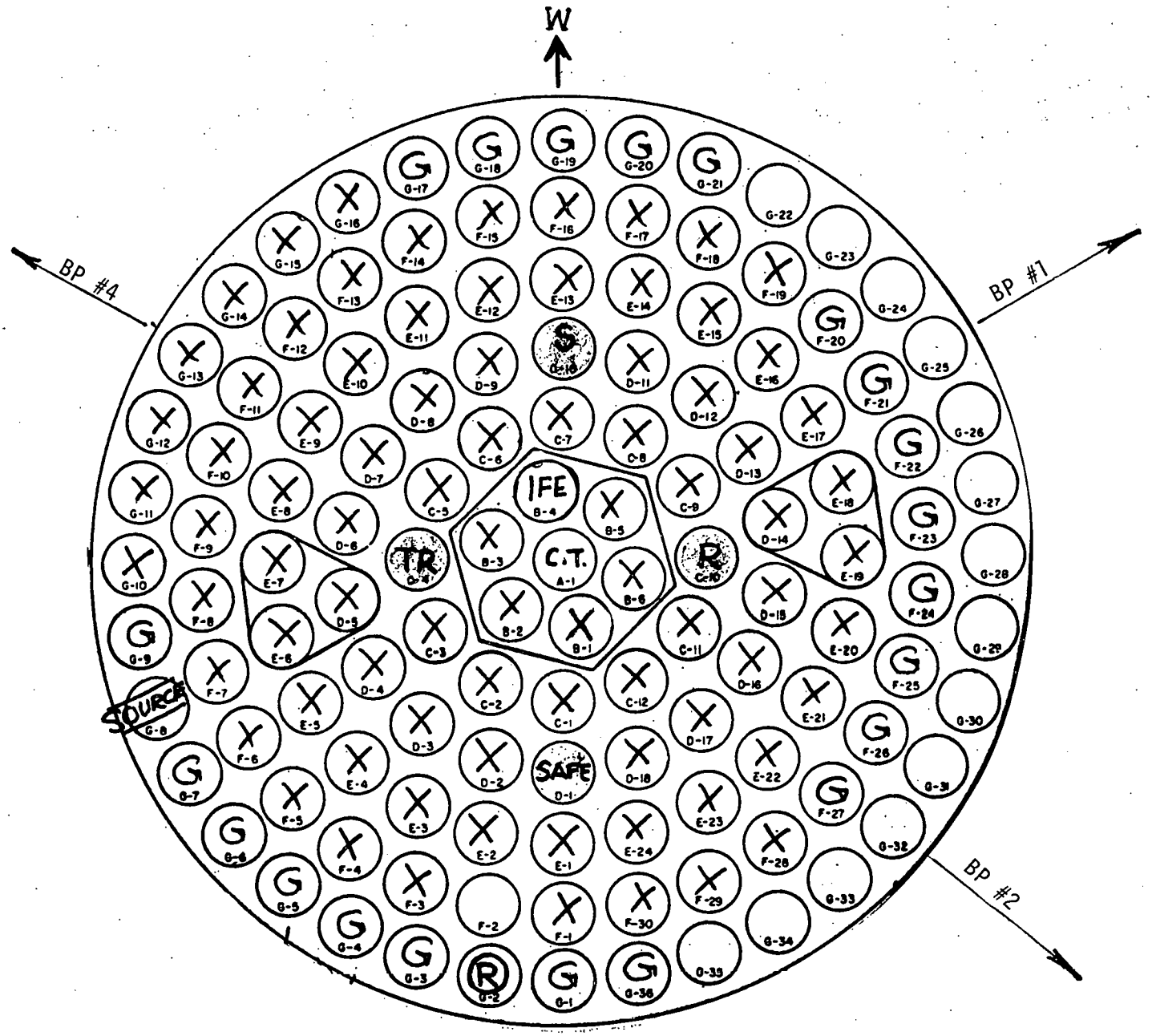
Figure III-2



G — GRAPHITE ELEMENT	CT — CENTRAL THIMBLE
X — FUEL ELEMENT	TR — TRANSIENT ROD
IFE — INSTRUMENTED FUEL ELEMENT	S — SHIM ROD
○ — EMPTY	R — REGULATING ROD
	SAFE — SAFETY ROD
	(R) — RABBIT FACILITY

Asymmetrical Core June 1979

Figure III-3



wide-range linear, wide-range log, and safety channel would be added, replacing our present linear, log, and startup channels. We have requested an amendment to our Technical Specifications in a letter dated April 16, 1979 to the NRC to accommodate this electronics upgrading.

b. We are also planning to increase our pulsed reactivity insertion limit from $2.35 to $2.55. The letter dated April 16, 1979 to the NRC also requests a change in our Technical Specifications to allow this.

c. We plan to add new radiation surveillance equipment to our facility in the form of a new constant air monitor and a new area radiation monitor. This equipment has been ordered, and it should be installed, calibrated, and operational by the end of 1979.

F. MAINTENANCE AND SURVEILLANCE

1. Maintenance

a. Oct '78: The reactor room exhaust fan motor shorted out. The field windings were replaced and the fan put back in service. The reactor down time was about two days total.

b. Jan '79: The regulating rod drive gear box was replaced. The bull wheel in the gear train was worn out. We had a replacement gear box in our spare parts inventory; thus reactor down time was only about five hours.

c. Jun '79: The transient rod drive piston ring was replaced. The old ring was deteriorating and letting too much air past the piston resulting in inconsistent reactivity insertion rates and peak power values during pulsing. The ring that was replaced was the original ring installed over 12 years ago. The reactor down time was about 2.5 hours.

2. Tests and Inspections

The OSTR has a routine test and inspection surveillance program. These T&I lists are presented in Tables III-8 through III-11. Those items marked with an asterisk (*) are required by the Technical Specifications.

G. REPORTABLE OCCURRENCE

On June 7, 1979, the measured shutdown margin for the OSTR was $0.48, nine cents less than our Technical Specifications (Part 3.2) limitation of $0.57. This was reported to the NRC, Region V, Office of Inspection and Enforcement by telephone on June 8, 1979 and by a letter dated June 19, 1979.

This incident occurred when the reactor core was changed from a symmetrical arrangement (See Figure III-2) to a asymmetrical arrangement. This change was made to accommodate a neutron radiography research program.

APPENDIX J T & I's FOR THE MONTH OF_____

	TEST OR INSPECTION TO BE PERFORMED	DUE DATE	DATE COMPLETED	INITIAL
* 1.	Functional check of reactor water level alarms.			
2.	Measure reactor primary water system pH.			
3.	Measure the pH of the bulk shiled tank water.			
4.	Check TRIGA tank water activity.			
5.	Emergency power systems battery liquid level and terminal checks.			
6.	Emergency evacuation alarm system battery liquid level and terminal checks.			
7.	Inspect brushes on rabbit system blower motor.			
8.	Functional check of evacuation alarm.			
9.	Blow down the transient rod air accumulator tank.			
10.	Calculate the average monthly conductivity. (Average conductivity must be less than 5 micro mhos per centimeter.)			
11.	Change the light bulb in the green light.			
12.	Change the light above side entrance to reactor building.			
13.	Check filter tape speed on stack monitor (1"/hr).			
14.	Lubricate the TRIGA tube loading tool as needed.			
15.	Check cam oil level.			
16.	Propane tank liquid level check (% full)			

Table III-9

T & I's FOR THE QUARTER OF _____

	TEST OR INSPECTION TO BE PERFORMED	DUE DATE	DATE COMPLETED	INITIAL
* 1.	ROC audit reactor operations.			
2.	Inspect and oil (as needed) solenoid operated valves in rabbit system.			
3.	Time the sample insertion and retrieve time interval of the rabbit system.			
4.	Check lazy susan for unknown samples.			
5.	Functional check of emergency lighting (16 units)			
6.	Westronics Recorder: clean slide wire contacts.			
7.	Varian Recorders: clean, inspect and lubricate; replace reference cells.			
8.	MAP 1B (a) Check HV source. (b) Check ratemeter test position. (c) Oil drive motors (fast and slow).			
9.	RM I-110 Area Monitors (a) Check HIGH & LOW alarms. (b) Check ±25 volt supply. (c) Check HV *(Note: use AX-30 test and calibrate meter.)*			
10.	Arm system alarm checks:			
* 11.	Rx Super evaluates operators with comments.			

CHAN	1	2	3	4	5	6	7
AUD							
LIGHT							
PANEL							
ANN							

APPENDIX L SEMI-ANNUAL T & I's FOR _____

	TEST OR INSPECTION TO BE PERFORMED	DUE DATE	DATE COMPLETED	INITIAL
1.	Functional check of the following interlocks: (a) Source interlock. (b) Simultaneous withdrawal of 2 rods. (c) Pulse initiation above 1 kw. (d) Pulse interlock on range switch position 1 MW. (e) Transient rod cylinder air interlock. (f) Pulse mode rod movement interlock. (g) Prevents pulsing above $2.35 reactivity insertion.			
* 2.	Test safety circuits below: (a) Linear channel. (b) Safety channel. (c) Manual scram. (d) Preset times on pulse (less than 15 seconds).			
* 3.	Check (1) rod drop time (time must be less than two seconds) and (2) rod withdrawal and insertion time.			
* 4.	Pulse reactor and compare fuel temperature and peak power with previous pulses of the same reactivity insertion.			
* 5.	Functional check of reactor room ventilation shutdown system.			
* 6.	Calibrate FE temp. meter.			
* 7.	ROC MTG at least semiannual.			
* 8.	Clean and lubricate transient rod internal barrel and piston (check for excessive air leakage).			
9.	Lube ball nut drive and threaded cylinder on transient rod.			
10.	Lubricate lazy susan drive and indicator assembly bearings.			
11.	MAP-1B: Disassemble and clean orifice plate for flow indicator.			
12.	Console: Perform check list (Appendix I in GA manual #7615).			
13.	AM-2A Air Monitor: Inspect and clean recorder, lightly lubricate recorder bearings.			
14.	Westronics Recorder: Check zero and calibration.			

	TRANS	SAFE	SHIM	REG
Rod Drop				
Withdrawal				
Insertion				

ANNUAL T & I's FOR _____

	TEST OR INSPECTION TO BE PERFORMED	DUE DATE	DATE COMPLETED	INITIAL
* 1.	[BI ANNUAL] Remove and inspect all control rods for signs of corrosion and wear.			
* 2.	Annual report (due 30 June + 60 days)			
* 3.	Calibrate control rods.			
* 4.	Calibrate reactor power.			
* 5.	Calibrate bulk H_2O temp. meter.			
* 6.	Calibrate the constant air monitor.			
* 7.	Stack Monitor (a) Calibrate particulate monitor. (b) Calibrate gas monitor.			
* 8.	Calibrate the Area Radiation Monitor.			
† 9.	Conduct evacuation drill.			
†10.	Calibrate the reactor water activity monitor.			
†11.	Count rate meter discriminator check. Draw new curve.			
12.	Inspect standard rod drive mechanisms.			
13.	Change oil if needed in the thermal column door drive assembly reduction gear casing.			
14.	Change oil in cam blower and oil motor.			
15.	Lubricate thermal column door drive assembly as needed.			
16.	Check beam port loading tool hydraulic reservoir level and lubricate mechanisms as needed.			
*17.	Rx operator requalification			
*18	SNM inventory			
19	Intrusion Alarm Response Drill			
20	Security Guard Training			

The core change had been reviewed and approved by the Reactor Operations Committee. The change was carried out in sequences, with rod worths being measured and shutdown margins calculated at the end of each sequence. After the final sequence, the core excess reactivity had increased more and the control rod worths had increased less than was predicted from the previous sequence. This resulted in a shutdown margin slightly less than the limit in the Technical Specifications.

As soon as this situation was discovered, two fuel elements were moved and the shutdown margin went up to $0.74. See Figure III-3 for the final asymmetrical core arrangement. More details regarding this incident can be found in our letter to NRC dated June 19, 1979.

IV. Utilization Data

IV. UTILIZATION DATA

A. TEACHING PROGRAMS

1. The OSTR was used to accommodate 10 courses in nuclear engineering and nuclear engineering technology. These courses were:

NE 101	Nuclear Engineering Orientation
NE 102	Nuclear Engineering Orientation
NE 441	Nuclear Reactor Experiments
NE 442	Nuclear Reactor Experiments
NE 203	Nuclear Radiation Detection and Measurement
NT 203	Nuclear Radiation Detection and Measurement
NT 311	Radiation Protection
NT 312	Radiation Protection
NT 491	Nuclear Technology Experiments
NT 492	Nuclear Technology Experiments

Six chemistry courses utilized the OSTR. They were:

CH 107	General Chemistry Laboratory
CH 419	Radioactive Tracer Methods
CH 528	Activation Analysis
CH 316	Radiochemistry
CH 207	General Chemistry Laboratory
CH 515	Experimental Nuclear Chemistry

2. A special class was held for four Taiwan Power Company students, which was an introduction to nuclear reactor operations. The training included at least 10 startups and shutdowns for each student, with power changes in manual and automatic modes, rod balancing, temperature effects, scram recovery, and approach to critical. A total of 29 hours of reactor time was required for this class during the reporting period.

See Tables IV-1A, IV-2, IV-3, and IV-4 for data showing the use of the OSTR to accommodate teaching and academic programs.

3. Two trainees from Malaysia arrived September, 1978. They enrolled in several academic classes and started their training for a reactor operator license in June, 1979. The Malaysian operator training was integrated into the regular reactor schedule and therefore their hours of on-the-job training are not reflected in any of the teaching statistics. (See Table IV-1B.) The Malaysian operators are Yaziz Bin Yunis and Mohd. Puad Bin Haji Abu.

Table IV-1A

OSTR TEACHING HOURS

Description	1 Jul 78 to 30 Jun 79 (hours)	Cumulative 1 Aug 76 to date (hours)
Departmental	170	567
Chemistry (58) Nuclear Engineering (83) Nuclear Engineering Technology (29)		
Special Classes		
Reactor Operator Trainees[1]	29	57
Urban League Workshop	3	10
Total Teaching Time[2,3]	202[4]	634

[1]Special training class was conducted for four Taiwan Power Company students.
[2]Includes sample loading and unloading.
[3]See Table IV-2 for class and student statistics
[4]See Table III-4B.

Table IV-1B

OSTR OPERATOR TRAINING HOURS

Name	Training Accomplishment
Yaziz Bin Yunis	Reactor Operator
Mohd. Puad Bin Haji Abu	Reactor Operator
Total Training Hours	3

Table IV-2

STATISTICS OF STUDENTS IN

NUCLEAR ENGINEERING AND NUCLEAR SCIENCE COURSES

Course	Cr.	Course Title	Number of Students FAL 1978	WIN 1979	SPR 1979
Nuclear Engineering Courses					
NE 101*	3	Nuclear Engineering Orientation	17	--	--
NE 102*	3	Nuclear Engineering Orientation	--	18	--
NE 103x	3	Nuclear Engineering Fundamentals	--	--	20
NE 201	3	Nuclear Energy Fundamentals	28	--	--
NE 202	3	Nuclear Radiation & Matter	--	23	--
NE 203**	3	Nuclear Radiation Detection & Meas.	--	--	26
NE 406		Projects	5	3	6
NE 407	1	Seminar	--	20	--
NE 420	3	Intro. to Nuclear Reactor Analysis	--	--	31
NE 421	3	Nuclear Reactor Analysis & Comput.	34	--	--
NE 422	3	Nuclear Reactor Analysis & Comput.	--	32	--
NE 423	3	Nuclear Reactor Analysis & Comput.	--	--	30
NE 441**	3	Nuclear Reactor Experiments	29	--	--
NE 442**	3	Nuclear Reactor Experiments	--	23	--
NE 461	3	Reactor Thermohydraulics & Power Gen.	21	--	--
NE 462	3	Reactor Thermohydraulics & Power Gen.	31	--	--
NE 463	3	Reactor Design	--	--	17
NE 464	3	Reactor Safety Engineering	--	25	--
NE 465	3	Nuclear Fuel Cycle	--	38	--
NE 481	3	Nuclear Materials	--	--	34
NE 501		Research	1	1	3
NE 503	1-15	Thesis	8	8	9
NE 505		Reading & Conference	1	6	12
NE 506P		Projects	--	--	
NE 507		Seminar	--	2	--
NE 511	2	Neutron Trans. Theory	7	--	--
NE 512	2	Neutron Trans. Theory		5	--
NE 513	3	Nuclear Reactions Var. Thry.	--	--	5
NE 521	3	Reactor Environmental Problems	6	--	--
NE 522	3	Reactor Safety Problems	--	4	--
NE 523	3	Advanced Reactor Design	--	--	7
NE 531	3	Nuclear Reactor Kinetics	--	7	--
NE 535	2	Nuclear Reactor Burnup	11	--	--
NE 552	3	Computational Methods for Nuc. React.	--	17	--
NE 553	3	Computational Methods for Nuc. React.	--	--	10
NE 581	3	Selected Topics in Reactor Theory	--	10	--

*OSTR used occasionally for demonstration experiments.
**OSTR heavily used.

Course	Cr.	Course Title	Number of Students FAL 1978	WIN 1979	SPR 1979
Nuclear Engineering Technology Courses					
NT 101*	3	Nuclear Engineering Orientation	5	--	--
NT 102x*	2	Nuclear Engineering Orientation	--	3	--
NT 103x	3	Nuclear Engineering Fundamentals	--	--	1
NT 201	3	Nuclear Energy Fundamentals	5	--	--
NT 202	3	Nuclear Radiation & Matter	--	4	--
NT 203**	3	Nuclear Radiation Detection & Meas.	--	--	4
NT 311**	4	Radiation Protection	--	13	--
NT 312**	4	Radiation Protection	--	--	8
NT 330x	3	Nuclear Engr. Calculations	--	--	7
NT 405	1	Reading & Conference	--	1	--
NT 405A	1	Reading & Conference (Nuclear Engr. Calc.)	10	--	--
NT 406		Projects	--	1	7
NT 407		Seminar	6	--	
NT 410	3	Field Practice	2	--	--
NT 411	3	Nuclear Rules & Regulations	12	--	--
NT 413	3	Nuclear Plant Environmental Impact	--	--	11
NT 431	3	Nuclear Power Plant Technology	16	--	--
NT 432	3	Nuclear Power Plant Technology	--	14	--
NT 433	2	Nuclear Quality Assurance	--	--	13
NT 491**	3	Nuclear Technology Experiments	9	--	--
NT 492**	3	Nuclear Technology Experiments	--	9	--
Chemistry Courses					
CH 105	4	General Chemistry Lecture	--	631	94
CH 107*	2	General Chemistry Labs	67	--	--
CH 207*	2				
CH 316**	3	Nuclear Reactor Chemistry	32	--	--
CH 419**	4	Radioactive Tracer Methods	10	--	--
CH 515**	3	Experimental Nuclear Chemistry	--	--	4
CH 528**	3	Activation Analysis	--	11	--
Other Courses					
GS 460	3	Radiation Health	13	--	--
Special Class for Taiwan Power Company			--	--	4

*OSTR used occasionally for demonstration experiments.
**OSTR heavily used.

Table IV-3

OTHER EDUCATIONAL INSTITUTIONS USING OSTR*

	Number of Faculty Involved	Number of Students Involved	Number of Visits to OSTR
University of Oregon	5**	7**	7
Louisiana State University	1	0	1
Rice University	1	0	1
Urban League Workshop (Portland)	2	7	2

*Does not count community college, high school and grade school classes that come through for special tours. These are listed under the section on "Public Relations."

**Includes researchers and students from other universities working through the University of Oregon. (See Table IV-4.)

Table IV-4

GRADUATE STUDENTS DOING THESIS RESEARCH THAT USED THE OSTR

Name	Degree	Department	Advisor	Thesis
Oregon State University				
A. Ungerer	MS	Chemistry	Loveland	Air Analysis
R. Cobler	MS	Chemistry	Dymond	Galapagos Rise Hydrothermal Study
R. Poeton	MS	General Science	Johnson	Effect of Cadmium Ratio on TLD Flux Calibration
M. Smith	PhD	Chemistry	Schmitt	Chemical & Petrological Characterization of Individual Rock Casts in a Brecciated Meteorite
K. Keasler	PhD	Chemistry	Loveland	Stable Activable Tracer for an Estuarine Environment
G. Priest	PhD	Geology	Taylor	Analysis Little Walker Rocks
University of Oregon				
G. Nixon	PhD	University of British Columbia Through the University of Oregon		
Roberts	N/A	University of Georgia Through the University of Oregon		
J. Metz	PhD	Biology	Bishop	A Study of Photosynthetic Apparatus in Green Algea
S. Goldberg	PhD	Geology	Goles	Anorthosite Genesis
C. Bow	PhD	Geology	Goles	Geochemistry of Galapagos Lavas
H. Nashland	PhD	Geology	McBirney	Petrology of the Upper Border Group of the Skaergaard Intrusion
C. White	MS	Geology	McBirney	Sodium Analysis of Mt. Hood Geologic Samples

B. RESEARCH PROJECTS

Fifty-two research projects utilized 363 hours of reactor time. Thirty-two of these research projects were from Oregon State University, 19 were from the University of Oregon, and one was from Battelle Northwest in Richland, Washington.

Three of the Oregon State University projects were conducted and correlated with other universities and institutions. These organizations were:

1. Rice University
2. Louisiana State University
3. Battelle Northwest Laboratory*

Several of the University of Oregon projects were also correlated with other universities. These institutions were:

1. McGill University (Montreal, Canada)
2. University of British Columbia (Canada)
3. Washington State University
4. University of Georgia
5. University of Tubigen (Germany)
6. University of California, Riverside.

See Table IV-5 for statistics regarding research hours and Table IV-6 for a summary of the research projects.

*Under ERDA prime contract EY-76-6-06-1830.

Table IV-5

OSTR RESEARCH HOURS

Reactor Research Hours Statistics	1 Jul 78 to 30 Jun 79 (hours)	Cumulative 1 Aug 76 to date (hours)
OSU Research*	289	1374
(About 10% of this time was thesis & research combined)		
Off-Campus Research*	74	257
(About 14% of this time was thesis & research combined)		
Commercial	0	0
Total Research*	363	1631

*Includes sample loading and unloading time.

NOTE: Research hours, OSU funded: 114
Research hours, other funded: 249

Table IV-6

SUMMARY OF OREGON STATE UNIVERSITY TRIGA RESEARCH PROJECTS AND FUNDING AGENCIES

Listing Number	Name of Person(s) Using Reactor	Department and Institution	Project Title	Description	Funding Agency
1.	R.A. Schmitt, I.J. Tinsley	Ag Chemistry, OSU	Toxicology of Brominated Oils	INAA of Bromine in Marine Organisms	NIIHS
2.	R.A. Schmitt I.J. Tinsley	Ag Chemistry OSU	Toxicology of Brominated Fatty Acids	Evaluation of the Distribution and Absorption of Brominated Fatty Acids	NIIHS
3.	R.A. Schmitt M. Smith	Chemistry, OSU	Lunar and Meteoritic Activation Analysis for Thesis (Ph.D.)	Chemical & Petrological Characterization of Rock Casts in a Brecciated Meteorite	NASA
4.	R.A. Schmitt, M.S. Ma	Chemistry, OSU	Chemical Studies of Lunar, Meteoritic and Terrestrial Samples	INAA of Selected Samples	NASA
5.	R.A. Schmitt, W.P. Leeman	Chemistry, OSU & Rice Univ	Trace Element Studies of Volcanic Rocks	INAA for Selected Trace Elements in a Variety of Volcanic Rocks From French and Hawaii Polynesia	Rice University
6.	R.A. Schmitt, G. Priest	Geology, OSU	Composition Analysis of Selected Volcanic Rocks for Thesis (Ph.D)	INAA for Trace Elements in Little Walker Volcanic Center	OSU Geology Dept.
7.	R.A. Schmitt A. Weibel	Chemistry, OSU	Carbonate Crystal INAA	Crystals Found in Geothermal Investigations to be Analyzed for Uranium & Thorium	OSU Radiation Center
8.	R.A. Schmitt, A. Weibel	Chemistry, OSU	INAA of African Soils	Examine Soils From Kenya, Africa to Correlate with Published Data	OSU Radiation Center
9.	R.A. Schmitt, L. Norris	Forestry Sci. Lab, OSU	Dy Tracer Studies	INAA for Dy Tracer in Forest Spraying	OSU Forestry Science Lab.
10.	R.A. Schmitt, E. Trione	OSU	Western Wheat Quality Control	INAA for Funge Which is Found in Wheat. To Determine any Difference in Elemental Content.	OSU Radiation Center
11.	R.A. Schmitt, W. Fredericks	Chemistry, OSU	High Purity Crystal Production	Crystals Analyzed for Purity to Help Explain Aberations on Light & Other Sources of Radiation	OSU Chemistry
12.	R.A. Schmitt, V.N. Smith	Chemistry, OSU	Forensic Investigations	INAA for Selected Trace Elements in a Variety of Forensic Samples	Oregon Law Enforcement Agencies
13.	R.A. Schmitt, T. Fukuoka	Chemistry, OSU	Elemental Abundances in Meteoritic Specimens	INAA & RNAA of Selected Chondrules to Determine REE, Sr, and BG Content in Meteorites	NASA

Table IV-6 (continued)

Listing Number	Name of Person(s) Using Reactor	Department and Institution	Project Title	Description	Funding Agency
14.	R.A. Schmitt	Chemistry, OSU	Rock Studies of Terrestrial Basalts	INAA of Terrestrial Basaltic Rocks	NASA
15.	A.H. Robinson	Nuclear Engr.	Neutron Radiography Studies of Liquid Propellants	Development of High Speed Neutron Radiography of Burning Propellants	DOD
16.	W. Loveland	Chemistry, OSU	Radiochemical Studies of Low Energy & Relativistic Heavy Ion Reactions	To Measure Mass, Charge, Angular, Energy, & Momentum Distributions by NAA of Target Materials	USDOE
17.	W. Loveland	Chemistry, OSU	Willamette River Tracer Experiment for Pollutants	Develop a Tracer Method for Tracing Fluid Bound Substances in Fresh Water	USDI
18.	W. Loveland	Chemistry, OSU	Atmospheric Trace Elements Associated With Forest Fires	INAA of Atmospheric Air Samples of Forest Fires & Slash Burning	Water Resources
19.	W. Loveland	Chemistry, OSU	Herbicide Tracing	Use of Tracers to Monitor Herbicide Dispersal	USDI
20.	W. Loveland	Chemistry, OSU	Hydrospheric Trace Elements and Their Use in Water Pollutant Tracers	Development of a Cheap, Fast Means of Tracing the Behavior of Fluid-Bound Substances in Natural Waters, Such as Rivers	U.S. Dept. of Interior
21.	W. Loveland	Chemistry, OSU	Precipitation Scavenging of Tracers Released into Frontal Storms	Analyze for Trace Elements in Rain Water Using NAA	Air Resources Center
22.	W. Loveland K. Keasler	Chemistry, OSU	Hydrospheric Trace Elements in Water Pollutant Tracing for Thesis (PhD)	Activable Tracers Being Developed to Trace Soluble Materials in an Estuarine Environment	USDI
23.	S.E. Binney	Nuclear Engr., OSU	Extraction of Uranium From Sea Water	Various Methods and Materials for the Extraction of Uranium from Seawater are Being Tested and Analyzed	Exxon Nuclear research grant
24.	S.E. Binney	Nuclear Engr., OSU	NAA in the Zirconium Metals Industry for Uranium/Thorium	INAA of Samples From the Plant Streams & Sludge Ponds in a Zirconium Separation Plant	Teledyne Wah Chang Albany research grant
25.	S.E. Binney	Nuclear Engr., OSU	"Fluorine"	INAA of Zirconium Salts for Selected Elements	Teledyne Wah Chang Albany research grant
26.	S.E. Binney A.G. Johnson	Nuclear Engr., OSU	Thorium Assay	Thorium Assay in Tissue by Delayed Neutron Counting	OSU Radiation Center

Table IV-6 (continued)

Listing Number	Name of Person(s) Using Reactor	Department and Institution	Project Title	Description	Funding Agency
27.	A.G. Johnson R. Poeton	OSU General Science	Effect of Cadmium Ratio on TLD Flux Calibrations	To Study the Variation of TLD Response to Thermal Neutrons as a Function of Cadmium Ratio	OSU Radiation Center
28.	J.P. Barton	Nuclear Engr., OSU	Evaluate Neutron Radiography Capabilities for Reactor Analysis and Safety Program	Development of Neutron Radiography of Large Fuel Bundles Inside Substantial Steel Shrouds; The Results will be Specifically Relevant to the Fast Breeder Reactor Systems	ANL
29.	K.S. Krane	Physics, OSU	Angular Correlation Measurements of Nuclear Gamma Ray	Nuclear Spectroscopic Study of Excited States in Odd-Mass Spherical Nuclei by Gamma-Gamma Angular Correlation Technique	OSU Physics Department
30.	R.M. Knaus	Radiation Center OSU & Louisiana State University	Lanthanum & Molybdenum Sorption in Willow Roots	INAA of Roots Exposed to La and Mo to Determine Sorp to the Root Surface	OSU Radiation Center
31.	J. Dymond R. Cobler	Oceanography, OSU	Galapagos Rise Hydrology Study For Thesis (Ph.D)	Geochemical Study of Galapagos by NAA	NSF
32.	J. Corliss	Oceanography, OSU	Galapagos Project	INAA for Trace Metals of Trench Rock and Mn Crust, Sediments & Hydrothermal Deposits	NSF
33.	J.C. Laul	Battelle NW	Lunar Chemical Characterization	INAA for Chemical Study of Lunar and Meteorite Samples	ERDA prime contract EY-76-C-06-1830, sp. agreement B-29210-KF
34.	G.G. Goles MacCaskie	Geology, Univ. of Oregon	Bushveld Granites: Petrogenesis	Study of Granites of the Bushveld Complex, South Africa	Geological Society of America
35.	G.G. Goles	Geology, Univ. of Oregon	Rockwell Hanford Analysis	Determination of Compositions of Columbia River Basalts. Purpose to see if Safe Reservoirs for Disposal of Radioactive Waste can be Found	DOE
36.	G.G. Goles G. Nixon	University of British Columbia Through University of Oregon	WACK-1 for Thesis (Ph.D)	Dynamic Geochemistry of Iztaccihuatl (Snowy-Broad)	University of Oregon & University of British Columbia
37.	G.G. Goles	Geology, Univ. of Oregon	No Name	Trace Element Analysis of Rock Powders for Coastal Mining Co.	University of Oregon
38.	G.G. Goles Mr. Weill	University of Oregon	Experimental Petrology of Na-Glasses	Test of Exp. Glasses for Na	University of Oregon & NSF

Table IV-6 (continued)

Listing Number	Name of Person(s) Using Reactor	Department and Institution	Project Title	Description	Funding Agency
39.	G.G. Goles, Mr. Martin	McGill Univ. & Univ. of Oregon	INAA of Mutton Bay Syenitic Complex & Associated Rodingites	Trace & Rare Earth Element Determination of Syenites & Rodingites	University of Oregon & McGill University
40.	G.G. Goles, P. Robinson	Univ. of Cal. (Riverside)	Investigation of Rocks of the John Day Fm., Oregon	INAA of Selected Rock Samples for Petrologie Interpretations	University of Oregon & Univ. of Cal. (Riverside)
41.	G.G. Goles, C. White	Geology, Univ. of Oregon	Geological and Geochemical Survey of Young Cascade Volcanisms for Thesis (Ph.D)	INAA of Selected Volcanic Specimens from the Central Cascades (including both Western Cascades and High Cascades) of Oregon, Especially Mt. Hood	D.O.G.M.I. State of Oregon
42.	G.G. Goles, H.R. Naslund	Geology, Univ. of Oregon	Petrology of the Upper Border Group of the Skaergaard Intrusion	INAA Trace Element Analysis to Correlate Upper Border Group to Major Element Data	NSF
43.	G.G. Goles, N.I. Bishop, J. Metz	University of Oregon	A Study of Photosynthetic Apparatus in Green Algae	Determination of Manganese Levels in Photosynthetic Membranes of Wild Type & Mutant Algae	NSF
44.	G.G. Goles, Mr. Stormer, Mr. Roberts	Geology, Univ. of Oregon Through Univ. of Georgia	INAA of Granite Rocks for Thesis Work	INAA of Ore Samples Related to Mr. Roberts Thesis	NSF Through the Univ. of Georgia
45.	G.G. Goles, Mr. Loeschke	University of Tubigen (Germany) Through Univ. of Oregon	Investigation of Oregon Basalts in Relation to Their Tectonic Setting	INAA of Selected Geological Basalts of the Pacific Northwest	University of Oregon
46.	V. Trommsdorf, B. Evans, G.G. Goles	Geology, Univ. of Oregon Through Univ. of Washingtor	Regional & Contact Metamorphism, Swiss Alps	Petrogenesis of Metamorphic Rocks in the Swiss Alps	University of Oregon
47.	G.G. Goles, Mr. Crawford	Geology, University of Oregon	INAA of Metavolcanics From Penn.	To Determine Meta Somatic Changes Between Amphibolite & Granulite Facres Using Trace & Rare Earths	University of Oregon
48.	G.G. Goles, S. Goldberg	Geology, Univ. of Oregon	Anorthosites of the Adirondachs Thesis (Ph.D)	INAA of Selected Geological Samples From Adirondachs, New York	University of Oregon
49.	G.G. Goles, C. Bow	Geology, Univ. of Oregon	Geochemistry and Petrogenesis of Galapagos Lavas for Thesis (Ph.D)	INAA of Selected Rock Samples for Trace Element Analysis	University of Oregon

Table IV-6 (continued)

Listing Number	Name of Person(s) Using Reactor	Department and Institution	Project Title	Description	Funding Agency
50.	G.G. Goles, Mr. Lahr	Geology, Univ. of Oregon	Siliccous Volcanics in the Mexican Volcanic Belt	NAA of Airfall Pumice & Ash Flow Deposits in the Mexican Belt	University of Oregon
51.	G.G. Goles, Mr. Herring	Geology, Univ. of Oregon	SE Oregon Volcanic Study	NAA of Rock Samples to Determine Petrologic History of the Volcanics	University of Oregon
52.	G.G. Goles, B. Baker	Geology, Univ. of Oregon	Study of Petrogenesis of Mount Kenya Lavas	INAA of Selected Geological Samples on Mt. Kenya	University of Oregon

C. PUBLICATIONS RESULTING FROM OSTR OPERATIONS THAT WERE REPORTED TO THE RADIATION CENTER

1. Publications in Print

Ma M.-S. and R.A. Schmitt 1979. Genesis of the cumulate eucrites Serra de Mage and Moore County. Meteoritics, 14, 81-90.

Ma M.-S. and R.A. Schmitt 1979. A chemical review of the various types of lunar mare low K basalts. In Lunar and Planetary Science X, Lunar and Planetary Science Institute, Houston, Texas, pp. 753-755.

Wentworth S., G.J. Taylor, R.D. Warner, K. Keil, M.-S. Ma and R.A. Schmitt 1979. The unique nature of Apollo 17 VLT mare basalts. In Lunar and Planetary Science X, Lunar and Planetary Science Institute, Houston, Texas, pp. 1332-1334.

Ma M.-S. and R.A. Schmitt 1979. Chemistry of a new type of Apollo 11 low-K mare basalt. In Lunar and Planetary Science X, Lunar and Planetary Science Institute, Houston, Texas, pp. 759-861.

Ma M.-S., R.A. Schmitt, R.D. Warner, G.J. Taylor and K. Keil 1979. Composition, petrography, and genesis of Apollo 17 high-Ti mare basalts. In Lunar and Planetary Science X, Lunar and Planetary Science Institute, Houston, Texas, pp. 765-767.

Ma M.-S., R.A. Schmitt, R.L. Nielsen, R.D. Warner, G.J. Taylor, and K. Keil 1979. Luna 16 basalts and breccias: new chemical and petrologic data. In Lunar and Planetary Science X, Lunar and Planetary Science Institute, Houston, Texas, pp. 762-764.

Ma M.-S. and R.A. Schmitt 1979. Chemistry of lithic fragments from the Apollo 17 drill core sections 70004 and 70005. In Lunar and Planetary Science X, Lunar and Planetary Science Institute, Houston, Texas, pp. 756-758.

Gooding J.L., T. Fukuoka, K. Keil and R.A. Schmitt 1979. Refractory and siderophile element variations among chondrules: evidence for primary compositional differences. In Lunar and Planetary Science X, Lunar and Planetary Science Institute, Houston, Texas, pp. 443-445.

Scherpelz R.I. and S.E. Binney 1978. "A Review of the Delayed Fission Neutron Technique," Nuclear Instruments and Methods, 154, 413 (1978).

2. Publications in Press

Ma M.-S., R.A. Schmitt, R.L. Nielsen, G.J. Taylor, and R.D. Warner 1979. Petrogenesis of Lunar 16 aluminous mare basalts. J. Geophys. Res. Letts. (submitted).

Warner R.D., G.J. Taylor, G.H. Conrad, H.R. Northrup, S. Barker, K. Keil, M.-S. Ma and R.A. Schmitt 1979. Apollo 17 high-Ti mare basalts: new bulk compositional data, magma types, and petrogenesis. Proc. Lunar and Planet. Sci. Conf. 10th, Geochim. Cosmochim. Acta. Suppl. 10 (in press).

Beaty D.W., S.M.R. Hill, A.L. Albee, M.-S. Ma and R.A. Schmitt 1979. The petrology and chemistry of basaltic fragments from the Apollo 11 soil, Part I. Proc. Lunar and Planet. Sci. Conf. 10th Geochim. Cosmochim. Acta Suppl. 10 (in press).

Fodor R.V., J.L. Berkley, K. Keil, J.W. Husler, M.-S. Ma and R.A. Schmitt 1979. Petrology and chemistry of basalt drilled from the Galapagos spreading center, DSDP Leg 54. Initial Reports of the Deep Sea Drilling Project V. Washington (U.S. Geol. Printing Office), (in press).

Curtis D.B. and R.A. Schmitt 1979. The petrogenesis of L-6 chondrites-insights from the chemistry of minerals. Geochim. Cosmochim. Acta (in press).

Tinsley I.J. and R.R. Lowry 1979. "Bromine Content of Lipids of Marine Organisms," Journal of American Oil Chemists Society (in press).

3. Reports and Papers

J.P. Barton 1978. "Feasibility of Neutron Radiography for Large Bundles of Fast Reactor Fuel," IRT Corporation Final Report #6247-004, IRT Corp., Box 80817, San Diego, California, 92138.

A.G. Johnson and R. Poeton 1979. "The Influence of Cadmium Ratio on Thermal Neutron Measurements with TLD-600 Lithium Fluoride Thermoluminescent Dosimeters," Radiation Center Project Report, Oregon State University.

G.G. Goles (Dept. of Geology, University of Oregon) 1978. Final Report of subcontract SA-911 of Prime Contract No. EY-77-C-06-1030 for: Rockwell International Corporation, Atomics International Division, Rockwell Hanford Operations, Richland, Washington 99352.

NOTE: This report by Dr. Goles may be of interest to those that may be (or are) involved in underground high-level waste storage. His findings suggest sub-surface basalts, under and near the Hanford reservation, probably were affected by alternation processes. This condition may strongly suggest that the storage of nuclear wastes in deep chambers, hollowed out within basalts, may not be a simple matter, and may be undesirable as contaminants could conceivably be brought back to or near the surface environment.

D. COMMERCIAL OR NON-ACADEMIC UTILIZATION

None

E. PUBLIC RELATIONS

The continued interest of the general public in the TRIGA reactor is evident in the number of people who have toured the facility. In addition to several hundred visitors during university open house events and interested individuals who happened to be in the vicinity, an estimated 1,095 people were given pre-planned and scheduled tours this fiscal year. See Table IV-7 for scheduled visitor statistics.

F. PLANNED CHANGES IN UTILIZATION

One shift (40 hours per week) operation is the current OSTR utilization mode. This can and will increase, however, depending upon the demand for OSTR time.

Table IV-7

RADIATION CENTER SCHEDULED VISITORS

July 1, 1978 - June 30, 1979

DATE	NAME	NO. OF VISITORS
10-06-78	Willamina High School	15
10-12-78	American Nuclear Society	38
11-21-78	American Society for Metals	17
11-30-78	Oakridge High School	7
12-02-78	American Nuclear Society Student Chapter	11
12-18-78	NET Workshop	10
1-27-79	Beaver Open House	200
1-29-79	NE 102x	20
2-02-79	Oregon House Committee on Energy & Environment	12
3-05-79	Cub Scouts	15
3-19-79	NET Workshop	10
3-28-79	Japanese Peace Rally Team	20
4-04-79	Youth Energy Awareness Day	180
4-05-79	LBCC	15
4-10-79	ESPREE Day	80
4-12-79	OSU - English Language Institute	10
4-18-79	Salem Academy	25
4-20-79	Vernonia High School	10
4-23-79	LBCC	21
4-24-79	LBCC	20
4-25-79	LBCC	20
4-27-79	Oregon Elementary School Teachers	30
5-04-79	Mom's Weekend	70
5-08-79	OSU - Chemical Engineering 351	82
5-10-79	OSU - Industrial Arts	12
5-11-79	Hidden Valley High School	20
5-11-79	Grants Pass High School	20
5-15-79	OSU - English Language Institute	12
5-18-79	OSU - Chemistry 206	10
5-18-79	Monroe Union High School	15
5-22-79	Chemeketa	6
5-24-79	Gardner Junior High School	30
5-30-79	Western View Junior High School	25
6-26-79	Pacific Power & Light Company	7
	T O T A L	1,095

V. Environmental and Radiation Protection Data; July 1, 1978 - June 30, 1979

TABLE OF CONTENTS

Page

LIST OF TABLES AND FIGURES

V. Environmental and Radiation Protection Data; July 1, 1978 Through June 30, 1979

A. INTRODUCTION

The data contained in this section have been prepared to comply with the requirements of Nuclear Regulatory Commission (NRC) Facility License No. R-106 (Docket No. 50-243) and the Technical Specifications contained in Appendix A to that license, dated July 21, 1976. The material has also been prepared in compliance with Oregon Department of Energy Rule No. 345-30-010, which requires an annual report of environmental effects due to research reactor operations.

Within the scope of this program, all releases of radioactivity to the unrestricted environment and all occupational exposures to radiation and radioactive materials are consistently maintained "as low as reasonably achievable."

B. A SUMMARY OF THE NATURE AND AMOUNT OF RADIOACTIVE EFFLUENTS RELEASED OR DISCHARGED TO THE ENVIRONS BEYOND THE EFFECTIVE CONTROL OF THE LICENSEE AS MEASURED AT OR PRIOR TO THE POINT OF SUCH RELEASE OR DISCHARGE

1. Liquid Waste (summarized on a monthly basis)

   (a) The radioactivity in liquid waste discharged during the applicable reporting period has been summarized according to the following items. All liquid waste data pertaining to these items are contained in Table V-1.

      (1) The total estimated quantity of radioactivity released (in curies).

(2) The detectable radionuclides present in this waste.

(3) An estimate of the specific activity for each detectable radionuclide present if the specific activity of the released material after dilution was greater than 1×10^{-7} microcuries/cubic centimeter.

(4) A summary of the total release (in curies) for each radionuclide determined in (2) above for the reporting period, based on representative isotopic analysis.

(5) The estimated average concentration of the released radioactive material at the point of release for the reporting period (in terms of microcuries/cubic centimeter) and the fraction of the applicable MPC value.

(b) The total volume (in gallons) of effluent water (including diluent) released during each period when liquid waste was released is also summarized in Table V-1.

2. Gaseous Waste (summarized on a monthly basis)

(a) The radioactivity in gaseous waste discharged during the applicable reporting period has been summarized according to the following items. All gaseous waste data pertaining to these items are contained in Table V-2.

(1) The total estimated quantity of radioactivity released (in curies) determined by an appropriate sampling and counting method.

(2) The detectable radionuclides present in this waste.

(3) The total estimated quantity of Argon-41 released (in curies) during the reporting period based on data from an appropriate monitoring system.

(4) The estimated average atmospheric diluted concentration of Argon-41 released during the reporting period (in terms of microcuries/cubic centimeter) and the fraction of the applicable MPC value.

(5) The total estimated quantity of radioactivity in particulate form with half-lives greater than eight days (in curies) released during the reporting period, as determined by an appropriate particulate monitoring system.

(6) The average concentration of radioactive particulates with half-lives greater than eight days (in microcuries/cubic centimeter) released during the reporting period.

(7) An estimate of the average concentration of other significant radionuclides present in the gaseous waste discharge (in terms of microcuries/cubic centimeter) and the fraction of the applicable MPC value for the reporting period, if the estimated release was greater than 20% of the applicable MPC.

3. Solid Waste (summarized on an annual basis)

(a) The radioactivity in solid waste discharged during the applicable reporting period has been summarized according to the following items. All solid waste data pertaining to these items are contained in Table V-3.

(1) The total amount of solid waste packaged (in cubic feet).

(2) The detectable radionuclides present in this waste.

(3) The total radioactivity in the solid waste (in curies).

(b) The dates of shipment and disposition of solid wastes (if shipped off-site) are also contained in Table V-3.

C. AN ANNUAL SUMMARY OF THE RADIATION EXPOSURE RECEIVED BY FACILITY PERSONNEL AND BY VISITORS IN TERMS OF THE AVERAGE RADIATION EXPOSURE PER INDIVIDUAL AND THE GREATEST EXPOSURE PER INDIVIDUAL FOR EACH OF THE TWO GROUPS

The annual summary of the radiation exposure received by facility personnel and visitors for the applicable reporting period is contained in Table V-4.

D. AN ANNUAL SUMMARY OF THE RADIATION LEVELS AND THE LEVELS OF CONTAMINATION OBSERVED DURING ROUTINE SURVEYS PERFORMED AT THE FACILITY IN TERMS OF THE AVERAGE AND THE HIGHEST LEVELS

The annual summary of radiation and contamination levels observed during routine facility surveys for the applicable reporting period is presented in Table V-5.

E. THE LOCATION AND MAGNITUDE OF THE MAXIMUM MEASURED OR CALCULATED DIRECT RADIATION LEVEL IN UNRESTRICTED AREAS DUE TO DIRECT RADIATION FROM THE FACILITY, AND DIRECT RADIATION FROM FACILITY EFFLUENTS

1. The Maximum Direct Radiation Level in Unrestricted Areas Due to Direct Radiation From the Facility

The location and magnitude of the maximum (measured and calculated) direct radiation level in the unrestricted area due to direct radiation from the facility can best be understood by referencing Figures V-1 and V-2, and Tables V-6 and V-7.

Early in the operating history of the OSU TRIGA reactor, two potential sources of direct radiation from the TRIGA facility were identified. These were the demineralizer tank for the reactor primary water system, and the graphite-natural uranium subcritical pile located in the main reactor room (see Figure V-1).

The demineralizer tank was removed from its original position as indicated in Figure V-1 to location "A" in Figure V-1 on January 3, 1972, and henceforth ceased to be a major contributor to the direct radiation from the facility. On February 23, 1972, the east side (the exterior wall side)

of the subcritical pile and the entire demineralizer tank were conservatively shielded with concrete and lead, further limiting any small direct radiation contribution from the demineralizer tank, and effectively reducing the direct radiation to unrestricted areas from the subcritical pile and the demineralizer tank to essentially zero millirem per year.

With the elimination of the preceding two sources of direct radiation from the facility, two additional sources of lesser magnitude became apparent. One of these was the particulate filter for the reactor primary water system, which is located on the demineralizer platform (see Figure V-1), and the second is best collectively termed "normal use of reactor experimental facilities and operating areas for research and teaching."

The particulate filter was completely shielded by July 10, 1972, and the new shield eliminated any further radiation contribution to the unrestricted area from this source. The second source, relating to normal use of the OSU research reactor, takes into consideration the routine handling of radioactive materials within the facility as a whole, and the need for relatively frequent access into reactor experimental and irradiation facilities. Both of these latter activities create a small potential for low levels of direct radiation exposure of reactor facility origin in immediately adjacent unrestricted areas.

Direct radiation levels in unrestricted areas (which potentially may arise from the TRIGA facility) are evaluated on the basis of three different types of radiation measurements. First, direct radiation levels are measured and analyzed as part of our routine radiation survey program. Second, data from area monitoring film badges installed at strategic locations within the TRIGA reactor operating-area are routinely documented and utilized to indicate locations where direct radiation from the facility might be entering unrestricted areas. The film badge data are corrected, as appropriate, to reflect radiation attenuation in the reactor facility walls. Finally, assessment of the direct radiation levels in unrestricted areas is conducted on the basis of area monitoring data collected through our thermoluminescent dosimetry (TLD) program.

The locations of pertinent vendor supplied (the vendor being Radiation Detection Co. [R.D. Co.], Mt. View, California) beta-gamma-neutron area monitoring film badges inside the restricted operating-area at the OSU TRIGA facility are shown in detail in Figure V-1, and are again shown as part of an overall area diagram in Figure V-2. Figure V-2 also shows the locations of R.D. Co., $CaSO_4$ TLD area monitors, (started during the 1977-78 reporting period, replacing the beta-gamma-neutron film packs used previously on the reactor area fence) plus OSU supplied and processed TLD area monitors

(normally 3 Harshaw LiF TLD-700 chips per monitor). Both types of TLD area monitors are positioned on the fence surrounding the TRIGA reactor facility. This fence was originally installed in September 1972. Figure V-2 also shows the location of three R.D. Co. beta-gamma-neutron area monitoring film badges used in conjunction with the University's AGN reactor. The AGN reactor and its monitors are not part of this report.

With the addition of the fence around the reactor area, area monitoring film badge data from inside the TRIGA facility (contained in Table V-6) no longer have a high degree of correlation to direct radiation levels in surrounding unrestricted areas. Nevertheless, we believe the data from inside the facility reflect the general character of our operation and therefore plan to continue including it in all reports of this type.

In Figure V-1 and V-2, film badge locations within the TRIGA reactor facility are abbreviated to indicate their position on a north, south, east or west wall of the main reactor bay, or their location in the reactor's adjacent heat exchanger room. For example, MRCTSE is interpreted as Monitor Radiation Center TRIGA, South badge, East wall of the main reactor bay building. Similarly, MRCTHXS is the badge for the adjacent Heat Exchanger room, South wall. Monitoring locations on the fence are simply designated MRCFE-1 through MRCFE-9, and imply Monitor Radiation Center Fence Environmental (TLD position number).

After the addition of the previously described shielding and the reactor area fence, direct radiation levels in unrestricted areas due to the TRIGA facility dropped to essentially background levels. Data presented in Table V-6 show the extremely low annual doses recorded inside the reactor facility's operating-area. Table V-7 provides verification of the essentially normal annual radiation levels measured in the unrestricted areas, as recorded by the area monitoring TLD's located on the reactor area fence, and as indicated by the direct microroentgen per hour exposures rates taken at each area monitoring station. See footnote (7) of Table V-7 for a further explanation of the μR/hr data and its application.

We are continuing our efforts to achieve closer agreement between R.D. Co. and OSU TLD data. At the present time, R.D. Co. uses a considerably higher background than OSU, and they may be reporting dose accumulated during periods when their TLD's are not in service at OSU (e.g., during transportation, etc.). Present control and QA procedures used by OSU for its outside dosimetry vendor will continue to be carefully scrutinized, and will be modified as deemed necessary during the next year in order to isolate and eliminate suspected sources of vendor error, should they exist.

As a final note on the fence monitoring stations, it should be reported that there is little or no occupancy of any specific point on the perimeter of the fence throughout the entire year.

2. The Maximum Direct Radiation Level in Unrestricted Areas Due to Direct Radiation From the Facility Effluents

The location and magnitude of the maximum (measured and calculated) direct radiation level in unrestricted areas due to direct radiation from facility effluents will be reviewed in light of both liquid and gaseous releases.

As reported in Table V-1, the total annual quantity of radioactivity released in liquid effluents has been quite small. The microcurie quantity for the reporting period in even a few hundred cubic centimeters of solution would not normally present a significant direct radiation potential, particularly when the radionuclide composition of the radioactivity is examined. In our particular operation, the majority of the liquid radioactive effluent is now normally associated with a single annual demineralizer resin change. When released from the reactor facility, this liquid is mixed with up to 3000 gallons of waste water from the Radiation Center laboratories on a batch basis before final discharge into the unrestricted area (the sanitary sewer system).

The annual average concentration for total reactor facility radioactivity in liquid effluents entering the unrestricted area equaled 2.32×10^{-6} μCi/cc for the year July 1, 1978 through June 30, 1979. With respect to this value and the total radioactivity released in the liquid effluent, recall that no city water background radioactivity

has been subtracted. Also, note that the main contributor to the microcuries released is tritium ($\sim$ 22.4 μCi). Even though nearly all of the liquid effluent volume from the reactor facility now originates during the changing of demineralizer resins, which occurs about every 12 months, it appears that little, if any, of the tritium is of reactor origin. Our routine analysis of city water indicates a normal tritium background concentration within a range of 3.42×10^{-5} μCi/cc to 1.53×10^{-6} μCi/cc for the year July 1, 1978 through June 30, 1979. Our annual average concentration for tritium based on all liquids released to the unrestricted area from the reactor facility is within this background range at 2.26×10^{-6} μCi/cc for the year July 1, 1978 through June 30, 1979. If the tritium is omitted from the total radioactivity released in the reactor's liquid effluent and a calculation performed using the remaining radioactivity ($\sim$ 0.55 μCi), some of which is also city water background, the annual average concentration for reactor facility radioactivity entering the unrestricted area becomes 5.56×10^{-8} μCi/cc for the year July 1, 1978 through June 30, 1979.

In view of the radionuclides present, and the relative abundance of each, it can be easily determined (as shown in Table V-1) that the annual average concentration of total reactor facility radioactivity in liquid effluents represents but a small fraction (0.174%) of the appropriate unrestricted

area maximum permissible concentration. In addition, the average concentration DOES NOT take into consideration the additional mixing with approximately 95,000 to 115,000 gallons per year of liquids and sewage normally discharged by the Radiation Center complex into the sanitary sewer system. For these reasons, we have concluded that the direct radiation to unrestricted areas due to radioactivity in reactor liquid effluents has been negligible.

On pages 4-53 through 4-58 of the Safety Analysis Report (SAR) for the OSU TRIGA Research Reactor, dated August 1968, consideration is given to routine discharge and atmospheric dilution of gaseous effluents from the reactor facility. This particular analysis in the 1968 SAR was conducted using the original TRIGA facility stack height of 55 feet above ground level. On page 4-57 of this report, it is specified that the activity discharge rate assumed for the purpose of calculation was 100 MPC, meaning 100 times the normal 4×10^{-8} μCi/cc Argon-41 unrestricted area maximum permissible concentration, or a value of 4×10^{-6} μCi/cc. On page 4-58 (Table 4.11 of the Safety Analysis Report) it is concluded that under the most unfavorable atmospheric conditions (with the 55 foot stack) a person standing for a full year at the point of maximum concentration would be exposed to less than 9% (8.53%) of the normal unrestricted area MPC for Argon-41. As a result, a person could stand at that point continuously for one

year under the most unfavorable atmospheric conditions, while the reactor operated continuously at 1000 kW, (and continuously discharged an assumed worst case concentration of 4×10^{-6} μCi/cc of Argon-41) and receive a whole body gamma dose from Argon-41 of less than 45 mrem (42.6 mrem) integrated over an entire year's occupancy.

Since the OSU TRIGA does not operate on a 24-hour per day basis, does not operate continuously at 1000 kW while it is operating, and does not discharge Argon-41 at 4×10^{-6} μCi/cc while operating at 1000 kW, the annual average Argon-41 concentration, as measured by the facility stack monitor, has always been much less than the assumed calculational value of 4×10^{-6} μCi/cc. Consequently, the maximum annual dose to the unrestricted area due to direct radiation from gaseous effluents has also been significantly less than the nominal 45 mrem per year value projected in the 1968 Safety Analysis Report.

As indicated in OSU's May 16, 1973 report of 10 CFR 50.59 items to the former USAEC Division of Reactor Licensing, (a copy of which also went to the former Oregon Nuclear and Thermal Energy Council) on February 23, 1972 the TRIGA facility stack height was increased from its original 55 feet above the ground to 65 feet, 10 inches above ground level. As a result of the new stack height, new atmospheric dispersion calculations were necessary in order to evaluate the atmospheric dilution of gaseous effluents from the

reactor facility. The results of the original 1968 calculations and the first evaluation following the stack change were included in Table 2 of OSU's May 16, 1973 report to the USAEC, and indicated a slightly lower concentration at the point of maximum concentration using the higher stack. Additional plume studies during 1973 and 1974, and again during 1978 using USNRC Regulatory Guide 1.111, evaluated the influence of the new stack height on gaseous effluent dispersion, and essentially confirmed earlier data. Only a slight change is introduced if the most unfavorable values from the expanded 1973-74 and newer 1978 study are used.

Using the same basic assumptions employed for the shorter stack, and in particular a continuous Argon-41 discharge rate of 100 MPC, the 1973-74 results indicate that for atmospheric conditions giving the highest ground concentration (i.e., the worst atmospheric conditions) a person standing at the point of maximum concentration would encounter approximately 3.018% (as opposed to 2.85% in the 1972 report) of the unrestricted area MPC for Argon-41. Furthermore, the 1978 study produced a nearly identical value of 3.005% of the unrestricted area Argon-41 MPC. As a result, a person could stand at this point of maximum concentration (currently projected to be 130 meters from the stack as opposed to 150 meters in the 1973-74 calculation, and 135 meters in

the 1972 report) continuously for one year under the worst atmospheric conditions, while the reactor continuously discharged 100 times the Argon-41 MPC, (4×10^{-6} μCi/cc) and receive a whole body gamma dose from Argon-41 of 15 (15.03) mrem integrated over an entire year's occupancy.

As we have indicated, the OSU TRIGA does not operate on a 24-hour per day basis, nor does it operate continuously at 1000 kW. Also, the facility's annual average Argon-41 concentration is always much lower than the 4×10^{-6} μCi/cc value used for purposes of calculation. As a result, the maximum annual dose in the unrestricted area due to direct radiation from gaseous effluents consistently remains much less than the nominal 15 mrem per year projected using the new stack height and the 1978 plume dispersion data.

In order to evaluate the maximum dose in the unrestricted area from gaseous effluents during the reporting period, one should assume continuous annual occupancy at the point of maximum concentration. Furthermore, it will be necessary to assume the existence of the most unfavorable meteorological conditions for a full year in order to achieve the maximum concentration at the specified point for one entire year. If these conservative assumptions are applied in conjunction with the reported annual average Argon-41 concentration, (5.97×10^{-8} μCi/cc) as derived

from actual measurements at the point of release with the facility's continuous stack monitor (see Table V-2), then the maximum annual dose in the unrestricted area (at 130 meters from the stack under the most unfavorable atmospheric conditions) would be approximately 0.224 mrem for the year July 1, 1978 through June 30, 1979.

F. AN ANNUAL SUMMARY OF THE GENERAL METHODS AND THE RESULTS OF ENVIRONMENTAL SURVEYS PERFORMED OUTSIDE THE FACILITY

The environmental radiation monitoring program will be categorized according to onsite and offsite environmental monitoring systems. A description of the two categories follows.

1. The Onsite Environmental Monitoring Systems

Onsite radiation monitoring programs which we believe qualify as environmental radiation monitoring systems include the facility radioactivity stack monitor, onsite area monitoring film badges, TLD's and 0-200 mrem gamma-sensitive integrating ionization chambers (self-reading pocket dosimeter type), and the monitoring procedures associated with the analysis of radioactivity in liquid effluents from the reactor facility. Also, routine (daily, weekly, bi-weekly and monthly) direct radiation surveys conducted by the OSU TRIGA Radiation Protection Staff provide a wealth of essential information on existing radiation conditions throughout the various onsite areas.

The reactor facility radioactivity stack monitoring system consists of a continuous moving-filter-paper particulate monitor, followed by a separate chamber which functions as a gas monitor. The system is consistently placed in operation before the reactor is started up, remains in operation at all times while the reactor is in use, and is kept operable after reactor shutdown until both detection channels reach normal background. The system is equipped with an isokinetic sampling head which draws its sample near the point of discharge in the reactor building stack. The system is calibrated at least annually with standardized particulate samples of appropriate types and energies, and with known quantities of Argon-41 gas. The system reads out continuously in both the particulate and gaseous channels, with each channel having its own count rate meter and recorder. A count integrating scaler is also attached to the gas channel to increase the accuracy of determining Argon-41 released. The system is equipped with alarm circuits which will automatically shut off the facility ventilation system and close dampers on the intake and exhaust lines in the event preset airborne radioactivity concentration limits are reached. One of the most valuable applications of this system from the standpoint of environmental monitoring is the data derived from its operation which

can be applied to determining potential exposures in unrestricted areas from gaseous radioactive effluents.

Onsite area monitoring film badges consist of standard personnel-type beta-gamma-neutron film packs, located at strategic positions inside the reactor facility operating-area (see Figures V-1 and V-2). The films within the facility are changed once per month.

Onsite area monitoring using TLD's now consists of two different types of dosimeters, both located at identical positions on the reactor area fence (see Figure V-2). One type of TLD monitor is supplied and interpreted by our vendor, Radiation Detection Company (R.D. Co.), Mt. View, California. The vendor supplied system utilizes $CaSO_4$ TLD's prepackaged by R.D. Co., and exchanged on a quarterly basis. These dosimeters replace the R.D. Co. beta-gamma-neutron film packs previously used on the reactor area fence. The R.D. Co. TLD's are located in the same thin sheet metal boxes previously used to house the film packs, and are accompanied at each location by the second TLD monitoring package which is prepared and interpreted by OSU. Each OSU TLD monitoring device normally consists of three lithium fluoride chips, presently Harshaw TLD-700's, exchanged on a quarterly basis.

Prior to April 1976, each onsite group of three OSU TLD chips was packaged first in a plastic mount which was then placed inside an outer container consisting of a thin walled copper tube. The copper tube was subsequently taped to the reactor area fence. The plastic mount and copper container were essentially identical to those presently being used by the Oregon Radiation Control Section in their TLD program. In April 1976, the copper tube outer containers were discontinued for the OSU supplied TLD's on the reactor area fence, and the remaining inner plastic mounts were placed inside thin sheet metal boxes located at each of the reactor area fence monitoring stations. This was done to reduce data loss due to increasing theft of the small copper tube TLD packs. OSU and R.D. Co. TLD packs are currently located at each of the nine reactor area fence positions identified in Figure V-2.

In addition to the above monitoring devices, each of the nine reactor area fence monitoring positions is presently equipped with two 0-200 mrem gamma-sensitive integrating ionization chambers (self-reading pocket dosimeter type). These dosimeters are located inside the thin sheet metal box at each fence monitoring station, which also contains the two different TLD monitoring packets. The ionization chamber dosimeters are read every two weeks and are used as backup monitors for each station.

For the July 1, 1978 through June 30, 1979 reporting period, an additional onsite environmental monitoring program was conducted. This program involved the bi-weekly (every 2 weeks) measurement of the direct radiation exposure rate in terms of microroentgens per hour (μR/hr) at each reactor fence monitoring station. Measurements were taken with an Eberline Instrument Co. micro-R per hour rate meter containing a 1" x 1" NaI detector. The 26 annual readings were then averaged and ultimately converted to an expected (calculated) annual mrem dose equivalent for each location.

In terms of environmental monitoring, onsite area monitoring films, TLD's, integrating ionization chambers, and direct radiation exposure rate measurements at appropriate locations may be used to estimate maximum potential doses in nearby unrestricted areas due to direct radiation from the reactor facility. Normally, these estimates are made to reflect the annual dose equivalent which could be delivered in the unrestricted area assuming continuous occupancy, although occupancy of unrestricted areas adjacent to the reactor facility is virtually zero throughout the year.

The routine analysis of gross radioactivity in liquid effluents (with isotopic identification as appropriate) prior to discharge into the unrestricted

area allows evaluation of the reactor facility contribution to potential radiation exposures to the general public from this source.

2. The Offsite Environmental Monitoring Systems

Offsite environmental monitoring systems useful as indicators of potential radiation dose in unrestricted areas due to reactor operations include a soil, water, and vegetation monitoring program, and an airborne gamma monitoring program.

The soil, water, and vegetation monitoring program centers around the collection of a limited number of samples in each category on a quarterly basis. It is operated in conjunction with the reactor facility and the OSU Radiation Center, and considered useful for indicating general trends in gross radioactivity concentrations for the substances sampled. See Figure V-3 for the location of sampling positions for G-Grass, S-Soil, W-Water, and RW-Rain Water.

The airborne gamma monitoring program is generally described on pages 4-59 and 4-60 of the August 1968 Safety Analysis Report for the OSU TRIGA Reactor. As of January 1, 1975, nine additional offsite airborne gamma monitoring stations were implemented to increase the total number of these stations now in use to nineteen. See Figure V-3 for the location of the nineteen airborne gamma monitoring stations.

As of January 1, 1975, the coding technique used to designate each specific offsite monitoring station was modified slightly to indicate the radiation monitoring devices present at a particular station. Under the new coding system, stations which contain only a standard OSU TLD monitoring pack (described previously in this report) will have an "L" after the station number. For example, MRCTE-2L is interpreted as Monitor Radiation Center TRIGA Environmental Station number 2 with a standard OSU TLD pack in a copper tube being the only monitoring device at this station. (NOTE: The copper tube outer container is still used for all OSU TLD packs employed in the offsite environmental monitoring program. They were discontinued only for the OSU TLD's used on the reactor area fence). At offsite stations where only an OSU TLD monitor is used, the copper tube containing the TLD's is taped directly onto a mounting post or other permanent object used to identify the monitoring station. Stations which have no "L" after the station number consist of a thin weather-tight aluminum box mounted on a post about four feet off the ground. Each of these stations include one R.D. Co. TLD pack, one standard OSU copper tube TLD monitoring pack identical to those previously described, and two 0-200 mrem gamma-sensitive integrating ionization chambers (self-reading pocket dosimeter type) as backup monitors. At these stations,

the OSU TLD's are not enclosed inside the aluminum box, but instead the copper tube is taped directly onto the box mounting post at the station. All TLD monitors in the offsite airborne gamma environmental monitoring program are exchanged on a quarterly interval beginning January 1 of each year. The ionization chamber (dosimeters) are read once every 2 weeks throughout the year.

For the July 1, 1978 through June 30, 1979 reporting period, the previously described program for biweekly measurements of the direct radiation exposure rate in μR/hr at each reactor fence monitoring station was extended to include each of the nineteen airborne gamma monitoring stations. The data was handled in the same manner as already mentioned and the objective was to derive an expected (calculated) annual mrem dose equivalent for each location based on an annual average μR/hr exposure rate.

A summary of the environmental monitoring results for the year July 1, 1978 through June 30, 1979 is given below, and includes, as appropriate for the measurement under consideration:

(a) The number of sampling locations.

(b) The total number of samples per year.

(c) The annual average concentration of gross radioactivity, and in some cases, concentrations of specific radionuclides in the medium being assayed.

(d) The total annual millirem of external radiation dose for a particular location as well as a general description of that location.

The data from the environmental monitoring systems will be arranged to correspond to the specific individual systems identified previously in conjunction with onsite and offsite programs.

Reactor Facility Stack Monitor, (onsite):

(a) The system has one sampling location as indicated previously.

(b) Samples are continuous; (i.e., prior to, during, and after reactor operation). It is normal for the stack monitor to begin operation as one of the first systems in the morning and to cease operation as one of the last systems at the end of a normal operating day.

(c) The annual average concentration of gross radioactivity based on the facility stack monitor is given in Table V-2. As indicated in this table, the only gaseous component identified has been Argon-41,

and only naturally occurring particulate activity (radon daughter products) has been detected by the particulate channel. The normal concentration for the naturally occurring particulate daughters during the reporting period remained about the same as in previous years, and was within a range of 3.76×10^{-10} μCi/cc to 8.60×10^{-12} μCi/cc.

Reactor Facility Area Monitoring Film Badges, Reactor Fence TLD's, Integrating Ionization Chambers and Direct Radiation Measurements (onsite):

(a) There are presently eight applicable area monitoring film badges within the TRIGA reactor facility operating-area. There are also nine vendor (R.D. Co.) supplied $CaSO_4$ TLD monitors plus nine standard OSU TLD monitoring packs and eighteen (2 per station) 0-200 mrem gamma-sensitive integrating ionization chambers on the reactor area fence. There are also nine specific locations (the fence monitoring stations) where routine biweekly μR/hr measurements are made. All of these have application as onsite environmental monitors.

(b) Since each film badge within the TRIGA facility is changed once per month, there is a total of 96 different samples of this type each year. Quarterly changes of the fence TLD monitors result in another 36 vendor supplied TLD samples and 108 OSU TLD samples (9 stations x 3 TLD chips per station x 4 changes per year = 108 samples) for these locations each year. The eighteen integrating ionization chambers are read once every two weeks and thus result in approximately 468 samples (readings) each year. There are a total of 26 μR/hr measurements made at each of the nine fence monitoring stations each year for a total of 234 such measurements annually.

(c) TRIGA internal sampling locations are identified in Figure V-1, with film badges being located on the inside of the indicated walls at approximately head height above the floor. Locations of the film badges are coded Monitor Radiation Center TRIGA, North badge, East wall (MRCTNE) and so on. Locations for the TRIGA internal film badges plus the locations of the fence monitors are shown in

Figure V-2. Fence monitoring locations are coded Monitor Radiation Center Fence Environmental-1 (MRCFE-1) and so on through MRCFE-9. TLD monitors on the fence are in sealed moisture-resistant packages inside thin sheet metal mailboxes about four feet off the ground. The integrating ionization chambers are also contained in the metal boxes. Total annual levels of radiation exposure recorded at the area monitoring locations are given in Tables V-6 and V-7.

Analysis of Reactor Contributed Radioactivity in Liquid Effluents, (onsite):

(a) TRIGA liquid effluent is analyzed before release to a collection point, and is analyzed again in conjunction with other radioactivity prior to discharge from the collection point into the unrestricted area.

(b) The total number of samples were as follows: July 1, 1978 through June 30, 1979 = 1 reactor liquid effluent sample before release to the collection point. July 1, 1978 through June 30, 1979 = 1 reactor liquid effluent sample before release from the collection point to the unrestricted area.

(c) The liquid effluent data for environmental assessment have been summarized for the reporting period in Table V-1. Section V-E-2 of this report also addresses the estimated level of external radiation from radioactivity in liquid effluent.

Soil, Water and Vegetation Monitoring Program, (offsite):

(a) For this program there are now a total of 22 sampling locations: 4 soil locations, 4 water locations (when water is available), and 14 vegetation locations.

(b) Samples (as available) are taken at each location on a quarterly basis. Samples have been collected as follows:

	July 1, 1978 through June 30, 1979
Total number of samples =	86
Total number of soil samples =	16
Total number of water samples* =	14
Total number of vegetation samples =	56

*(Water sampling location 1W was dry on two sampling dates during the year July 1, 1978 through June 30, 1979.)

(c) The annual average concentration of gross beta radioactivity for the offsite environmental soil, water and vegetation samples is given in Table V-8. Identification of specific radionuclides is not routinely carried out as part of this program, but would be conducted if unusual radioactivity levels above natural background were evident. Locations of sampling points relative to the reactor facility are given in Figure V-3, and as shown in this figure, most locations are within a 1000 foot radius of the reactor building. In general, samples are collected over a local area having a radius of about 10 feet at the positions indicated in Figure V-3.

Airborne Gamma Monitoring Program, (offsite):

(a) The offsite airborne gamma monitoring program currently utilizes nineteen stations and each station is considered a sampling location. Presently, eleven stations have a vendor (R.D. Co.) supplied $CaSO_4$ TLD monitor, plus a standard OSU TLD monitoring pack, and two 0-200 mrem gamma pocket dosimeters. Eight stations have only a standard OSU TLD monitoring pack. In addition, each of the nineteen monitoring stations is included in the ongoing program for measurement of the μR/hr exposure rate.

(b) The TLD's at each airborne gamma monitoring station are changed once every calendar quarter for a total of 44 vendor TLD samples per year, and a total of 228 OSU TLD samples per year (19 stations x 3 TLD chips per station x 4 changes per year = 228 samples). The two backup monitors (integrating ionization chamber dosimeters) are read every two weeks, which results in approximately 572 individual dosimeter readings each year. There are a total of 26 μR/hr measurements made at each of the nineteen airborne gamma monitoring stations each year for a total of 494 individual measurements annually.

(c) Locations of the nineteen airborne gamma monitoring stations are shown in Table V-3. Like the soil, water, and vegetation sampling locations, most of the airborne gamma monitoring stations are within a 1000 foot radius of the reactor building. These locations generally correspond to the atmosphere (plume) dispersion results mentioned earlier in this report.

The results reported for the airborne gamma monitoring stations are summarized in Table V-9, and are based on the vendor supplied TLD data, the OSU TLD data,

and results obtained from the μR/hr measurements. See footnote (8) of Table V-9 for a further explanation of the μR/hr data and its application.

This is the second complete year for the vendor supplied TLD monitors, which were substituted for the previous vendor supplied environmental film packs. As already indicated in the next to the last paragraph of section E-1 of this report, OSU is still somewhat reluctant to accept the R.D. Co. TLD data without greater confidence in their QA and control procedures. As mentioned, we plan to continue a careful assessment of our program in this area to ascertain whether our suspicions are real or not. Future reports will hopefully show closer agreement between the OSU and R.D. Co. TLD results, or will provide data allowing one to state more clearly the reasons for the differences.

Our in-house OSU TLD program was started in 1974 and we believe a number of improvements have been made in the program since that time. There are, however, a few aspects which we continue to improve and some which may still require added refinement. In particular, we are still continuing to study our reported TLD background for the airborne gamma monitoring stations, and still do not believe reported values are always representative of what most stations are experiencing. We increased the number of background stations during 1976, and

between July 1, 1978 and June 30, 1979 we continued to make a series of direct background measurements with our μR/hr monitoring equipment (started July 1, 1977) in order to obtain a better profile of the background variation. The results have increased our faith in our background values, but we plan to continue studying this variable.

From our viewpoint, the major purpose of the airborne gamma monitoring stations is to give an indication of general increases or trends in unrestricted area radiation levels which might be linked to Argon-41 released from the OSU TRIGA. Past experience (over the last nine years) has shown that annual results per location vary slightly from year to year. Although the data have not been included in this report, by following the mrem per year history for a single station and comparing the annual mrem total to the curies of Argon-41 emitted for the corresponding year, it becomes evident that there is no consistent pattern to the results, and that other factors must be responsible for the minor mrem per year variations. For example, such variations may be the result of small annual differences in cosmic or terrestrial background, fallout, etc. In any event, the small amount of Argon-41 released annually does not seem to be a significant factor in determining the total mrem per year reported for any particular monitoring

station. A comparison of the data contained in Table V-9 to past results from these monitoring stations and to the values in footnote (8) of Table V-9 leads us to the conclusion that there has been no meaningful increase in the unrestricted area gamma radiation levels due to Argon-41 released by the OSU TRIGA during the defined reporting period.

References

1. Eisenbud, Merril, Environmental Radioactivity, Second Edition, p. 190, Academic Press, New York, NY (1973).

2. U.S. Environmental Protection Agency, "Estimates of Ionizing Radiation Doses in the United States, 1960-2000," ORP/CSD 72-1, Office of Radiation Programs, Rockville, Maryland (1972).

3. U.S. Environmental Protection Agency, "Radiological Quality of the Environment in the United States, 1977," EPA 520/1-77-009, Office of Radiation Programs; Washington, D.C. 20460 (1977).

Table V-1

MONTHLY SUMMARY OF LIQUID WASTE DISCHARGES
FOR THE YEAR JULY 1, 1978 THROUGH JUNE 30, 1979[1]

Date of Discharge (month)	Total Quantity of Radioactivity Released (to sanitary sewer) (curies)	Detectable Radionuclides in the Waste	Specific Activity for Each Radioactive Material in Waste Discharge Where Released Concentration After Dilution was > 1.0×10^{-7} μCi/cc (μCi/cc)	Total Curies of Each Detectable Radionuclide Released in the Waste (curies)	Average Concentration of Released Radioactive Material at Point of Release (to sanitary sewer) (μCi/cc)	Percent of Applicable MPC for Released Radioactive Material (%)	Total Volume of Effluent, Including Diluent Released (to sanitary sewer) (gallons)
July-78	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
August-78	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
September-78	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
October-78	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
November-78	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
December-78	2.30×10^{-5}	^{51}Cr ^{54}Mn ^{58}Co ^{60}Co ^{3}H	---------- ---------- ---------- ---------- 2.26×10^{-6}	2.21×10^{-8} 3.58×10^{-8} 4.87×10^{-8} 4.48×10^{-7} 2.24×10^{-5}	2.32×10^{-6}	0.174	2620
January-79	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
February-79	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
March-79	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
April-79	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
May-79	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
June-79	NONE	NONE	NOT APPLICABLE	NONE	NOT APPLICABLE	NOT APPLICABLE	NONE
Annual Value	2.30×10^{-5}	SEE ABOVE	NOT APPLICABLE	2.30×10^{-5}	2.32×10^{-6}	0.174	2620[2]

(1) The OSU operational policy is to subtract only detector background from our water analysis data and not background radioactivity in the Corvallis city water.

(2) Total volume of effluent plus diluent does not take into consideration the additional mixing with approximately 95,000 to 115,000 gallons per year of liquids and sewage normally discharged by the Radiation Center complex into the same sanitary sewer system.

Table V-2

MONTHLY SUMMARY OF GASEOUS WASTE DISCHARGES FOR THE YEAR

JULY 1, 1978 THROUGH JUNE 30, 1979

Date of Discharge (Month)	Total Estimated Radioactivity Released (Curies)	Total Estimated Quantity of Argon-41 Released[1] (Curies)	Estimated Average Atmospheric Diluted Concentration of Argon-41 at Point of Release (reactor stack) (μCi/cc)	Percent of the Applicable MPC for Diluted Concentration of Argon-41 at Point of Release (reactor stack) (%)	Total Estimated Quantity of Radioactivity in Particulate Form with Half-Life >8 Days[2] (Curies)	Average Concentration of Radioactive Particulates Released With Half-Life >8 Days (Curies)	Estimated Average Concentration of Other Significant Radionuclides in Discharge if >20% of the Applicable MPC (μCi/cc)	Percent of MPC if the Estimated Release was >20% of the Applicable MPC
July-78	1.57	1.57	1.03×10^{-7}	2.58	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
August-78	1.04	1.04	6.83×10^{-8}	1.71	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
September-78	1.53	1.53	1.04×10^{-7}	2.60	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
October-78	0.52	0.52	3.44×10^{-8}	0.86	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
November-78	0.17	0.17	1.19×10^{-8}	0.30	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
December-78	0.90	0.90	5.91×10^{-8}	1.48	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
January-79	0.62	0.62	4.11×10^{-8}	1.03	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
February-79	0.97	0.97	7.08×10^{-8}	1.77	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
March-79	0.29	0.29	1.96×10^{-8}	0.49	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
April-79	1.89	1.89	1.29×10^{-7}	3.22	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
May-79	0.54	0.54	3.57×10^{-8}	0.89	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
June-79	0.58	0.58	3.92×10^{-8}	0.98	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE
Annual Value	10.62	10.62	5.97×10^{-8}	1.49	NONE	NOT APPLICABLE	NOT APPLICABLE	NOT APPLICABLE

(1) Routine gamma spectroscopy evaluation of the gaseous radioactivity in the stack discharge indicated that it was virtually all Argon-41.

(2) Evaluation of the particulate radioactivity in the stack discharge confirmed its origin as naturally occurring radon daughter products, predominantly lead-214 and bismuth-214, not associated with reactor operations.

Table V-3

ANNUAL SUMMARY OF SOLID WASTE DISCHARGES
FOR THE YEAR JULY 1, 1978 THROUGH JUNE 30, 1979

Total Amount of Solid Waste Packaged (cubic feet)	Detectable Radionuclides in the Waste	Total Quantity of Radioactivity in Solid Waste (curies)	Dates of Shipment and Disposition(1)
9.50	Cobalt-60	6.51×10^{-4}	December 12, 1978
	Iron-59		May 22, 1979
	Sodium-24		
	Manganese-56		
	Chromium-51		
	Selenium-75		

(1) All solid waste is transferred to our waste disposal service vendor, Nuclear Engineering Company, for burial at their installation at Richland, Washington. Transfer takes place at Oregon State University, Radiation Center, Corvallis, Oregon.

Table V-4

ANNUAL SUMMARY OF RADIATION EXPOSURE RECEIVED
BY FACILITY PERSONNEL AND VISITORS FOR THE
YEAR JULY 1, 1978 THROUGH JUNE 30, 1979

Personnel Group	Average Annual Exposure for Each Personnel Group		Greatest Individual Exposure per Personnel Group	
	Whole Body (mRem)	Extremities (mRem)	Whole Body (mRem)	Extremities (mRem)
Facility Operating Personnel	8.00	208.00	30.00	680.00
Key Facility Research Personnel	0.00	82.00	0.00	450.00
Facility Visitors:				
Film Badges	0.00	(1)	0.00	(1)
Pocket Dosimeters	1.00	(1)	25.00	(1)

(1) OSU TRIGA reactor policy does not normally allow people in the visitor category to become actively involved in the use or handling of radiation or radioactive materials. Therefore, extremity dosimeters are not normally necessary and no visitor data are available for extremities.

Table V-5

ANNUAL SUMMARY OF RADIATION LEVELS AND
CONTAMINATION LEVELS OBSERVED DURING
ROUTINE RADIATION SURVEYS FOR THE
YEAR JULY 1, 1978 THROUGH JUNE 30, 1979

Location	Direct Radiation Levels (mRem/hr)($\beta\gamma$+neutrons)				Contamination Levels (dpm/100 cm^2)($\beta\gamma$)(1)			
	Average		Maximum		Average		Maximum	
Reactor Top	< 1.00		100.00		≤ 370		≤ 370	
Sample Handling Area	< 1.00		100.00		≤ 370		≤ 370	
Reactor Room Floor	< 1.00		50.00		≤ 370		≤ 370	
Beam Port Facilities	< 1.00		50.00		≤ 370		≤ 370	
Demineralizer Tank	Outside Shield		Inside Shield		Outside Shield		Inside Shield	
	Avg.	Max.	Avg.	Max.	Avg.	Max.	Avg.	Max.
	<1.00	10.00	5.00	75.00	(2)	(2)	≤ 370	≤ 370
Class Experiments	≤ 1.00		215.00		≤ 370		≤ 370	

(1)No contamination was found at the designated locations during the entire reporting period. The 370 dpm/100 cm^2 value used in this table is based on the normal beta efficiency and a net count rate equal to the normal background counting rate for the portable survey meters routinely used in the field to screen for radioactive contamination (i.e., field measurements would normally have to show a gross counting rate equal to twice the normal background counting rate before contamination would be considered present). However, in addition to normal field screening, smears suspected of containing removable radioactive contamination are routinely counted in a more sensitive radiation detection system. Based on usual counting times, a normal instrument counting efficiency and a normal background counting rate, during the current reporting period such a detection system typically provided a lower limit of detection (LLD) at 95% confidence of approximately 11-12 dpm for the radionuclides normally expected to be on the smears. Smearing efficiency for radioactivity removal is conservatively assumed to be ∿10%, and positive smear results would usually be multiplied by 10 before final conversion to dpm/100 cm^2.

(2)Not an applicable measurement.

Figure V-1

OPERATING-AREA FILM BADGE MONITOR LOCATIONS FOR THE TRIGA REACTOR

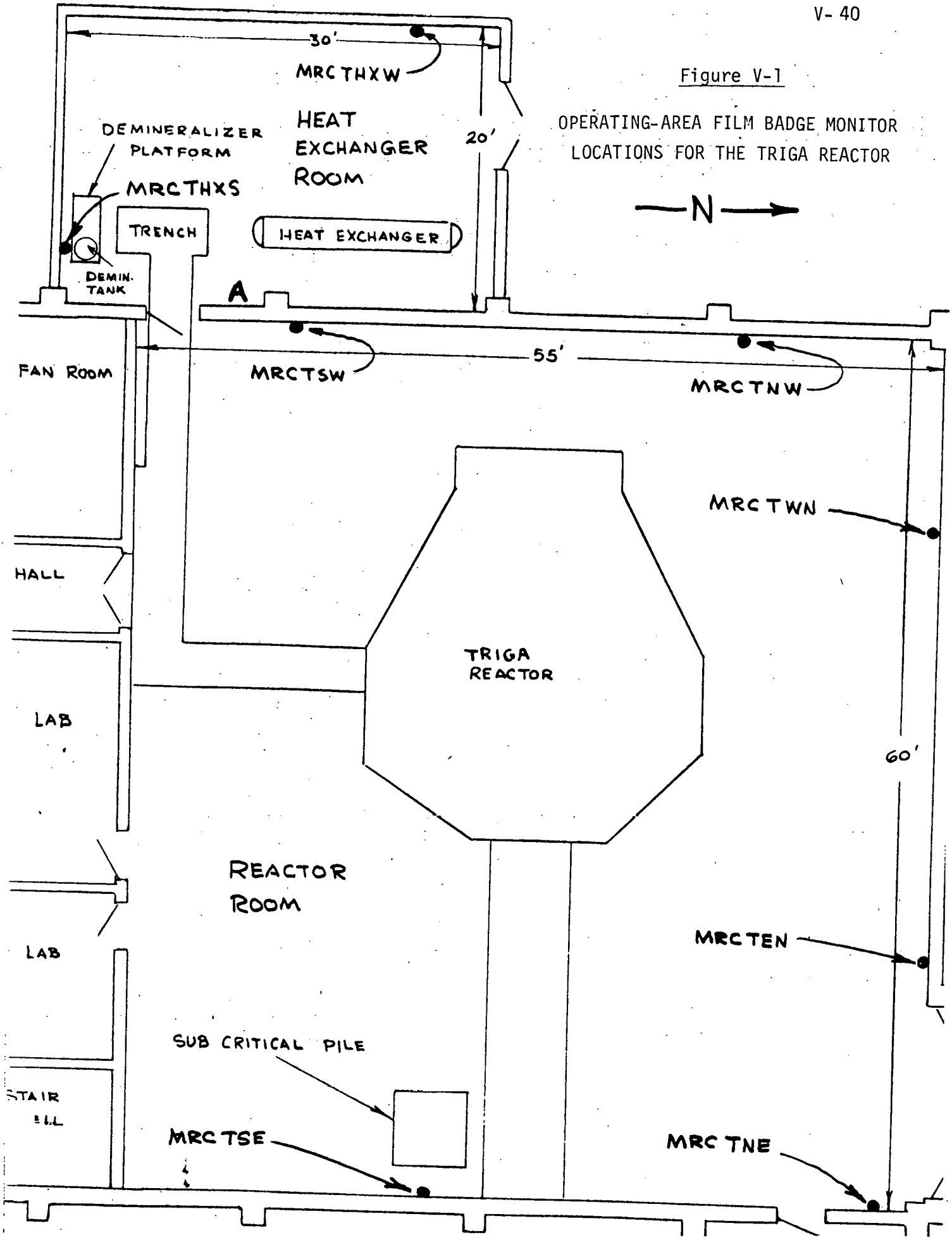


Figure V-2

AREA RADIATION MONITOR LOCATIONS FOR THE
TRIGA AND AGN REACTORS, AND THE TRIGA REACTOR AREA FENCE

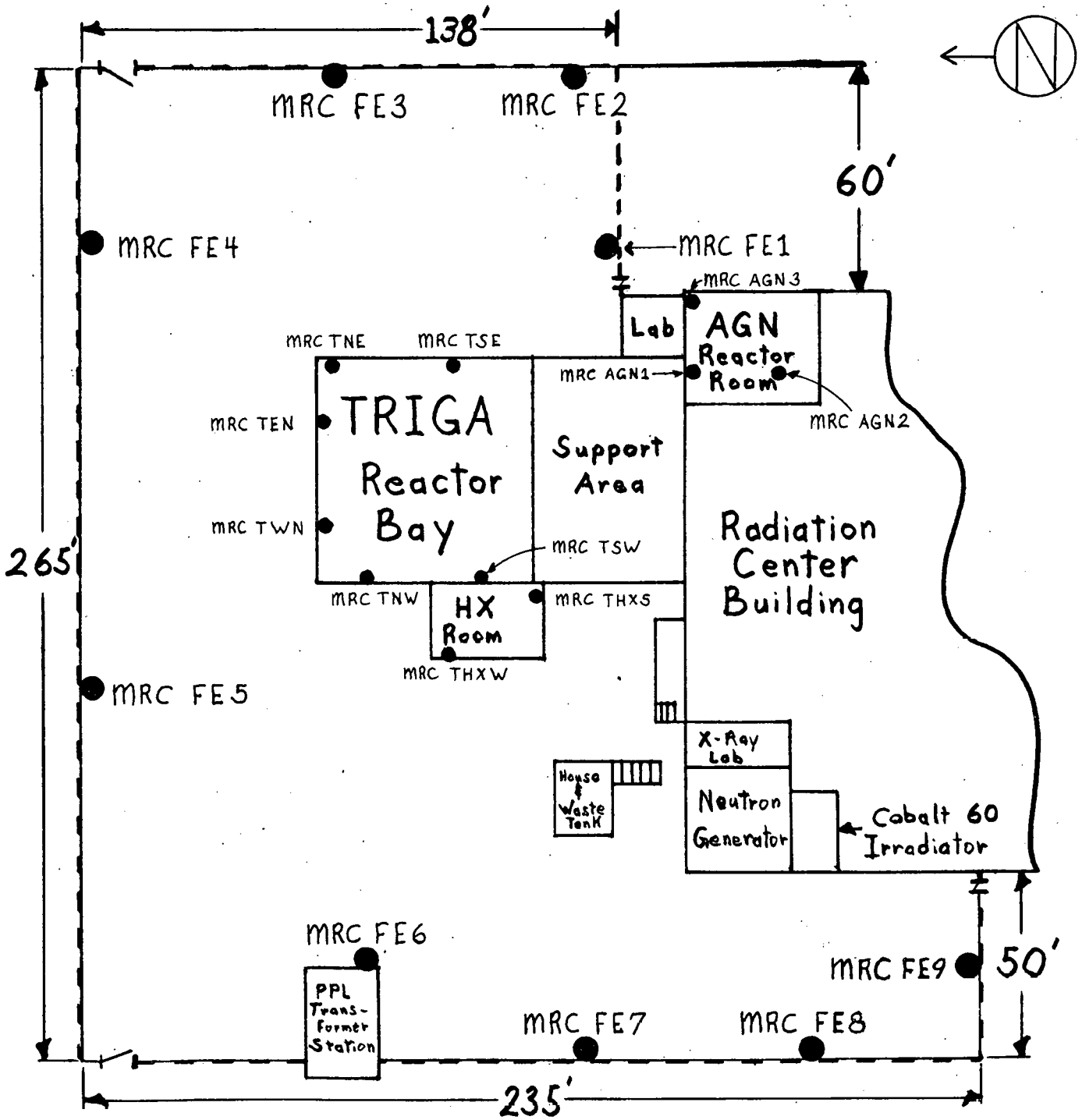


Table V-6

TOTAL DOSE EQUIVALENT RECORDED ON OPERATING-AREA FILM BADGE MONITORS LOCATED INSIDE THE TRIGA REACTOR FACILITY FOR THE YEAR JULY 1, 1978 THROUGH JUNE 30, 1979

Location(1)	Total Recorded mRem for the Year July 1, 1978 Through June 30, 1979(2)(5)
MRCTNE	0
MRCTSE	0(3)
MRCTSW	0
MRCTNW	15
MRCTWN	0
MRCTEN	0
MRCTHXS	0(4)
MRCTHXW	0

(1)These locations do not represent radiation exposure through an exterior wall directly into an unrestricted area.

(2)Totals do not include natural background contribution.

(3)Film badge opposite subcritical pile. Shield for subcritical pile completed February 23, 1972.

(4)Film badge opposite particulate filter for reactor primary water cleanup system. Shield around this filter was completed July 10, 1972.

(5)These area film badge monitors are exchanged on a monthly interval, and the total mRem value reflects the summation of results from 12 different film packets.

Table V-7

TOTAL DOSE EQUIVALENT AT THE TRIGA
REACTOR AREA FENCE FOR THE YEAR
JULY 1, 1978 THROUGH JUNE 30, 1979

Location(1)	Total Recorded mRem for the Year July 1, 1978 Through June 30, 1979 Based on R.D. Co. TLD's (8)	Total Recorded mRem for the Year July 1, 1978 Through June 30, 1979 Based on OSU TLD's (3)(4)(8)		Total Calculated mRem for the Year July 1, 1978 Through June 30, 1979 Based on the Annual Average μR/hr Exposure Rate Measured at Each Location(4)(7)
MRCFE-1	124.0	54.0 ± 9.7(5)	72.0 ± 11.0(6)	71.0 ± 20.0
MRCFE-2	140.0	57.0 ± 13.9	76.0 ± 15.4	75.0 ± 17.0
MRCFE-3	146.0	49.0 ± 15.1	65.0 ± 16.3	74.0 ± 20.0
MRCFE-4	137.0	47.0 ± 9.2	63.0 ± 10.4	77.0 ± 22.0
MRCFE-5	138.0	44.0 ± 10.6	59.0 ± 11.8	62.0 ± 22.0
MRCFE-6	130.0	51.0 ± 16.2	68.0 ± 17.9	63.0 ± 28.0
MRCFE-7	124.0	53.0 ± 13.2	71.0 ± 14.6	68.0 ± 23.0
MRCFE-8	126.0	60.0 ± 8.7	80.0 ± 9.8	63.0 ± 14.0
MRCFE-9	135.0	48.0 ± 9.6	64.0 ± 10.9	64.0 ± 15.0

(1) The TRIGA reactor area fence was installed September 15, 1972.

(2) Radiation Detection Company (R.D. Co.), Mt. View, California, TLD totals include an annual natural background contribution of 115.0 mRem for the reporting period.

(3) OSU fence TLD totals include a measured three calendar quarter natural background contribution of 52.0 ± 13.1 mRem for data in the left column (see footnote 5), and a calculated four calendar quarter annual natural background contribution of 70.0 ± 14.9 mRem for data in the right column (see footnotes 5 and 6).

(4) ± values represent the standard deviation at the 95% confidence level.

(5) Total mRem values shown in this column are based on data from only three calendar quarters. During the 1978-79 reporting period, one quarter's data (the third quarter of 1978, which is the first quarter of the current reporting period) were completely invalidated due to TLD equipment malfunction.

(6) Total mRem values shown in this column are estimated annual (four calendar quarter) values for each location. The estimated values were derived by summing the three quarters of measured data and a fourth value obtained by averaging the three quarters of measured data. The latter value (the average of the three measured quarters) was used to represent the best estimate of the missing quarter's data for the 1978-79 reporting period.

(7) The annual average microroentgen (μR) per hour exposure rate for each location was determined by averaging 26 separate μR/hr measurements taken at 2 week intervals throughout the year. The total mRem for the period was calculated by multiplying this average μR/hr value by 8760 hours per year and then converting microroentgens to millirem. Normal μR/hr values for the U.S. (terrestrial plus cosmic radiation) range between about 7.0 and 11.0 μR/hr (Ref. 1)(excluding areas of unusually high natural radioactivity). These exposure rates correspond to annual dose equivalent totals of about 59 to 93 mRem per year. The U.S. EPA (Ref. 2,3) estimates the total annual terrestrial plus cosmic dose equivalent for Oregon to be about 110 mRem per year.

(8) TLD monitoring packets are exchanged on a quarterly interval.

FIGURE V-3
MONITORING STATIONS FOR THE OSU TRIGA REACTOR, JANUARY 6, 1976 THROUGH JUNE 30, 1979

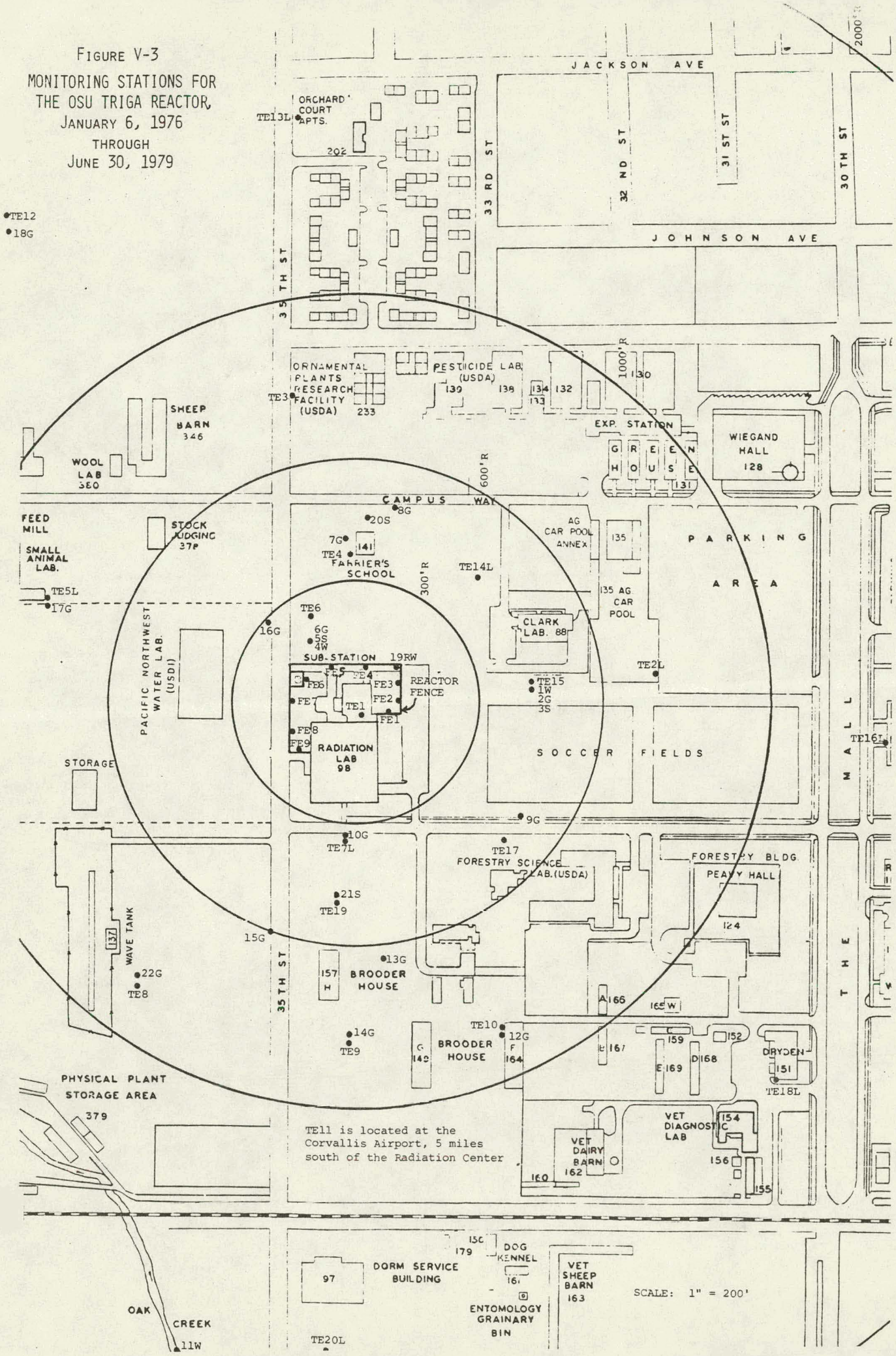


Table V-8

ANNUAL AVERAGE CONCENTRATIONS OF GROSS BETA RADIOACTIVITY FOR OFFSITE ENVIRONMENTAL SOIL, WATER, AND VEGETATION SAMPLES FOR THE YEAR JULY 1, 1978 THROUGH JUNE 30, 1979

Sample Identification Number, Type & Reporting Units	Annual Average Concentration of Gross Beta Radioactivity (minus ^{3}H)(1)(2)(3)
1-water (μCi/cc)	$5.01 \times 10^{-8} \pm 2.28 \times 10^{-8}$(4)
4-water (μCi/cc)	$1.12 \times 10^{-7} \pm 4.17 \times 10^{-8}$
11-water (μCi/cc)	$7.18 \times 10^{-8} \pm 1.67 \times 10^{-8}$
19-rainwater (μCi/cc)	$6.27 \times 10^{-8} \pm 1.75 \times 10^{-8}$
3-soil ($\frac{\mu Ci}{\text{gram of dry soil}}$)	$5.43 \times 10^{-5} \pm 2.33 \times 10^{-6}$
5-soil ($\frac{\mu Ci}{\text{gram of dry soil}}$)	$4.44 \times 10^{-5} \pm 2.00 \times 10^{-6}$
20-soil ($\frac{\mu Ci}{\text{gram of dry soil}}$)	$5.26 \times 10^{-5} \pm 2.15 \times 10^{-6}$
21-soil ($\frac{\mu Ci}{\text{gram of dry soil}}$)	$6.90 \times 10^{-5} \pm 2.87 \times 10^{-6}$
2-grass ($\frac{\mu Ci}{\text{gram of dry ash}}$)	$1.28 \times 10^{-4} \pm 2.72 \times 10^{-6}$
6-grass ($\frac{\mu Ci}{\text{gram of dry ash}}$)	$9.31 \times 10^{-5} \pm 2.98 \times 10^{-6}$
7-grass ($\frac{\mu Ci}{\text{gram of dry ash}}$)	$1.67 \times 10^{-4} \pm 2.86 \times 10^{-6}$

Sample Identification Number, Type & Reporting Units	Annual Average Concentration of Gross Beta Radioactivity (minus ^{3}H)(1)(2)(3)
8-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$1.41 \times 10^{-4} \pm 2.75 \times 10^{-6}$
9-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$1.20 \times 10^{-4} \pm 2.34 \times 10^{-6}$
10-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$1.48 \times 10^{-4} \pm 3.15 \times 10^{-6}$
12-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$1.49 \times 10^{-4} \pm 2.76 \times 10^{-6}$
13-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$1.26 \times 10^{-4} \pm 2.92 \times 10^{-6}$
14-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$9.59 \times 10^{-5} \pm 2.85 \times 10^{-6}$
15-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$9.11 \times 10^{-5} \pm 2.38 \times 10^{-6}$
16-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$9.03 \times 10^{-5} \pm 2.53 \times 10^{-6}$
17-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$1.46 \times 10^{-4} \pm 2.88 \times 10^{-6}$
18-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$1.57 \times 10^{-4} \pm 2.96 \times 10^{-6}$
22-grass ($\frac{\mu Ci}{gram\ of\ dry\ ash}$)	$1.76 \times 10^{-4} \pm 3.29 \times 10^{-6}$

(1)$\pm$ values represent the standard deviation at the 95% confidence level.

(2)Annual average concentrations were calculated using sample results which exceeded the lower limit of detection (LLD), except that sample results which were $\leq$ the LLD were averaged in at the corresponding LLD concentration.

(3)For this report, the lower limit of detection (LLD) has been defined as the smallest concentration of radioactive material in a sample that has a 95% probability of being detected (4.66 times the standard deviation of the average background value obtained with a blank sample, provided the relative standard deviation of the background [the coefficient of variation] is less than 25%). For the year July 1, 1978 through June 30, 1979, the LLD for gross β in water samples averaged 2.20×10^{-8} μCi/cc and ranged between 2.37×10^{-8} μCi/cc and 2.02×10^{-8} μCi/cc. For gross β in vegetation samples the LLD averaged 5.70×10^{-6} μCi/gm and ranged between 1.12×10^{-5} μCi/gm and 8.97×10^{-6} μCi/gm. For gross β in soil samples the LLD averaged 5.77×10^{-6} μCi/gm and ranged between 1.20×10^{-5} μCi/gm and 6.13×10^{-6} μCi/gm.

(4)This sample location was dry for two calendar quarters during the reporting period (the third quarter 1978 and the second quarter 1979). Therefore, no samples were collected for these intervals.

Table V-9

ANNUAL TOTALS FOR OFFSITE AIRBORNE GAMMA MONITORING STATIONS FOR THE YEAR JULY 1, 1978 THROUGH JUNE 30, 1979

Monitoring Station	Total Recorded mRem for the Year July 1, 1978 Through June 30, 1979 Based on R.D. Co. TLD's(1)(9)	Total Recorded mRem for the Year July 1, 1978 Through June 30, 1979 Based on Standard OSU TLD's(4)(5)(9)		Total Calculated mRem for the Year July 1, 1978 Through June 30, 1979 Based on the Annual Average µR/hr Exposure Rate Measured at Each Location(5)(8)
MRCTE-2L	-----(2)	63.0 ± 3.6(6)	84.0 ± 4.1(7)	62.0 ± 22.0
MRCTE-3	138.0(3)	65.0 ±10.2	87.0 ±11.5	76.0 ± 12.0
MRCTE-4	133.0	63.0 ± 5.6	84.0 ± 6.5	70.0 ± 15.0
MRCTE-5L	-----	64.0 ± 8.0	85.0 ± 9.1	73.0 ± 18.0
MRCTE-6	150.0	68.0 ± 5.4	91.0 ± 6.2	79.0 ± 16.0
MRCTE-7L	-----	75.0 ±11.7	100.0 ±13.2	75.0 ± 16.0
MRCTE-8	138.0	75.0 ± 6.0	100.0 ± 6.7	80.0 ± 20.0
MRCTE-9	152.0	65.0 ± 6.2	87.0 ± 7.0	86.0 ± 29.0
MRCTE-10	136.0	59.0 ± 6.4	79.0 ± 7.3	66.0 ± 16.0
MRCTE-11	119.0	52.0 ± 6.1	69.0 ± 7.1	60.0 ± 16.0
MRCTE-12	150.0	60.0 ± 4.7	80.0 ± 5.4	86.0 ± 19.0
MRCTE-13L	-----	60.0 ± 8.1	80.0 ± 8.9	70.0 ± 17.0
MRCTE-14L	-----	63.0 ± 4.4	84.0 ± 5.0	75.0 ± 21.0
MRCTE-15	140.0	52.0 ±10.0	69.0 ±11.3	82.0 ± 15.0
MRCTE-16L	-----	53.0 ± 6.0	71.0 ± 6.9	77.0 ± 18.0
MRCTE-17	145.0	44.0 ± 7.3	59.0 ± 8.1	68.0 ± 13.0
MRCTE-18L	-----	54.0 ± 8.5	72.0 ± 9.6	69.0 ± 13.0
MRCTE-19	156.0	58.0 ± 8.0	77.0 ± 8.9	83.0 ± 14.0
MRCTE-20L	-----	53.0 ±11.8	71.0 ±13.6	68.0 ± 20.0

(1) Radiation Detection Company (R.D. Co.), Mt. View, California, TLD totals include an annual natural background contribution of 115.0 mRem for the reporting period.

(2) Monitoring stations coded with an "L" contain one standard OSU TLD monitoring pack only. (No. R.D. Co. TLD pack.)

(3) Monitoring stations not coded with an "L" contain one R.D. Co. TLD monitoring pack, two 0-200 mRem gamma pocket dosimeters and one standard OSU TLD monitoring pack.

(4) OSU offsite airborne gamma TLD totals include a measured three calendar quarter natural background contribution of 45.0 ± 11.1 mRem for data in the left column (see footnote 6), and a calculated four calendar quarter annual natural background contribution of 60.0 ± 12.5 mRem for data in the right column (see footnotes 6 and 7).

(5) ± values represent the standard deviation at the 95% confidence level.

(6) Total mRem values shown in this column are based on data from only three calendar quarters. During the 1978-79 reporting period, one quarter's data (the third quarter of 1978, which is the first quarter of the current reporting period) were completely invalidated due to TLD equipment malfunction.

(7) Total mRem values shown in this column are estimated annual (four calendar quarter) values for each location. The estimated values were derived by summing the three quarters of measured data and a fourth value obtained by averaging the three quarters of measured data. The latter value (the average of the three measured quarters) was used to represent the best estimate of missing quarter's data for the 1978-79 reporting period.

(8) The annual average microroentgen (µR) per hour exposure rate for each location was determined by averaging 26 separate µR/hr measurements taken at 2 week intervals throughout the year. The total mRem for the period was calculated by multiplying this average µR/hr value by 8760 hours per year and then converting microroentgens to millirem. Normal µR/hr values for the U.S. (terrestrial plus cosmic radiation) range between about 7.0 and 11.0 µR/hr (Ref. 1)(excluding areas of unusually high natural radioactivity). These exposure rates correspond to annual dose equivalent totals of about 59 to 93 mRem per year. The U.S. EPA (Ref. 2,3) estimates the total annual terrestrial plus cosmic dose equivalent for Oregon to be about 110 mRem per year.

(9) TLD monitoring packets are exchanged on a quarterly interval.