RADIATION CENTER

October 24, 2000

U.S. Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

OREGON
STATE
UNIVERSITY

100 Radiation Center
Corvallis, Oregon
97331-5903

Reference: Oregon State University TRIGA Reactor (OSTR),
Docket No. 50-243, License No. R-106

In accordance with section 6.7.e of the OSTR Technical Specifications, we are hereby submitting the Oregon State University Radiation Center and TRIGA Reactor Annual Report for the period July 1, 1999 through June 30, 2000. Please note that we are also using this letter of transmittal to send copies of the current report to Mr. Al Adams, OSTR Senior Project Manager, USNRC, Washington, DC.

The 1999-2000 Annual Report continues the pattern established over the past few years by including information about the entire Radiation Center rather than concentrating primarily on the reactor. Because the report addresses a number of different interests, it is rather lengthy, but we have incorporated a short executive summary which highlights the Center's activities and accomplishments over the past year.

The executive summary indicates that the Radiation Center has maintained its high degree of productivity this past year. We hope that you will find the current report to be informative and interesting. Should there be any questions, please let me know.

Sincerely,

Steve

Stephen E. Binney
Director

SEB:jms-J:\ANNREPT\Letters 00\NRC letter
Enclosure

Telephone
541-737-2341

Fax
541-737-0480

A020

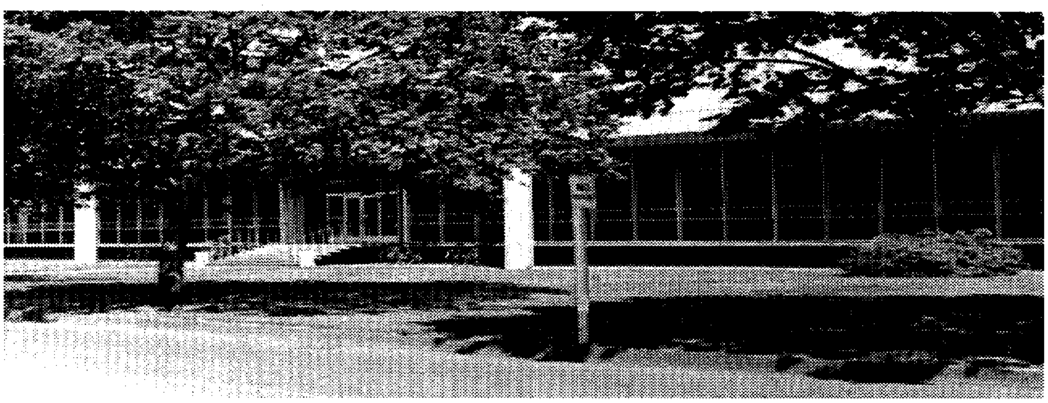
cc w/enclosure:

Mr. Al Adams, Jr., Senior Project Manager, USNRC, MS O11 B20, Washington, DC 20555-0001 (1 copy)
Mr. Craig Bassett, USNRC, 61 Forsyth St. SW, Ste. 23T85, Atlanta, GA 30303 (1 copy)
Mr. Ledyard Marsh, USNRC, MS O12 , Washington, DC 20555-0001 (1 copy)

cc w/out enclosure:

D. Stewart-Smith, Oregon Department of Energy
J. F. Higginbotham, Chairman, OSTR Reactor Operations Committee
A. D. Hall, OSTR Reactor Supervisor, OSU
S. R. Reese, OSTR Reactor Administrator, OSU
D. S. Pratt, Senior Health Physicist, OSU

Oregon State University Radiation Center and TRIGA Reactor



Annual Report

July 1, 1999 - June 30, 2000

Annual Report of the
Oregon State University
Radiation Center and TRIGA Reactor

July 1, 1999 - June 30, 2000

To satisfy the requirements of:

A. U.S. Nuclear Regulatory Commission, License No. R-106 (Docket No. 50-243), Technical Specification 6.7(e).

B. Task Order No. 3, under Subcontract No. C84-110499 (DE-AC07-76ER01953) for University Reactor Fuel Assistance-AR-67-88, issued by EG&G Idaho, Inc.

C. Oregon Office of Energy, OOE Rule No. 345-030-010.

Edited by:

S. E. Binney, Director

With contributions from:

S. E. Binney, Director
K. M. Brock, Health Physicist
S. C. Campbell, Business Manager
M. R. Conrady, Analytical Support Manager
A. D. Hall, Reactor Supervisor
R. A. Keen, Office Coordinator
S. A. Menn, Assistant Health Physicist
D. S. Pratt, Senior Health Physicist
S. R. Reese, Reactor Administrator
L. J. Robinson, Word Processor
E. G. Schütfort, Project Manager
S. P. Smith, Scientific Instrument Technician
J. M. Stueve, Office Coordinator
G. M. Wachs, Senior Reactor Operator

Submitted by:

S. E. Binney
Director, Radiation Center

Radiation Center
Oregon State University
Corvallis, Oregon 97331-5903
Telephone: (541) 737-2341
Fax: (541) 737-0480

October 2000

Annual Report of the
Oregon State University
Radiation Center and TRIGA Reactor

Table of Contents

PART III - FACILITIES

Page

PART IV - REACTOR

LIST OF TABLES

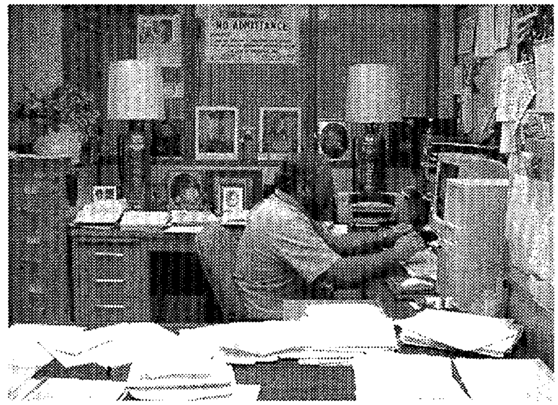
LIST OF TABLES (Continued)

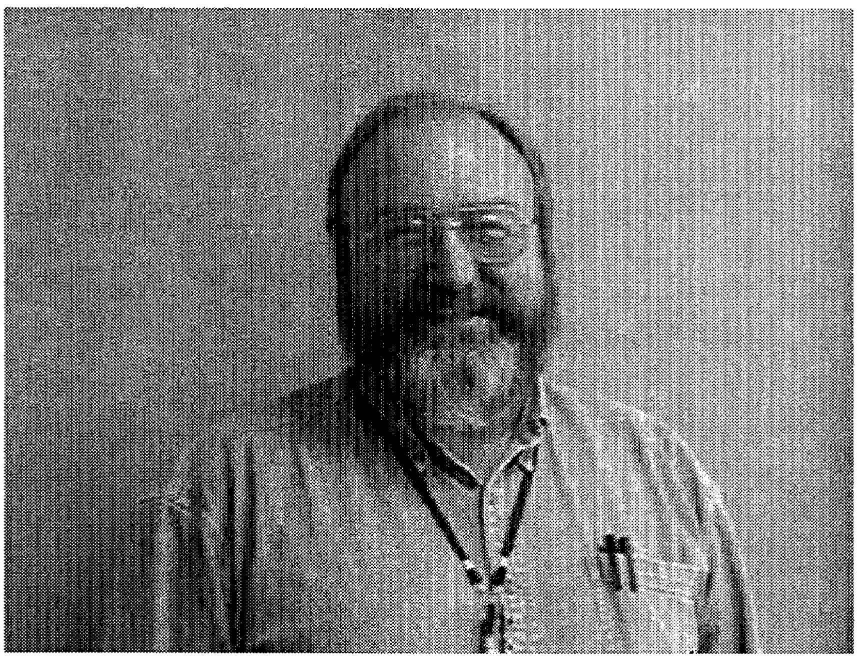
LIST OF TABLES (Continued)

LIST OF FIGURES

Part I

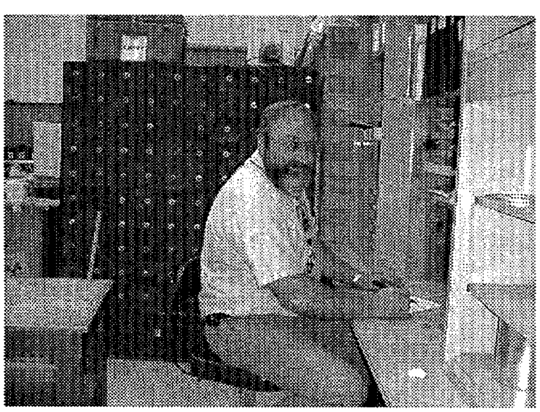
Overview

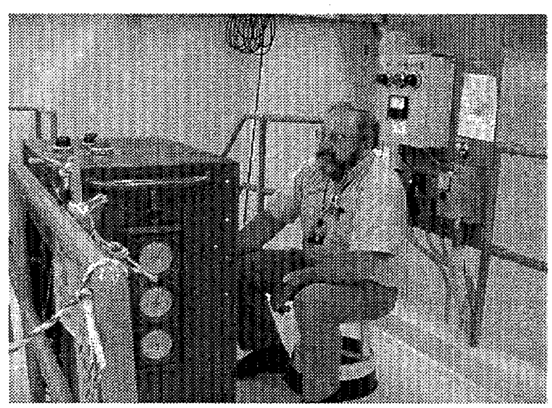




Dave Pratt

Retiring After 19 Glorious Years





Part I

OVERVIEW

A. Acknowledgments

Many individuals and organizations help the Radiation Center succeed, and in recognition of this, the staff of the Oregon State University (OSU) Radiation Center and TRIGA Reactor (OSTR) would like to extend its appreciation to all of those who contributed to the information and events contained in this report: to the University administration; to those who provided our funding, particularly the U. S. Department of Energy (USDOE) and the state of Oregon; to our regulators; to the researchers, the students, and others who used the Radiation Center facilities; to OSU Facilities Services; and to OSU Security Services and the Oregon State Police. We most earnestly say, "Thank you."

The Center would not be able to accomplish all that is shown in this report without the diligent efforts of all of its staff who have all worked hard. It is to their credit that we have managed to improve our level and quality of service. To each one,"Thank you."

Putting this report together each year is a major effort for several people. Only those who have been involved can fully understand what a great job Linda James and Eralee Jordan have done in the data-gathering, organization, and keyboarding of this Annual Report. Thanks, Linda! In addition, Erin Cimbri provided significant help in converting Access database information into word processor documents. Thanks, Erin!

This Annual Report is dedicated to Dave Pratt, Senior Health Physicist at the OSU Radiation Center since 1994. Dave has served faithfully as a member of the health physics staff since 1981. His delicate blend of authoritativeness and friendliness has helped the Radiation Center maintain an excellent radiation protection program while, at the same time, enabling researchers, other faculty, and students to do quality work in an encouraging and productive atmosphere. Thanks, Dave, for your nineteen years with us.

B. Executive Summary

The data from this reporting year show that the use of the Radiation Center and OSTR has continued to grow in many areas.

The Radiation Center supported 99 different courses this year, mostly in the Department of Nuclear Engineering. About one-quarter of these courses involved the OSTR. The number of OSTR hours used for academic courses and training was 790, while 1,021 hours were used for research projects. Eighty-seven percent of the OSTR research hours were in support of off-campus research projects, which reflects the increasing wider use of the OSTR nationally and internationally. Radiation Center users published 78 articles this year, with 25 more submitted for publication. There were also 14 theses completed and 45 presentations made by Radiation Center users. The number of samples irradiated in the reactor during this reporting period was 2,501. Funded OSTR use hours comprised 97% of the research use. This is consistent with the move to a more full cost recovery basis for services provided by the Center.

The OSTR continues to be the facility of choice for many of the $^{39}Ar/^{40}Ar$ and fission track geochronology laboratories around the world.

Personnel at the Radiation Center conducted 113 tours of the facility, accommodating 1,811 visitors. The visitors included elementary, middle school, high school, and college students; relatives and friends; faculty; current and prospective clients; national laboratory and industrial scientists and engineers; and state, federal and international officials. The Radiation Center is a significant positive attraction on campus because visitors leave with a good impression of the facility and of Oregon State University.

Research projects of personnel housed in the Radiation Center totaled approximately $1.5 million for this year.

The Radiation Center projects database continues to provide a useful way of tracking the many different aspects of work at the facility. The number of projects supported this year was 115. Reactor projects comprised 62% of all projects. The total research supported by the Radiation Center, based on 31 user responses, was $1,271,149. The actual total is likely considerably higher. This year the Radiation Center provided service to 86 research faculty and 102 students (for a total of 247 uses of Center facilities) from 64 different institutions, 55% of which were from other states and 14% of which were from outside the U. S. and Canada. So while the Center's primary mission is local, it is also a facility with a national and international clientele.

Furthermore, with the closing of the State of Oregon's environmental radiological monitoring laboratory in Portland, the Radiation Center is essentially now the only place in the state where radiological monitoring can be performed.

The Radiation Center web site provides an easy way for potential users to evaluate the Center's facilities and capabilities as well as to apply for a project and check use charges. The address is: http://www.ne.orst.edu/facilities/radiation_center.

C. Introduction

The current annual report of the Oregon State University Radiation Center and TRIGA Reactor follows the usual format by including information relating to the entire Radiation Center rather than just the reactor. However, the information is still presented in such a manner that data on the reactor may be examined separately, if desired. It should be noted that all annual data given in this report cover the period from July 1, 1999 through June 30,

2000. Cumulative reactor operating data in this report relate only to the FLIP-fueled core. This covers the period from August 1, 1976 through June 30, 2000. For a summary of data on the reactor's original 20% enriched core, the reader is referred to Table IV.A.2 in Part IV of this report or to the 1976-77 Annual Report if a more comprehensive review is needed.

In addition to providing general information about the activities of the Radiation Center, this report is designed to meet the reporting requirements of the U. S. Nuclear Regulatory Commission, the U. S. Department of Energy, and the Oregon Office of Energy. Because of this, the report is divided into several distinct parts so that the reader may easily find the sections of interest.

D. Overview of the Radiation Center

The Radiation Center is a unique facility which serves the entire OSU campus, all other institutions within the Oregon University System, and many other universities and organizations throughout the nation and the world. The Center also regularly provides special services to state and federal agencies, particularly agencies dealing with law enforcement, energy, health, and environmental quality, and renders assistance to Oregon industry. In addition, the Radiation Center provides permanent office and laboratory space for the OSU Department of Nuclear Engineering, the OSU Radiation Safety Office, the OSU Institute of Nuclear Science and Engineering, and for the OSU nuclear chemistry, radiation chemistry, geochemistry and cosmochemistry programs. *There is no other university facility with the combined capabilities of the OSU Radiation Center in the western half of the United States.*

Located in the Radiation Center are major items of specialized equipment and unique teaching and research facilities. Figure I.D.1 shows the layout of these facilities at the Radiation Center. They include a TRIGA Mark II research nuclear reactor; a ^{60}Co gamma irradiator; a large number of state-of-the art computer-based gamma radiation spectrometers and associated germanium detectors; and a variety of instruments for radiation measurements and monitoring. Specialized facilities for radiation work include teaching and research laboratories with instrumentation and related equipment for performing neutron activation analysis and radiotracer studies; laboratories for plant experiments involving radioactivity; a facility for repair and calibration of radiation protection instrumentation; and facilities for packaging radioactive materials for shipment to national and international destinations.

A major non-nuclear facility housed in the Radiation Center is the one-quarter scale thermal hydraulic advanced plant experimental (APEX) test facility for the Westinghouse AP600 reactor design. The AP600 is a next-generation nuclear reactor design which incorporates many passive safety features as well as considerably simplified plant systems and equipment. APEX operates at pressures up to 400 psia and temperatures up to 450°F using electrical heaters instead of nuclear fuel. All major components of the AP600 are included in APEX and all systems are appropriately scaled to enable the experimental measurements to be used for safety evaluations and licensing of the full scale plant. This world-class facility meets exacting quality assurance criteria to provide assurance of safety as well as validity of the test results.

Also housed in the Radiation Center is the Advanced Thermal Hydraulics Research Laboratory, which is used for state-of-the-art two-phase flow experiments.

The Radiation Center staff regularly provides direct support and assistance to OSU teaching and research programs. Areas of expertise commonly involved in such efforts include nuclear engineering, nuclear and radiation chemistry, neutron activation analysis, radiation effects on biological systems, radiation dosimetry, environmental radioactivity, production of short-lived radioisotopes, radiation shielding, nuclear instrumentation, emergency response, transportation of radioactive materials, instrument calibration, radiation health physics, radioactive waste disposal, and other related areas.

In addition to formal academic and research support, the Center's staff provides a wide variety of other services including public tours and instructional programs, and professional consultation associated with the feasibility, design, safety, and execution of experiments using radiation and radioactive materials.

E. Summary of Environmental and Radiation Protection Data

1. Liquid Effluents Released (See Table V.B.1.a)

a.	Total estimated quantity of radioactivity released (to the sanitary sewer)(1) (2)	3.9×10^{-5} Ci
b.	Detectable radionuclides in the liquid waste	^{3}H
c.	Estimated average concentration of released radioactive material at the point of release	3.9×10^{-6} $\mu Ci\ ml^{-1}$
d.	Percent of applicable monthly average concentration for released liquid radioactive material at the point of release	0.04%
e.	Total volume of liquid effluent released, including diluent(3)	2,618 gallons

2. Liquid Waste Generated and Transferred (See Table V.B.1.b)

a.	Volume of liquid waste packaged(4)	50 gallons
b.	Detectable radionuclides in the waste	^{3}H, ^{14}C, ^{22}Na, ^{32}P, ^{51}Cr, ^{59}Fe, ^{60}Co, ^{64}Cu, ^{65}Zn, ^{122}Sb, ^{124}Sb, ^{125}Sb, ^{131}I, ^{137}Cs, ^{152}Eu, ^{222}Rn
c.	Total quantity of radioactivity in the waste	6.0×10^{-5} Ci

---

(1) OSU has implemented a policy to reduce radioactive wastes disposed to the sanitary sewer to the absolute minimum.

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

(3) Total volume of effluent plus diluent does not take into consideration the additional mixing with the over 250,000 gallons per year of liquids and sewage normally discharged by the Radiation Center complex into the same sanitary sewer system.

(4) TRIGA and Radiation Center liquid waste is picked up by the Radiation Safety Office for transfer to its waste processing facility for solidification and final packaging.

3. Airborne Effluents Released (See Table V.B.2)

a.	Total estimated quantity of radioactivity released	4.41 Ci
b.	Detectable radionuclides in the gaseous waste(1)	^{41}Ar ($t_{½}$ = 1.83 hr)
c.	Estimated average atmospheric diluted concentration of ^{41}Ar at the point of release	2.9×10^{-8} $\mu Ci\ ml^{-1}$
d.	Percent of applicable monthly average concentration for diluted concentration of ^{41}Ar at the point of release	0.7%
e.	Total estimated release of radioactivity in particulate form with half lives greater than 8 days(2)	None

4. Solid Waste Released (See Table V.B.3)

a.	Total amount of solid waste packaged and disposed of	62 ft^3
b.	Detectable radionuclides in the solid waste	^{3}H, ^{14}C, ^{24}Na, ^{46}Sc, ^{47}Sc, ^{51}Cr, ^{54}Mn, ^{56}Mn, ^{58}Co, ^{59}Fe, ^{60}Co, ^{68}Ge, ^{82}Br, ^{90}Sr, ^{122}Sb, ^{124}Sb, ^{131}I, ^{137}Cs, ^{140}La, ^{152}Eu, ^{222}Rn, ^{226}Ra, ^{238}U
c.	Total radioactivity in the solid waste	5.1×10^{-4} Ci

---

(1) Routine gamma spectroscopy analysis of the gaseous radioactivity in the stack discharge indicated that it was virtually all ^{41}Ar.

(2) Evaluation of the detectable particulate radioactivity in the stack discharge confirmed its origin as naturally occurring radon daughter products, predominantly ^{214}Pb and ^{214}Bi, which are not associated with reactor operations.

5. Radiation Exposure Received by Personnel (See Table V.C.1)

a.	Facility Operating Personnel		(mrem)
	(1)	Average whole body	78
	(2)	Average extremities	112
	(3)	Maximum whole body	208
	(4)	Maximum extremities	310
b.	Key Facility Research Personnel		
	(1)	Average whole body	19
	(2)	Average extremities	14
	(3)	Maximum whole body	46
	(4)	Maximum extremities	64
c.	Facilities Services Maintenance Personnel		
	(1)	Average whole body	14
	(2)	Maximum whole body	30
d.	Laboratory Class Students		
	(1)	Average whole body	8
	(2)	Average extremities	2
	(3)	Maximum whole body	37
	(4)	Maximum extremities	49
e.	Campus Police and Security Personnel		
	(1)	Average whole body	37
	(2)	Maximum whole body	49
f.	Visitors		
	(1)	Average whole body	<1
	(2)	Maximum whole body	302[1]

(1) Elevated reading due to cell phone interference on the electronic dosimeter.

6. Number of Routine Onsite and Offsite Monitoring Measurements and Samples

a. Facility Survey Data

(1) Area Radiation Dosimeters (See Table V.D.1)

(a)	Beta-gamma dosimeter measurements	68
(b)	Neutron dosimeter measurements	68

(2) Radiation and Contamination Survey ~6000 measurements (See Table V.D.3)

b. Environmental Survey Data

(1) Gamma Radiation Monitoring (See Tables V.E.1 and V.E.2)

(a)	Onsite monitoring	
	-- OSU TLD monitors	108
	-- ICN TLD monitors	108
	-- Monthly μrem h^{-1} measurements	108
(b)	Offsite monitoring	
	-- OSU TLD monitors	240
	-- ICN TLD monitors	144
	-- Monthly μrem h^{-1} measurements	240

(2) Soil, Water and Vegetation Surveys (See Table V.E.3)

(a)	Soil samples	16
(b)	Water samples	12
(c)	Vegetation samples	56

F. History

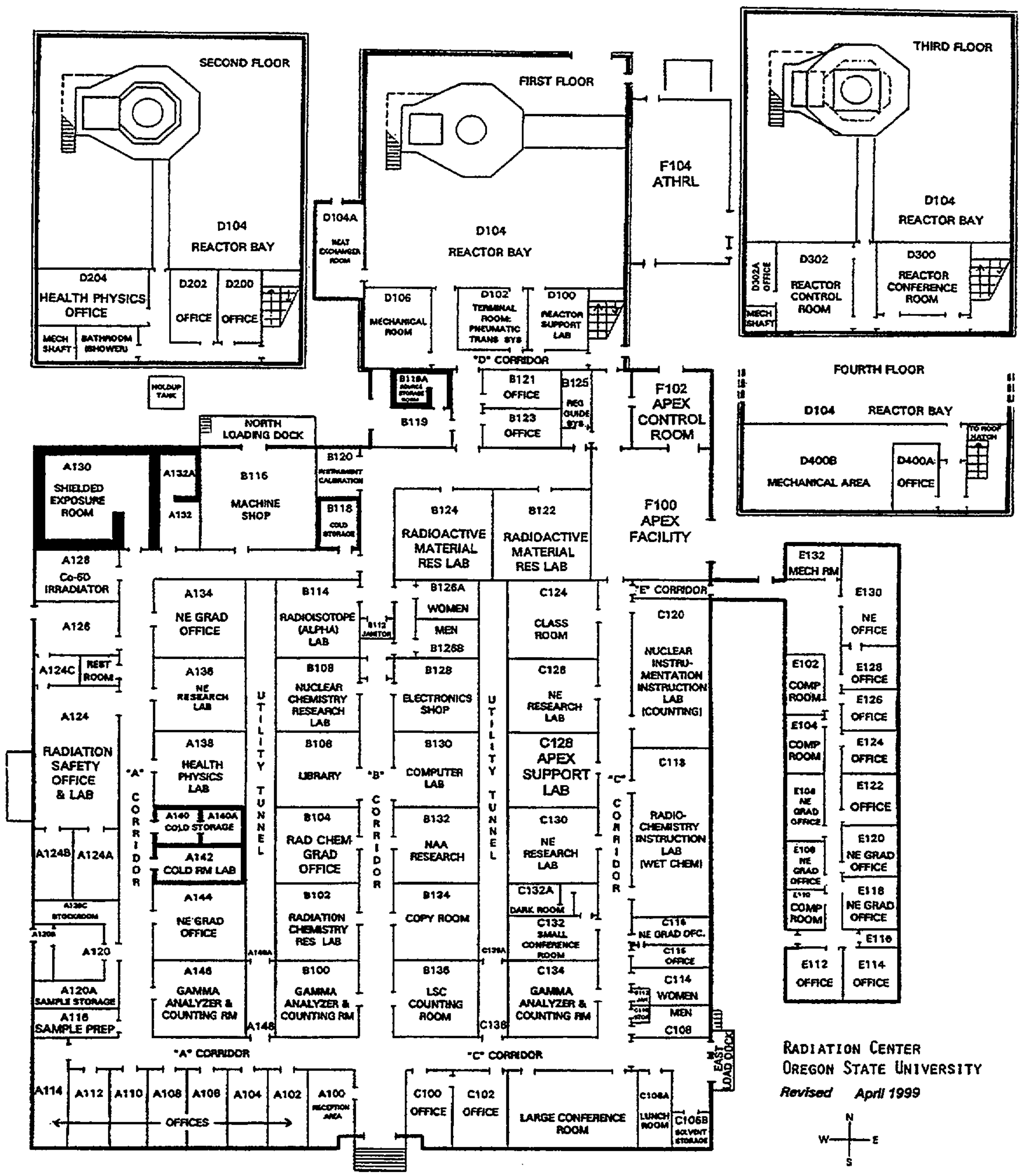
A brief chronology of the key dates and events in the history of the OSU Radiation Center and the TRIGA reactor is given below:

June 1964	Completion of the first phase of the Radiation Center, consisting of 32,397 square feet of office and laboratory space, under the direction of founding Director, C. H. Wang.
July 1964	Transfer of the 0.1 W AGN 201 reactor to the Radiation Center. This reactor was initially housed in the Department of Mechanical Engineering and first went critical in January, 1959.
October 1966	Completion of the second phase of the Radiation Center, consisting of 9,956 square feet of space for the TRIGA reactor and associated laboratories and offices.
March 1967	Initial criticality of the Oregon State TRIGA Reactor (OSTR). The reactor was licensed to operate at a maximum steady state power level of 250 kW and was fueled with 20% enriched fuel.
October 1967	Formal dedication of the Radiation Center.
August 1969	OSTR licensed to operate at a maximum steady state power of 1 MW, but could do so only for short periods of time due to lack of cooling capacity.
June 1971	OSTR cooling capacity upgraded to allow continuous operation at 1 MW.
April 1972	OSTR Site Certificate issued by the Oregon Energy Facility Siting Council.
September 1972	OSTR area fence installed.
December 1974	AGN-201 reactor permanently shut down.
March 1976	Completion of 1600 square feet of additional space to accommodate the rapidly expanding nuclear engineering program.
July 1976	OSTR refueled with 70% enriched FLIP fuel.
July 1977	Completion of a second 1600 square feet of space to bring the Radiation Center complex to a total of 45,553 square feet.
January 1980	Major upgrade of the electronics in the OSTR control console.

July 1980	AGN-201 reactor decommissioned and space released for unrestricted use.
June 1982	Shipment of the original 20% enriched OSTR fuel to Westinghouse Hanford Corporation.
December 1984	C. H. Wang retired as director. C. V. Smith became new director.
August 1986	Director C. V. Smith left to become Chancellor of the University of Wisconsin-Madison. A. G. Johnson became new Director.
December 1988	AGN-201 components transferred to Idaho State University for use in their AGN-201 reactor program.
December 1989	OSTR licensed power increased to 1.1 MW.
June 1990	Installation of a 7000 Ci ^{60}Co Gammacell irradiator.
March 1992	25th anniversary of the OSTR initial criticality.
November 1992	Start of APEX plant construction.
June 1994	Retirement of Director A. G. Johnson. B. Dodd became new Director.
August 1994	APEX inauguration ceremony.
August 1995	Major external refurbishment: new roof, complete repaint, rebuilt parking lot, addition of landscaping and lighting.
September 1998	B. Dodd left on a leave of absence to the International Atomic Energy Agency. S. E. Binney became new Director.
January 1999	Installation of the Argon Production Facility in the OSTR.
April 1999	Completion of ATHRL facility brings the Radiation Center complex to a total of 47,198 square feet.

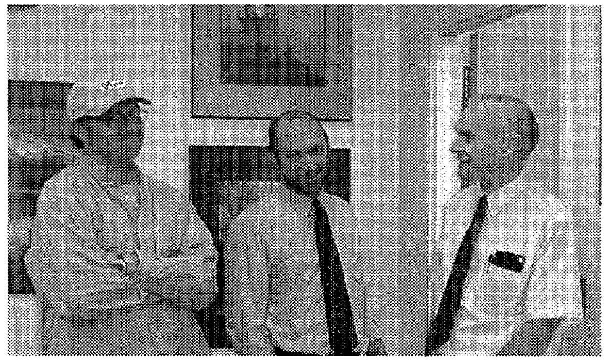
Figure I.D.1

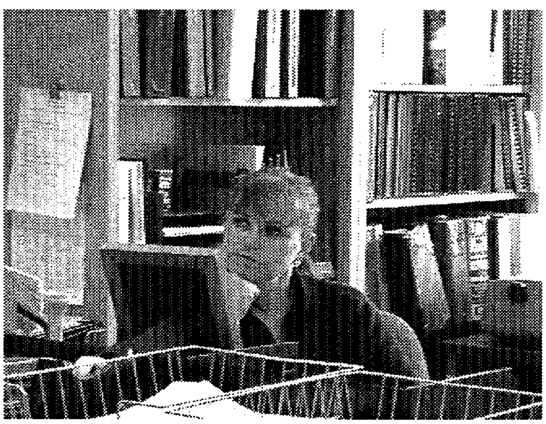
Floor Plan of the Radiation Center

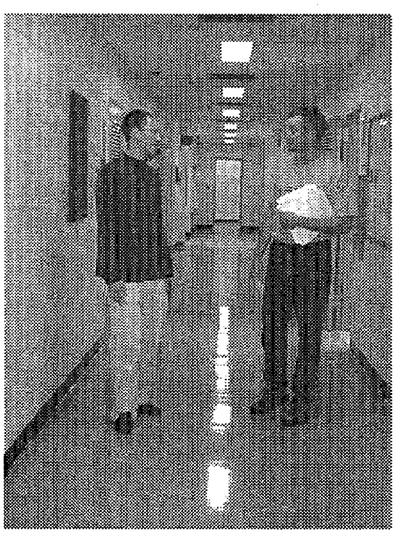


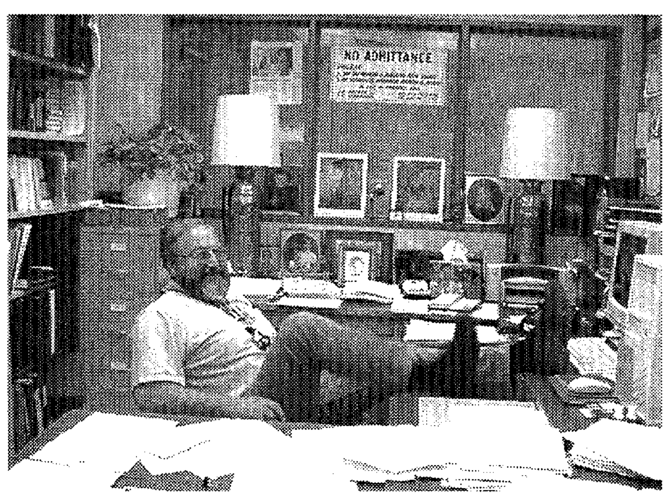
Part II

People









Part II

PEOPLE

This part contains a listing of all people who were residents of the Radiation Center or who worked a significant amount of time at the Center during this reporting period. Sections A, B, and C list the academic staff, trainees, and students, while sections D through G list the Radiation Center's operating staff. Section H shows the OSU Radiation Safety Office staff, and section I provides the composition of committees involving Center personnel.

It should be noted that not all of the faculty and students who used the Radiation Center for their teaching and research are listed in this part. Summary information on the number of people involved is given in Table VI.C.1, while individual names and projects are listed in Tables VI.C.2 and VI.C.3.

A. Professional and Research Faculty

Attfield, Martin P.
Faculty Research Associate
Chemistry

*Binney, Stephen E.
Director, Radiation Center
Director, Institute of Nuclear Science and Engineering
Professor
Nuclear Engineering and Radiation Health Physics

*Brock, Kathryn M.
Faculty Research Assistant
Health Physicist

*Conard, Bobbi L.
Senior Faculty Research Assistant
College of Oceanic and Atmospheric Sciences

*Conrady, Michael R.
Faculty Research Assistant
Analytical Support Manager

Craig, A. Morrie
Professor
College of Veterinary Medicine

* OSTR users for research and/or teaching.

Daniels, Malcolm
Professor Emeritus
Chemistry

Fekou-Youmbi, Valentin
Faculty Research Associate
Chemistry

Groome, John T.
Faculty Research Assistant
ATHRL Facility Operations Manager
Nuclear Engineering

Gunderson, Chris E.
Faculty Research Assistant
ATHRL Facility Operator/Test Engineer
Nuclear Engineering

Haggerty, Roy
Assistant Professor
Geosciences

Hamby, David
Associate Professor
Nuclear Engineering

Hart, Lucas P.
Faculty Research Associate
Chemistry

Harvey, Richard
Faculty Research Assistant
Nuclear Engineering

*Higginbotham, Jack F.
Chairman, Reactor Operations Committee
Associate Dean, Graduate School (until June 2000)
Professor
Nuclear Engineering and Radiation Health Physics

*Higley, Kathryn A.
Assistant Professor
Nuclear Engineering and Radiation Health Physics

---

* OSTR users for research and/or teaching.

Hovermale, Jeannette T.
Faculty Research Assistant
College of Veterinary Medicine

Johnson, Arthur G.
Director Emeritus, Radiation Center
Professor Emeritus
Nuclear Engineering and Radiation Health Physics

Johnson, Richard A.
Adjunct Faculty
Nuclear Engineering

Klein, Andrew C.
Department Head, Department of Nuclear Engineering
Director, Oregon Space Grant Program
Professor
Nuclear Engineering

*Krane, Kenneth S.
Professor
Physics

Krebs, Rolf
Faculty Research Associate
Crop and Soil Science

Lafi, Abd Y.
Assistant Professor Senior Research
ATHRL Research Analyst
Nuclear Engineering

*Loveland, Walter D.
Professor
Chemistry

*Meredith, Charlotte C.
Faculty Research Assistant
College of Oceanic and Atmospheric Sciences

Mommer, Niels K.
Faculty Research Associate
Physics

---

* OSTR users for research and/or teaching.

*Palmer, Todd S.
Assistant Professor
Nuclear Engineering

*Pastorek, Christine
Senior Instructor
Chemistry

Popovich, Milosh
Vice President Emeritus

*Prahl, Frederick G.
Professor
College of Oceanic and Atmospheric Sciences

*Pratt, David S.
Faculty Research Assistant
Senior Health Physicist

Reyes, Jr., José N.
ATHRL Principal Investigator
Professor
Nuclear Engineering

Ringle, John C.
Professor Emeritus
Nuclear Engineering

Robinson, Alan H.
Department Head Emeritus
Nuclear Engineering

*Schmitt, Roman A.
Professor Emeritus
Chemistry

*Schütfort, Erwin G.
Faculty Research Assistant
Project Manager

*Sparrow, Margaret
Senior Research Assistant
College of Oceanic and Atmospheric Sciences

* OSTR users for research and/or teaching.

*Sullivan, Barbara E.
Faculty Research Assistant
College of Oceanic and Atmospheric Sciences

Wang, Chih H.
Director Emeritus, Radiation Center
Professor Emeritus
Nuclear Engineering

Young, Roy A.
Professor Emeritus
Botany and Plant Pathology

* OSTR users for research and/or teaching.

B. Visiting Scientists and Special Trainees

Name	*Field (Affiliation)*	*Advisor or Research Program Director*
Bergman, Mattis	Visiting Scientist, Sweden	W. D. Loveland
Bissmarck, Frederick	Visiting Graduate Student, Sweden	W. D. Loveland
Cloughsey, Michael	ASE Summer Student	W. D. Loveland
Gallant, Aaron	Saturday Academy Mentorship Program Crescent Valley High School Corvallis, Oregon	W. D. Loveland
Souliotis, George	Postdoctoral Research Assistant	W. D. Loveland

C. OSU Graduate Students

Name	*Degree Program*	*Field*	*Advisor*
Alves, Mauro A.	PhD	Physics	J. A. Gardner
*Bergman, Joshua J.	MS	Radiation Health Physics	S. E. Binney
Ching, Brenton	MS	Nuclear Engineering	T. S. Palmer
*Crail, Scott A.	MS	Radiation Health Physics	J. F. Higginbotham
Eccleston, Bradley R.	MS	Nuclear Engineering	T. S. Palmer
Ellis, Christopher P.	MS	Nuclear Engineering	J. N. Reyes
Emerald, Kezia G.	PhD	Chemistry	W. D. Loveland
Gulich, John C.	MS	Nuclear Engineering	T. S. Palmer
*Keillor, Martin E.	PhD	Nuclear Engineering	S. E. Binney
Kim, Kang Seog	PhD	Nuclear Engineering	T. S. Palmer
Marianno, Craig M.	PhD	Radiation Health Physics	K. A. Higley
McCreary, David M.	MS	Nuclear Engineering	Q. Wu
Menn, Scott A.	PhD	Radiation Health Physics	K. A. Higley
Moss, Stephen C.	MS	Radiation Health Physics	K. A. Higley
*Povetko, Oleg G.	PhD	Radiation Health Physics	K. A. Higley
Richardson, Eric L.	MS	Nuclear Engineering	T. S. Palmer
Rios, Maribel G.	MS	Physics	K. S. Krane
Saiyut, Kittiphong	PhD	Nuclear Engineering	J. F. Higginbotham
*Schütfort, Erwin G.	MS	Geosciences	C. Field
Tang, Hong	PhD	Nuclear Engineering	Q. Wu
*Tiyapun, Kanokrat	PhD	Radiation Health Physics	S. E. Binney
Welter, Kent B.	PhD	Nuclear Engineering	T. S. Palmer

D. Business, Administrative and Clerical Staff

Director, Radiation Center	S. E. Binney
Business Manager	S. C. Campbell
Office Coordinator	J. M. Stueve
Office Specialists	(*to 5/31/00*) D. L. Snow
	(*from 6/1/00*) E. D. Jordan
	L. M. James
Custodian	E. Cimbri
Office Coordinator (Nuclear Engineering)	R. A. Keen
Word Processing Technician (Nuclear Engineering)	L. J. Robinson
Word Processing Technician (ATHRL – Nuclear Engineering)	T. L. Culver

E. Reactor Operations Staff

Principal Security Officer	S. E. Binney
Reactor Administrator	S. R. Reese
Reactor Supervisor, Senior Reactor Operator	A. D. Hall
Senior Reactor Operator	S. P. Smith
	G. M. Wachs
	J. F. Higginbotham
Reactor Operator	N. A. Carstens
Reactor Operator Trainee	J. A. Ammon
	M. A. Minton

F. Radiation Protection Staff

Senior Health Physicist	D. S. Pratt
Health Physicist	K. M. Brock
Assistant Health Physicist	(*to 2/28/00*) R. D. Normandin
	(*from 6/19/00*) S. A. Menn
Health Physics Monitors (Students)	M. Cheyne
	K. Fenton
	M. Hackett
	M. Helie
	C. Hepler
	K. Landry
	J. Wallace

G. Scientific Support Staff

Analytical Support Manager	M. R. Conrady
Projects Manager	E. G. Schütfort
Geochemist (*to 12/31/99*)	S. Geiger
Neutron Activation Analysis Technicians (Students)	S. Antoine
	A. Kachlik
	L. Lee
	E. Nes
	R. Nes
	E. Rougeux
	A. Shimanoff
Scientific Instrument Technician	S. P. Smith
Nuclear Instrumentation Support	E. Rougeux
	Z. Kenny

H. OSU Radiation Safety Office Staff

Radiation Safety Officer	R. H. Farmer
Assistant Radiation Safety Officers	D. L. Harlan
	M. E. Bartlett
Office Manager	K. L. Miller
Lab Technician	P. A. Schoonover
Student Technicians	(*to 6/18/00*) S. Menn
	W. Duffy

I. Committees

1. Reactor Operations Committee

Name	*Affiliation*
J. F. Higginbotham, Chair	Graduate School, and Nuclear Engineering
S. E. Binney	Radiation Center and Nuclear Engineering
A. D. Hall	Radiation Center
A. C. Klein	Nuclear Engineering
D. S. Pratt	Radiation Center
W. J. Richards	McClellan Nuclear Radiation Center
J. C. Ringle	Nuclear Engineering
S. R. Reese	Radiation Center and Nuclear Engineering
M. H. Schuyler	Chemistry
W. H. Warnes	Mechanical Engineering

2. Radiation Safety Committee (OSU)

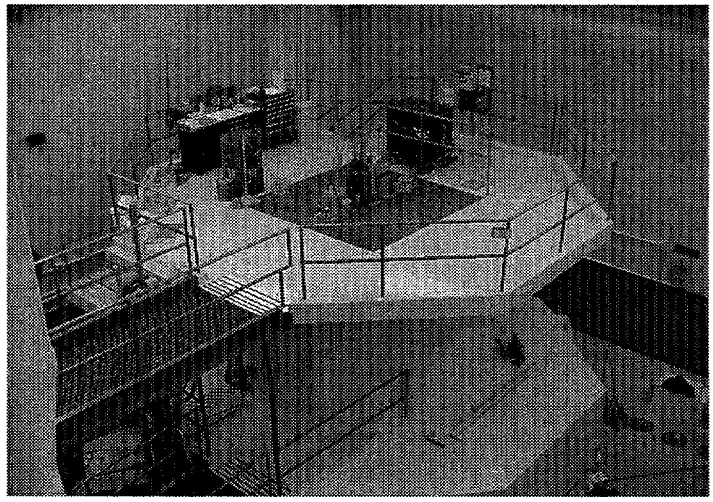
Name	*Affiliation*
R Collie, Chair	Oceanic and Atmospheric Sciences
J. Higginbotham, Vice Chair	Graduate School and Nuclear Engineering
R. Farmer, Secretary and RSO	Radiation Safety Office
T. Dreher	Agricultural Chemistry
B. Francis	Environmental Health and Safety
M. Leid	Pharmacy
C. Snow	Exercise and Sport Science
J. Steiner	USDA-ARS/Crop and Soil Science
I. Wong	Biochemistry/Biophysics
T. Wolpert	Botany and Plant Pathology

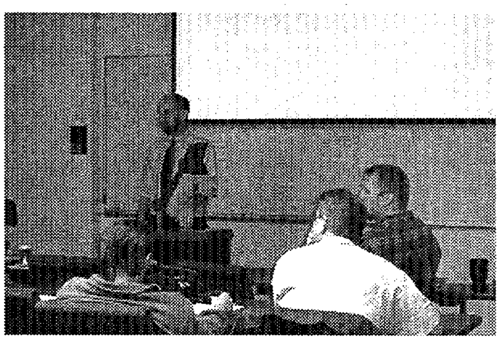
3. Radiation Center Safety Committee

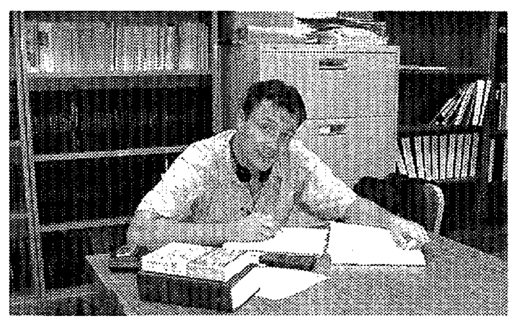
Name	*Affiliation*
W. D. Loveland, Chair	Chemistry
K. M. Brock	Radiation Center
M. R. Conrady	Radiation Center
J. T. Groome	Nuclear Engineering
J. F. Higginbotham	Graduate School and Nuclear Engineering
K. L. Miller	Radiation Safety
D. S. Pratt	Radiation Center

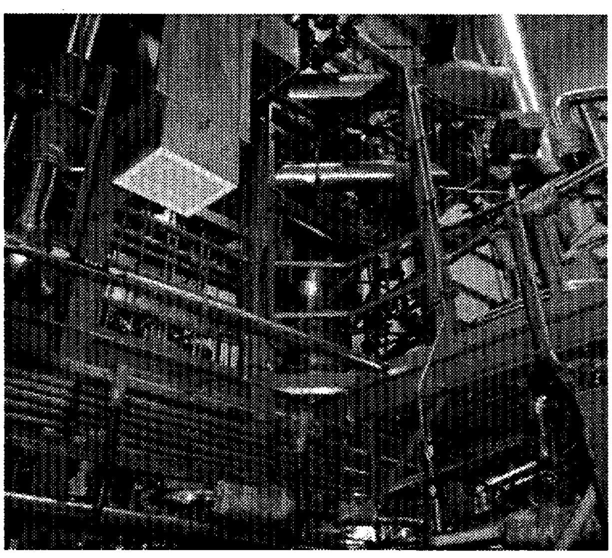
Part III

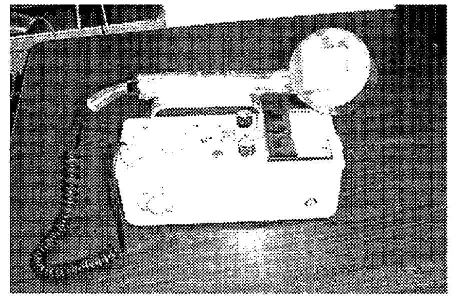
Facilities











Part III

FACILITIES

A. Research Reactor

1. Description

The Oregon State University TRIGA Reactor (OSTR) is a water-cooled, swimming pool type of research reactor which uses uranium/zirconium hydride fuel elements in a circular grid array. The reactor core is surrounded by a ring of graphite which serves to reflect neutrons back into the core. The core is situated near the bottom of a 22-foot deep water-filled tank, and the tank is surrounded by a concrete bioshield which acts as a radiation shield and structural support. See Figures III.A.1, III.A.2 and III.A.3.

The reactor is licensed by the U.S. Nuclear Regulatory Commission to operate at a maximum steady state power of 1.1 MW and can also be pulsed up to a peak power of about 2500 MW.

The OSTR has a number of different irradiation facilities including a pneumatic transfer tube, a rotating rack, a thermal column, four beam ports, five sample holding (dummy) fuel elements for special in-core irradiations, an in-core irradiation tube, and a cadmium-lined in-core irradiation tube for experiments requiring a high energy neutron flux. The OSTR also has an Argon Irradiation Facility for the production of ^{41}Ar.

The **pneumatic transfer facility** enables samples to be inserted and removed from the core in four to five seconds. Consequently this facility is normally used for neutron activation analysis involving short-lived radionuclides. On the other hand, the **rotating rack** is used for much longer irradiation of samples (e.g., hours). The rack consists of a circular array of 40 tubular positions, each of which can hold two sample tubes. Rotation of the rack ensures that each sample will receive an identical irradiation.

The reactor's **thermal column** consists of a large stack of graphite blocks which slows down neutrons from the reactor core in order to increase thermal neutron activation of samples. Over 99% of the neutrons in the thermal column are thermal neutrons. Graphite blocks are removed from the thermal column to enable samples to be positioned inside for irradiation.

The **beam ports** are tubular penetrations in the reactor's main concrete shield which enable neutron and gamma radiation to stream from the core when a beam port's shield plugs are removed. One of the beam ports contains the **Argon Production Facility** for production of curie levels of ^{41}Ar. The other beam ports are available for a variety of experiments.
If samples which are to be irradiated require a large neutron fluence, especially from higher energy neutrons, they may be inserted into a **dummy fuel element**. This device will then be placed into one of the core's inner grid positions which would normally be occupied by

a fuel element. Similarly samples can be placed in the **in-core irradiation tube (ICIT)** which can be inserted in the same core location.

The **cadmium-lined in-core irradiation tube (CLICIT)** enables samples to be irradiated in a high flux region near the center of the core. The cadmium lining in the facility eliminates thermal neutrons and thus permits sample exposure to higher energy neutrons only. The cadmium-lined end of this air-filled aluminum irradiation tube is inserted into an inner grid position of the reactor core which would normally be occupied by a fuel element. It is the same as the ICIT except for the presence of the cadmium lining.

2. Utilization

The two main uses of the OSTR are instruction and research. During this reporting period, the reactor was in use an average of 40 hours during a typical work week.

a. Instruction

Instructional use of the reactor is twofold. First, it is used significantly for classes in Nuclear Engineering, Radiation Health Physics, and Chemistry at both the graduate and undergraduate levels to demonstrate numerous principles which have been presented in the classroom. Basic neutron behavior is the same in small reactors as it is in large power reactors, and many demonstrations and instructional experiments can be performed using the OSTR which cannot be carried out with a commercial power reactor. Shorter-term demonstration experiments are also performed for many undergraduate students in Physics, Chemistry, and Biology classes, as well as for visitors from other universities and colleges, from high schools, and from public groups.

The second instructional application of the OSTR involves education of reactor operators, operations managers, and health physicists. The OSTR is in a unique position to provide such education since curricula must include hands-on experience at an operating reactor and in associated laboratories. The many types of educational programs that the Radiation Center provides are more fully described in Part VI (Section VI.C.5) of this report.

During this reporting period the OSTR accommodated 24 different OSU academic classes plus four other academic programs. In addition, portions of classes from other Oregon universities were also supported by the OSTR. The OSU teaching and training programs utilized 790 hours of reactor time. Tables III.A.1 and III.A.2, as well as Table III.D.1, provide detailed information on the use of the OSTR for instruction and training.

b. Research

The OSTR is a unique and valuable tool for a wide variety of research applications and serves as an excellent source of neutrons and/or gamma radiation. The most commonly used experimental technique requiring reactor use is instrumental neutron activation analysis (INAA). This is a particularly sensitive method of elemental analysis which is described in more detail in Part VI (Section VI.C.1). Part III.B provides a listing of equipment used in INAA at the Radiation Center.

The OSTR's irradiation facilities provide a wide range of neutron flux levels and neutron flux qualities which are sufficient to meet the needs of most researchers. This is true not only for INAA, but also for other experimental purposes such as the $^{39}Ar/^{40}Ar$ ratio and fission track methods of age dating samples.

During this reporting period, the OSTR accommodated 50 funded and 8 unfunded research projects. Details of the reactor's use specifically for research are given in Table III.A.3. Additional information regarding reactor use for research, thesis, and service can be found in Tables VI.C.1 through VI.C.3. In Table VI.C.1 OSTR use is indicated with an asterisk.

B. Analytical Equipment

1. Description

The Radiation Center has a large variety of radiation detection instrumentation. This equipment is upgraded as necessary, especially the gamma ray spectrometers with their associated computers and germanium detectors. During this report year four new germanium detectors and six digital multichannel analyzers were purchased. Tables III.B.1 through III.B.3 provide a brief listing of laboratory counting devices present at the Center. Additional equipment for classroom use and an extensive inventory of portable radiation detection instrumentation are also available.

2. Utilization

Radiation Center nuclear instrumentation receives intensive use in both teaching and research applications. In addition, service projects also use these systems and the combined use often results in 24-hour per day schedules for many of the analytical instruments. Use of Radiation Center equipment extends beyond that located at the Center and instrumentation may be made available on a loan basis to OSU researchers in other departments.

C. Radioisotope Irradiation Sources

1. Description

The Radiation Center is equipped with a 1,893 curie (as of 7/1/00) Gammacell 220 ^{60}Co irradiator (Fig. III.C.1), which is capable of delivering high doses of gamma radiation over a range of dose rates to a variety of materials.

Typically, the irradiator is used by researchers wishing to perform mutation and other biological effects studies; studies in the area of radiation chemistry; dosimeter testing; sterilization of food materials, soils, sediments, biological specimen, and other media; gamma radiation damage studies; and other such applications. In addition to the ^{60}Co irradiator, the Center is also equipped with a variety of smaller ^{60}Co, ^{137}Cs, ^{226}Ra, plutonium-beryllium, and other isotopic sealed sources of various radioactivity levels which are available for use as irradiation sources.

2. Utilization

During this reporting period there was a diverse group of projects using the ^{60}Co irradiator. These projects included the irradiation of a variety of biological materials including different types of seeds. In addition, the irradiator was used for sterilization of several media and the evaluation of the radiation effects on different materials. Table III.C.1 provides use data for the Gammacell 220 irradiator.

D. Laboratories and Classrooms

1. Description

The Radiation Center is equipped with a number of different radioactive material laboratories designed to accommodate research projects and classes offered by various OSU academic departments or off-campus groups.

Instructional facilities available at the Center include a laboratory especially equipped for teaching radiochemistry and a nuclear instrumentation teaching laboratory equipped with modular sets of counting equipment which can be configured to accommodate a variety of experiments involving the measurement of many types of radiation. The Center also has three student computer rooms equipped with a large number of personal computers and UNIX workstations.

In addition to these dedicated instructional facilities, many other research laboratories and pieces of specialized equipment are regularly used for teaching. In particular, classes are routinely given access to gamma spectrometry equipment located in Center laboratories. A number of classes also regularly use the OSTR and the Reactor Bay as an integral part of their instructional coursework.

There are two classrooms in the Radiation Center which are capable of holding about 35 and 18 students, respectively. In addition, there are two smaller conference rooms and a library that are suitable for graduate classes and thesis examinations. As a service to the student body, the Radiation Center also provides an office area for the student chapters of the American Nuclear Society and the Health Physics Society.

This reporting period saw continued high utilization of the Radiation Center's thermal hydraulics laboratory. This laboratory is being used by Nuclear Engineering faculty member to accommodate a one-quarter scale model of the Westinghouse Electric Corporation AP600 reactor. The AP600 is a next-generation reactor which features simplicity, passive safety, and standardization in its design. The multi-million dollar advanced plant experimental (APEX) facility was fully utilized by the U. S. Nuclear Regulatory Commission to provide licensing data and to test safety systems in "beyond design basis" accidents. The fully scaled, integral model APEX facility uses electrical heating elements to simulate the fuel elements, operates at 450°F and 400 psia, and responds at twice real time. It is the *only* facility of its type in the world and is owned by the U. S. Department of Energy, designed by Westinghouse, and operated by OSU. In addition, a new building, the Air-water Test Loop for Advanced Thermal-hydraulics Studies (ATLATS), was constructed next to the Reactor Building in 1998. Two-phase flow experiments are conducted in the ATLATS. Together APEX and ATLATS comprise the Advanced Thermal Hydraulics Research Laboratory (ATHRL).

2. Utilization

All of the laboratories and classrooms are used extensively during the academic year. For example, a listing of 96 courses accommodated at the Radiation Center during this reporting period along with their enrollments is given in Table III.D.1.

E. Instrument Repair and Calibration Facility

1. Description

The Radiation Center has a facility for the repair and calibration of essentially all types of radiation monitoring instrumentation. This includes instruments for the detection and measurement of alpha, beta, gamma, and neutron radiation. It encompasses both high range instruments for measuring intense radiation fields and low range instruments used to measure environmental levels of radioactivity. The Center's instrument calibration capability is described more completely in Section VI.C.7 of this report.

2. Utilization

The Center's instrument repair and calibration facility is used regularly throughout the year and is absolutely essential to the continued operation of the many different programs carried out at the Center. In addition, the absence of any comparable facility in the state has led to a greatly expanded instrument calibration program for the Center, including *calibration of essentially all radiation detection instruments used by state and federal agencies in the state of Oregon.* This includes instruments used on the OSU campus and all other institutions in the Oregon University System, plus instruments from the Oregon Health Division's Radiation Protection Services, the Oregon Office of Energy, the Oregon Public Utilities Commission, the Oregon Health Sciences University, the Army Corps of Engineers, and the U. S. Environmental Protection Agency. Additional information regarding instrument repair and calibration efforts is given in Tables VI.C.4, VI.C.5, and VI.C.6.

F. Library

1. Description

The Radiation Center has a library containing significant collections of texts, research reports, and videotapes relating to nuclear science, nuclear engineering, and radiation protection.

The Radiation Center is also a regular recipient of a great variety of publications from commercial publishers in the nuclear field, from many of the professional nuclear societies, from the U. S. Department of Energy, the U. S. Nuclear Regulatory Commission, and other federal agencies. Therefore, the Center library maintains a current collection of leading nuclear research and regulatory documentation. In addition, the Center has a collection over 50 sets of nuclear power reactor Safety Analysis Reports and Environmental Reports specifically prepared by utilities for their facilities.

The Center maintains an up-to-date set of reports from such organizations as the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurements, and the International Commission on Radiological Units. Sets of the current U.S. Code of Federal Regulations for the U.S. Nuclear Regulatory Commission, the U.S. Department of Transportation, and other appropriate federal agencies, plus regulations of various state regulatory agencies are also available at the Center.

The Radiation Center videotape library has over one hundred tapes on nuclear engineering, radiation protection, and radiological emergency response topics. In addition, the Radiation Center uses videotapes for most of the technical orientations which are required for personnel working with radiation and radioactive materials. These tapes are produced, recorded, and edited by Radiation Center staff, using the Center's videotape equipment and the facilities of the OSU Communication Media Center.

2. Utilization

The Radiation Center library is used mainly to provide reference material on an as-needed basis. It receives extensive use during the academic year. In addition, the orientation videotapes are used intensively during the beginning of each term and periodically thereafter.

Table III.A.1

OSU Courses Using the OSTR

Course Number	Course Name
NE 111	Introduction to Nuclear Engineering
NE 112	Introduction to Nuclear Engineering
NE 113	Introduction to Nuclear Engineering
NE 233	Nuclear Radiation Detection and Instrumentation
RHP 233	Nuclear Radiation Detection and Instrumentation
NE 457/557	Nuclear Reactor Laboratory
RHP 480	Field Practices in Radiation Protection
NE 484	Applied Radiation Safety
RHP 488/588	Radioecology
NE 503	Thesis (Nuclear Engineering)
RHP 503	Thesis (Radiation Health Physics)
RHP 506	Projects
RHP 588	Advanced Radioecology
NE 603	Thesis (Nuclear Engineering)
CH 222	General Chemistry for Science Majors
CH 225H	Chemistry
CH 462	Experimental Chemistry II
CH 503	Thesis (Chemistry)
GEO 503	Thesis (Geosciences)
OC 503	Thesis (Oceanography)
Adventures in Learning	Visiting Students
SMILE	Visiting Students
CH 419/519	Radioactive Tracer Methods
Hazmat	Hazmat Response Teams Radiological Course

Table III.A.2

OSTR Teaching Hours

Description	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
Departmental	444	7,521
Nuclear Engineering	384	
Chemistry	51	
Adventures in Learning	1	
SMILE	4	
World Affairs Council	2	
Hazmat	2	
Geosciences(1)	0	
Oceanic and Atmospheric Sciences(1)	0	
Special Classes and Projects(2)	346	4,782
TOTAL TEACHING HOURS(3,4,5)	790	12,303

(1) Some use hours by these departments are not shown under "Teaching Hours," but are reflected under Thesis Research, both funded and unfunded.

(2) A variety of educational classes were conducted which involved one-time meetings for orientation or support purposes. These included: high school science classes, new student programs support, community college classes, and classes from other universities. In addition, this category includes 266 hours of reactor operator training.

(3) See Table III.D.1 for classes and student enrollment.

(4) See Table IV.A.5 for a summary of all reactor use categories.

(5) Total teaching hours reflect all the time the reactor was in use for teaching, and because of this the total hours include time the reactor itself may not actually have been in operation.

Table III.A.3

OSTR Research Hours

Types of Research	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
OSU Research	137	8,584
Off-Campus Research	884	14,376
TOTAL RESEARCH HOURS[(1)]	1,021	22,960

---

(1) Total research hours statistics:
  (a) 97% (987.5 hours) of the total research hours were user-funded by federal, state, or other organizations.
  (b) 3% (33.5 hours) of the total research hours were user-unfunded studies in support of graduate thesis research or other academic investigations. Reactor costs for this research were absorbed (funded) by the OSU Radiation Center.

Table III.B.1

Radiation Center Spectrometry Systems:
Gamma, Low Energy Photon, Alpha

Room	System	Rel. Effic. (%)
B100	EG&G Ortec D-Spec MCA, HPGe	26.8
B100	EG&G Ortec D-Spec MCA, HPGe	38.1
B100	EG&G Ortec D-Spec MCA, HPGe	30.0
B100	EG&G Ortec D-Spec MCA, HPGe	28.8
C120	EG&G Ortec Ace 4k-MCA, NaI(Tl) 3x3	N/A
B125	EG&G Ortec D-Spec MCA, HPGe	24%
A138	Hewlett Packard Scaler, NaI(Tl) 2x2	N/A
A146	EG&G Ortec Ace 4k-MCA, EG&G Ortec Si(Li)	N/A
B100	EG&G Ortec Adcam 8k-MCA, PGT LEP	N/A
B100	EG&G Ortec Adcam 8k-MCA, EG&G Ortec LEP	N/A
A146	EG&G Ortec Ace 4k-MCA, 576A Alpha Spectrometer	N/A
D102	EG&G Ortec D-Spec MCA, HPGe	28%

Table III.B.2

Radiation Center Proportional Counting Systems

Room	System
A124	NMC AC5 84
A138	Protean MPC 9400
A138	Tennelec LB 5100 Auto Counting System w/IBM PC

Table III.B.3

Thermoluminescent Dosimeter Systems

Room	System
C120	Harshaw Model 2000
A132	Harshaw Model 2000

Table III.C.1

Gammacell 220 ^{60}Co Irradiator Use
(1893 Ci: 7/1/00)

Purpose of Irradiation	Samples	Dose Range (rads)	Number of Irradiations	Use Time (hours)
Sterilization	Glucometers, syringes, wood, soil, tissue, plastic tubes, catheters	2.0×10^6 to 5.0×10^6	46	1,166.9
Material Evaluation	Memory chips, golfballs	2.5×10^5 to 8.4×10^6	19	227.9
Botanical Studies	Bananas, bean seeds, lily bulbs, other food items	5.0×10^2 to 2.0×10^5	38	5.8
Biological Studies	spleen cells	1.5×10^3 one setting no range	5	0.05
TOTALS			108	1,400.6

Table III.D.1

Student Enrollment in Nuclear Engineering, Radiation Health Physics and Nuclear Science Courses Which Are Taught or Partially Taught at the Radiation Center

Course	Credit	Course Title	Number of Students			
			Fall 1999	Winter 2000	Spring 2000	Summer 2000
Nuclear Engineering Department Courses						
NE111*	3	Introduction to Nuclear Engineering	16	--	--	--
NE112	3	Introduction to Nuclear Engineering	--	17	--	--
NE113	3	Introduction to Nuclear Engineering	--	--	18	--
NE231	3	Nuclear and Radiation Physics	11	--	--	--
RHP231	3	Nuclear and Radiation Physics	1	--	--	--
NE232	3	Nuclear and Radiation Physics	--	8	--	--
RHP232	3	Nuclear and Radiation Physics	--	3	--	--
NE233*	3	Nuclear Radiation Detection and Instrumentation	--	--	8	--
RHP233*	3	Nuclear Radiation Detection and Instrumentation	--	--	1	--
NE319	3	Societal Aspects of Nucl Tech	49	--	--	--
NE361	3	Nuclear Reactor Systems	--	14	--	--
NE381	3	Principles of Radiation Safety	11	--	--	--
RHP381	3	Principles of Radiation Safety	3	--	--	--
NE401	1-16	Research	--	--	1	--
RHP401	1-16	Research	1	--	--	--
NE405H	1-16	R&C/Low Level Radioactive Waste	--	--	5	--
NE405	1-16	Reading and Conference	--	--	--	--
RHP405	1-16	Reading and Conference	--	--	--	--
NE406	1-16	Projects	--	1	2	2
RHP406	1-16	Projects	--	--	--	--
NE407	1	Nuclear Engineering Seminar	13	13	9	--
NE410	1-12	Internship	--	--	--	4
RHP410	1-12	Internship	--	--	--	--

ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

Table III.D.1 (continued)

Student Enrollment in Nuclear Engineering, Radiation Health Physics and Nuclear Science Courses Which Are Taught or Partially Taught at the Radiation Center

NE454	3	Nuclear Reactor Analysis	4	--	--	--
NE455	3	Nuclear Reactor Analysis	--	3	--	--
NE456	3	Nuclear Reactor Analysis	--	--	3	--
NE457**	3	Nuclear Reactor Laboratory	--	--	3	--
NE467	3	Nuclear Reactor Thermal Hydraulics	3	--	--	--
NE471	3	Nuclear Power Systems Design	--	4	--	--
NE472	3	Nuclear Power Systems Design	--	-	4	--
NE479	1-4	Individual Design Project	--	--	--	--
RHP479	1-4	Individual Design Project	--	1	--	--
RHP480	1-3	Field Practice in Radiation Protection	3	5	1	--
NE484*	3	Applied Radiation Safety	--	3	--	--
RHP484*	3	Applied Radiation Safety	--	6	--	--
NE486	3	Radiation Dosimetry	6	--	--	--
RHP486	3	Radiation Dosimetry	9	--	--	--
RHP487	3	Radiation Biology	--	--	7	--
RHP488	3	Radioecology	--	--	2	--
NE499	1-16	St/Environmental Aspects Nuclear Systems	--	1	--	--
RHP499	1-16	St/Envrionmental Aspects Nuclear Systems	--	1	--	--
NE501	1-16	Research	1	--	--	--
RHP501	1-16	Research	--	--	--	--
NE505	1-16	Reading and Conference	2	--	1	--
RHP505	1-16	Reading and Conference	--	--	--	--
NE506	1-16	Projects	--	--	--	--
RHP506	1-16	Projects	1	--	--	--
NE507	1	Nuclear Engineering Seminar	2	5	2	--
NE507	1	Sem/Management of Mixed Waste	1	--	--	--
NE510	1-12	Internship	--	--	--	--

ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

Table III.D.1 (continued)

Student Enrollment in Nuclear Engineering, Radiation Health Physics and Nuclear Science Courses Which Are Taught or Partially Taught at the Radiation Center

RHP510	1-12	Internship	--	1	1	--
NE535	3	Nuclear Radiation Shielding	--	5	--	--
RHP535	3	Nuclear Radiation Shielding	--	2	--	--
NE543	3	Radioactive Waste Management	--	--	2	--
RHP543	3	Radioactive Waste Management	--	--	2	--
NE554	3	Advanced Nuclear Reactor Analysis	5	--	--	--
NE555	3	Advanced Nuclear Reactor Analysis	--	5	--	--
NE556	3	Advanced Nuclear Reactor Analysis	--	--	5	--
NE557**	3	Nuclear Reactor Laboratory	--	--	4	--
NE567	3	Advanced Nuclear Reactor Thermal Hydraulics	3	--	--	--
NE568	3	Nuclear Reactor Safety	--	--	6	--
NE569	1-3	ST/Instr Nuclear Reactor Thermal Hydraulics	3	--	--	--
NE571	3	Nuclear Power Systems Design	--	3	--	--
NE572	3	Nuclear Power Systems Design	--	--	2	--
RHP580	1-3	Field Practice in Radiation Protection	--	--	--	--
NE 584*	3	Applied Radiation Safety	--	--	--	--
RHP584*	3	Applied Radiation Safety	--	--	--	--
NE585	3	Environmental Aspects Nuclear Systems	--	3	--	--
RHP585	3	Environmental Aspects Nuclear Systems	--	1	--	--
NE586	3	Advanced Radiation Dosimetry	1	--	--	--
RHP586	3	Advanced Radiation Dosimetry	2	--	--	--
RHP587	3	Radiation Biology	--	--	2	--
RHP589	1-3	St/Radiation Protection and Risk Evaluation	--	5	--	--
NE601	1-16	Research	--	--	--	--
RHP601	1-16	Research	1	--	--	--
NE603	1-16	Thesis	--	-	-	--

ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

Table III.D.1 (continued)

Student Enrollment in Nuclear Engineering, Radiation Health Physics and Nuclear Science Courses Which Are Taught or Partially Taught at the Radiation Center

NE603	1-16	Thesis	-	-	-	1
NE603	1-16	Thesis	4	3	3	--
RHP603	1-163	Thesis	4	4	5	1
NE605	1-16	Reading and Conference	--	--	--	--
RHP605	1-16	Reading and Conference	--	--	--	--
NE606	1-16	Projects	--	--	--	--
RHP606	1-16	Projects	--	--	--	--
NE607	1	Nuclear Engineering Seminar	1	1	--	--
RHP 607	1	Nuclear Engineering Seminar	1	--	--	--
RHP610	1-12	Internship	--	--	--	--
NE654	3	Neutron Transport Theory	5	--	--	--
Courses from Other Departments						
CH222*	5	General Chemistry (Science Majors)	--	441	--	--
CH462*	3	Experimental Chemistry II Laboratory	--	45	--	--
CH503	1-16	Thesis (Chemistry)	2	1	1	--
CHE101	3	Chemical Engineering Orientation	40	--	--	--
CE356	3	Technology and Environmental Systems	--	--	45	--
Courses from Other Institutions						
CH 223*	PCC	Chemistry	--	--	--	20
RH 289	LBCC	Alternate Energy Sources	12	30	--	--
GS 105	CCC	General Science	--	--	--	--
GS 105	LBCC	General Science	--	84	--	--
CH 223	LBCC	Nuclear Energy	54	38	68	--
CH100	WOU	Chemistry	--	-	60	--

NOTE:
This table does not include the thesis courses from other OSU departments (see Table VI.C.2).

ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

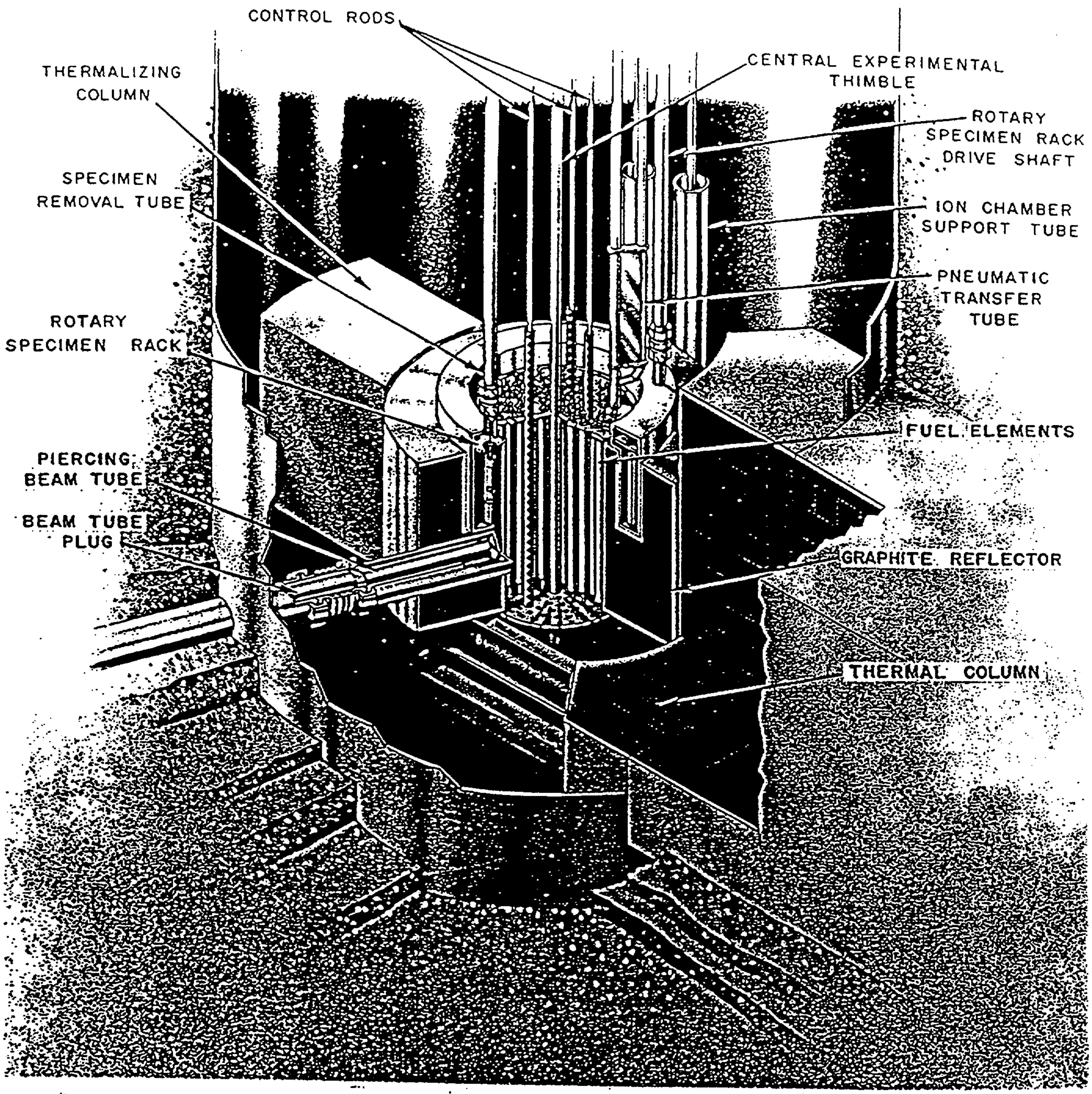


Fig. III.A.1 Cutaway View of Standard TRIGA Mark II Core Arrangement

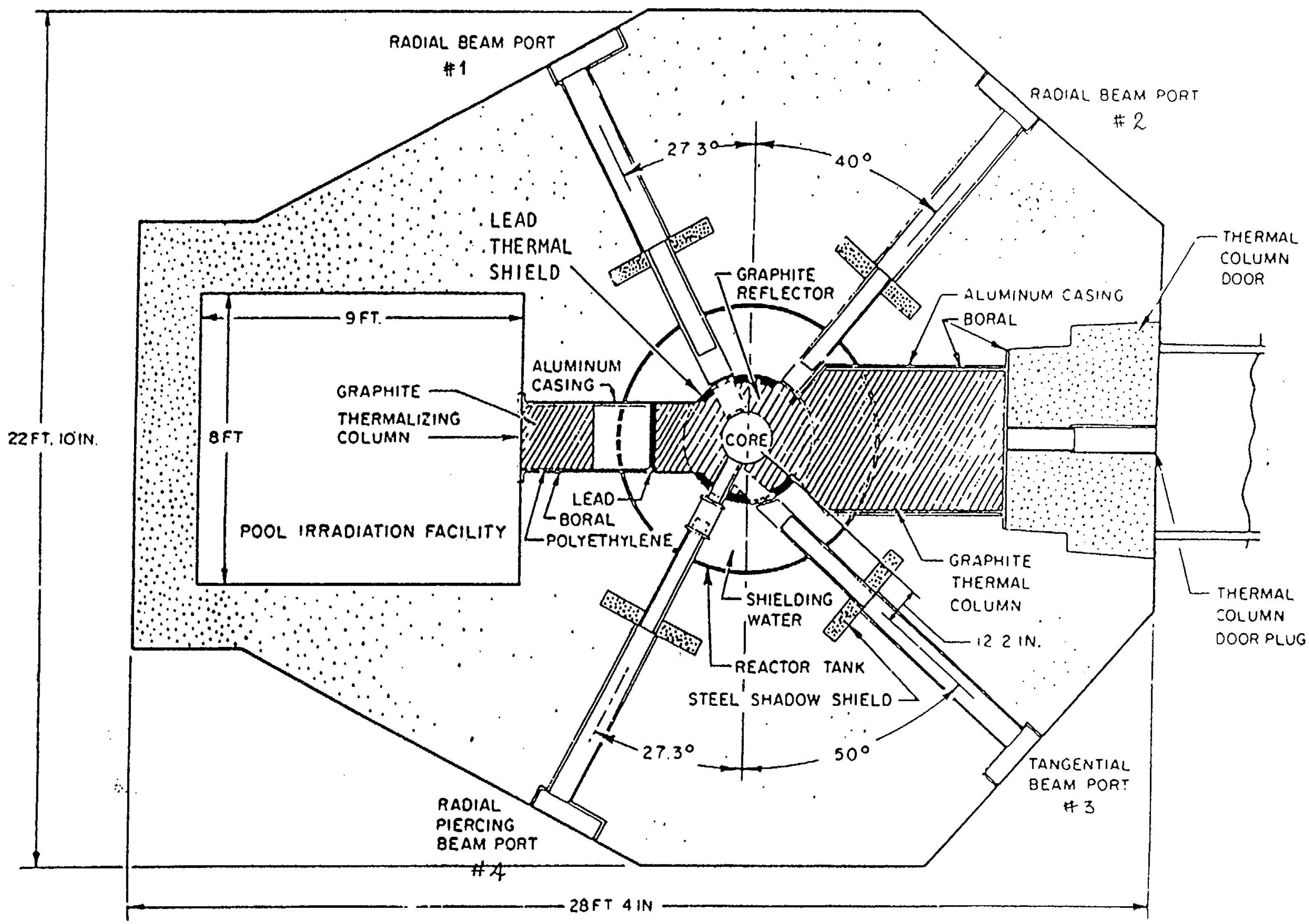


Fig. III.A.2 Horizontal Section of TRIGA Mark II Reactor

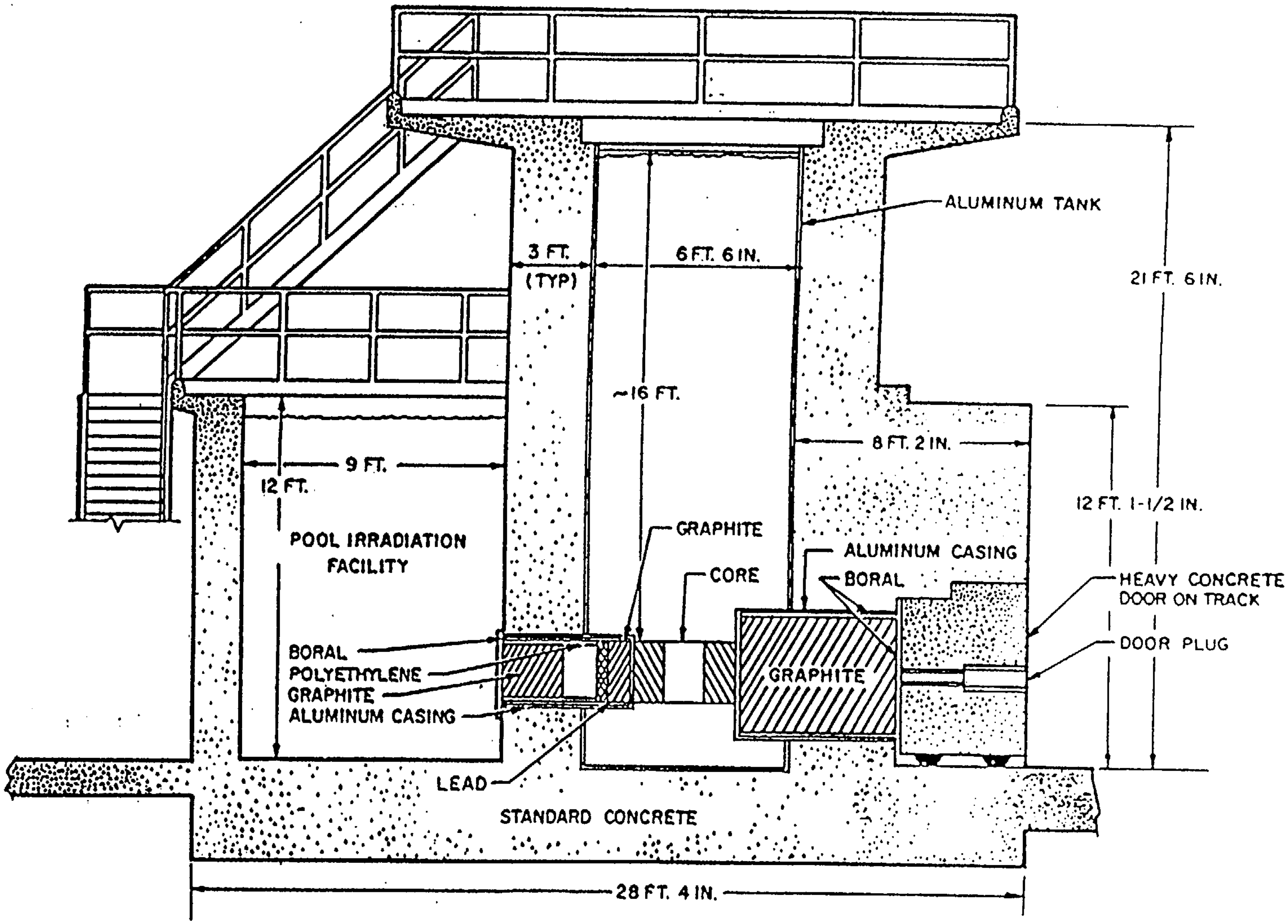


Fig. III.A.3 Vertical Section of TRIGA Mark II Reactor

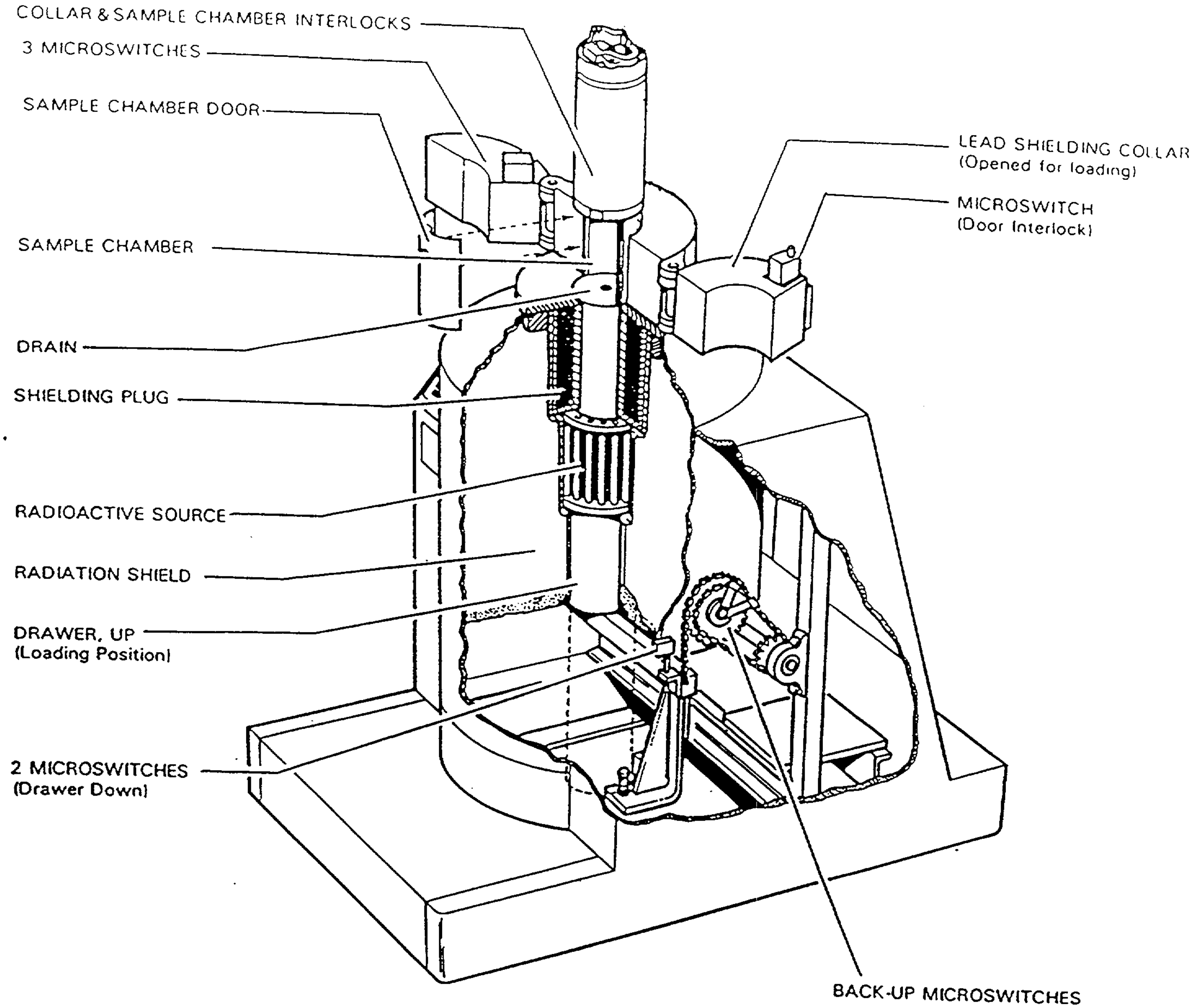
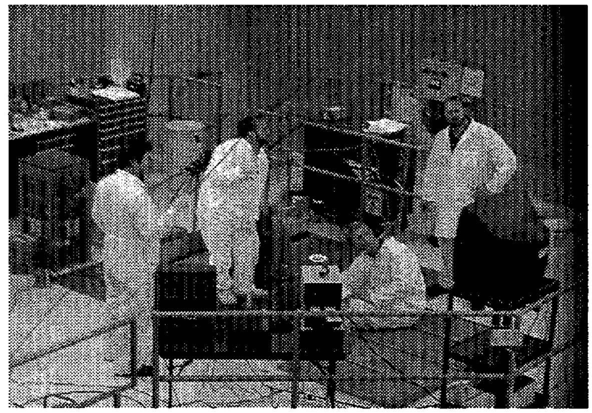
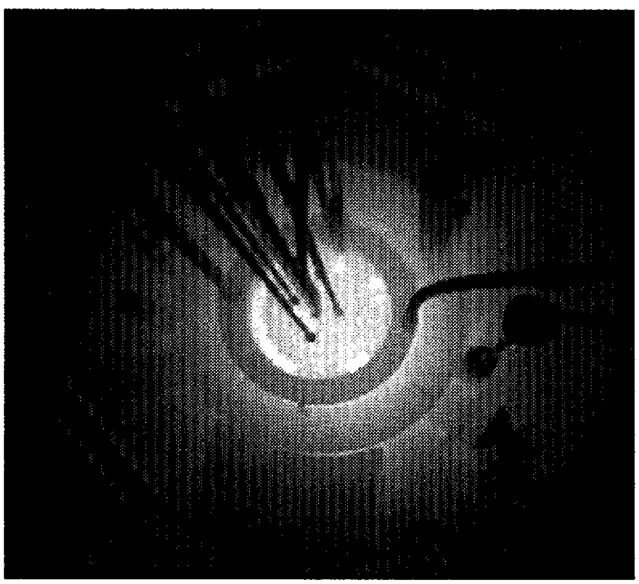


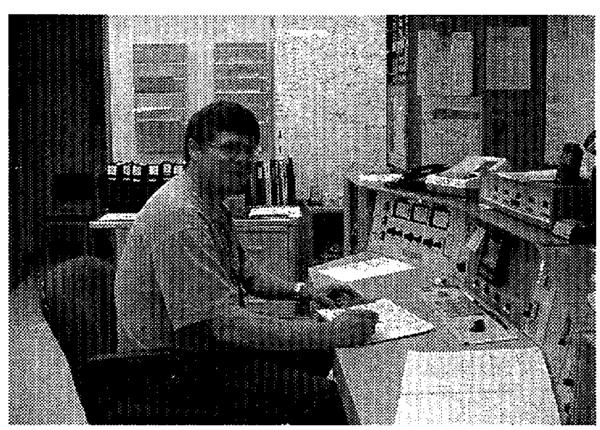
Fig. III.C.1 Gammacell 220 ^{60}Co Irradiator

Part IV

Reactor







Part IV

REACTOR

A. Operating Statistics

Operating data by individual category are given in Table IV.A.1 and annual energy production is plotted in Figure IV.A.1. Table IV.A.2 is included mainly for reference and summarizes the operating statistics for the original 20% enriched fuel.

Thermal energy generated in the reactor during this reporting period was 35.5 megawatt days (MWD). The cumulative thermal energy generated by the FLIP core now totals 910.4 MWD from August 1, 1976 through June 30, 2000. Reactor use time averaged 82% of the normal nine-hour, five-day per week schedule. Tables IV.A.3 through IV.A.5 detail the operating statistics applicable to this reporting period.

The reactor core excess reactivity increased slightly (~8¢) over this reporting period. This slight increase is due to the erbium poison in the fuel elements burning at a faster rate than the fuel.

B. Experiments Performed

1. Approved Experiments

During the current reporting period there were seven approved reactor experiments, listed below, available for use in reactor-related programs. Missing numbers signify reactor experiments which are in the inactive file and are not currently being used. These are listed in the next section.

A-1	Normal TRIGA Operation (No Sample Irradiation).
B-3	Irradiation of Materials in the Standard OSTR Irradiation Facilities.
B-11	Irradiation of Materials Involving Specific Quantities of Uranium and Thorium in the Standard OSTR Irradiation Facilities.
B-12	Exploratory Experiments.
B-23	Studies Using TRIGA Thermal Column.
B-29	Reactivity Worth of Fuel.
B-31	TRIGA Flux Mapping.
B-32	Argon Production Facility

Of the approved experiments on the active list, five were used during the reporting period. A tabulation of information relating to reactor experiment use is given in Table IV.B.1 and includes a listing of the experiments which were used, how often each was used, and the general purpose of the use.

2. Inactive Experiments

Presently 32 experiments are in the inactive file. This consists of experiments which have been performed in the past and may be reactivated. Many of these experiments are now performed under the more general experiments listed in the previous section. The following list identifies these 32 inactive experiments.

A-2	Measurement of Reactor Power Level via Mn Activation.
A-3	Measurement of Cd Ratios for Mn, In, and Au in Rotating Rack.
A-4	Neutron Flux Measurements in TRIGA.
A-5	Copper Wire Irradiation.
A-6	In-core Irradiation of LiF Crystals.
A-7	Investigation of TRIGA's Reactor Bath Water Temperature Coefficient and High Power Level Power Fluctuation.
B-1	Activation Analysis of Stone Meteorites, Other Meteorites, and Terrestrial Rocks.
B-2	Measurements of Cd Ratios of Mn, In, and Au in Thermal Column.
B-4	Flux Mapping.
B-5	In-core Irradiation of Foils for Neutron Spectral Measurements.
B-6	Measurements of Neutron Spectra in External Irradiation Facilities.
B-7	Measurements of Gamma Doses in External Irradiation Facilities.
B-8	Isotope Production.
B-9	Neutron Radiography.
B-10	Neutron Diffraction.
B-13	This experiment number was changed to A-7.
B-14	Detection of Chemically Bound Neutrons.

B-15	This experiment number was changed to C-1.
B-16	Production and Preparation of ^{18}F.
B-17	Fission Fragment Gamma Ray Angular Correlations.
B-18	A Study of Delayed Status (n, γ) Produced Nuclei.
B-19	Instrument Timing via Light Triggering.
B-20	Sinusoidal Pile Oscillator.
B-21	Beam Port #3 Neutron Radiography Facility.
B-22	Water Flow Measurements Through TRIGA Core.
B-24	General Neutron Radiography.
B-25	Neutron Flux Monitors.
B-26	Fast Neutron Spectrum Generator.
B-27	Neutron Flux Determination Adjacent to the OSTR Core.
B-28	Gamma Scan of Sodium (TED) Capsule.
B-30	NAA of Jet, Diesel, and Furnace Fuels.
C-1	PuO_2 Transient Experiment.

C. Unplanned Shutdowns

There were seven unplanned reactor scrams during the current reporting period. A scram occurs when the control rods drop in as a result of an automatic trip or as a result of the operator pushing the manual trip button. Table IV.C.1 contains a summary of the unplanned scrams, including a brief description of the cause of each.

D. Changes to the OSTR Facility, to Reactor Procedures, and to Reactor Experiments Performed Pursuant to 10 CFR 50.59

The information contained in this section of the report provides a summary of the changes performed during the reporting period under the provisions of 10 CFR 50.59. For each item listed, there is a brief description of the action taken and a summary of the applicable safety evaluation. Although it may not be specifically stated in each of the following safety evaluations, all actions taken under 10 CFR 50.59 were implemented only after it was established by the OSTR Reactor Operations Committee (ROC) that the proposed activity did not require a change in the facility's Technical Specifications and did not introduce or create an unreviewed safety question as defined in 10 CFR 50.59(a)(2).

1. 10 CFR 50.59 Changes to the Reactor Facility

There were six changes to the reactor facility during the reporting period.

(1) *Disassembly of the Beam Port #3 Blockhouse*

a. Description

In order to utilize the neutron radiography facilities, the reactor operations staff proposed to disassemble the blockhouse surrounding the door to Beam Port #3. This involved disconnecting the Beam Port #3 High Radiation Area, Beam Port #3 Water Shutter, Beam Port #3 Lead Shutter and the Beam Port #3 Access Door annunciator panel alarms as they would no longer be relevant. Following the removal of the concrete blockhouse, the water shutter was removed (for maintenance/repair) and the inner and outer beam plugs were reinserted. This returned Beam Port #3 to its original configuration, identical to Beam Port #2. This evaluation only covered the disassembly of the Beam Port #3 blockhouse. Reconstruction of the blockhouse will be covered under a future 50.59 safety evaluation.

A series of flux measurements, under Experiment B-31, are planned for Beam Port #1 and Beam Port #3 to determine the thermal and epithermal neutron and gamma fluxes in each.

(b) Safety Evaluation

There were no changes in reactivity expected or observed. Beam Port #3 is a tangential beam intersecting with Beam Port #4. Although the inner plug is composed of concrete (capped with lead and boron), there is no expected or observed increase in the core reactivity from neutrons reflected back through the tangential beam port.

The dose rate observed on the outside of the beam port door when fully assembled was expected and observed to be considerably less than Beam Port #2 due to the lack of a direct path to the core. Experience with the Beam Port #2 configuration shows that all radiation fields emanating will not only be well within regulatory limits, but also consistent with Radiation Center ALARA principles.

(2) *Installation of a Timer for the Inverter Battery Charger*

(a) Description

The reactor operations staff proposed to add a timer to the inverter battery charger. The emergency power system inverter battery charger includes provisions for a step change in charge voltage. This increased charge voltage is referred to as an equalize charge. The purpose of this equalize charge is to equalize the charge on all of the cells in the battery bank. As designed, the equalize charge was started manually with a toggle switch and could be stopped either manually or automatically after 24 hours. For a lead/acid battery bank, the 24-hour charge was excessive and led to high water consumption. For this reason, the charge was usually stopped manually after 2 to 4 hours. The proposed modification to the inverter added a timer to start and stop the equalize charge automatically, much the same way the timer on the emergency generator functions.

The solid state timer module receives 120 VAC from the inverted AC output meter. When the relay output of the timer module turns on, transistor Q1 is turned on as C1 charges through R1. Relay K1 is picked up and the battery charger is placed in the equalized charge mode. Transistor Q1 will be on for about 0.25 s while C1 charges. When the timer output turns off, C1 discharges and C2 charges, turning on Q2 and picking up relay K2. This turns off the equalize charge, placing the batteries on a float charge. The timer was located on the front panel of the inverter.

(b) Safety Evaluation

The purpose of this device was to reduce excess wear and tear on the inverter batteries by providing a consistent and repeatable charge time. Addition of the timer to the inverter system did not effect reactivity of the core. The system was functionally tested after installation and a test of the entire inverter system was performed per OSTROP 16.XVII, *Emergency Power Inverter Test.*

(3) *Control Rod Position Indication*

(a) Description

The Reactor Operations staff proposed to replace the current Nixie tube control rod position indicators with new LCD displays. These displays were positioned directly below the data recorder in the main console.

The new rod position indication system displays control rod positions on a scale ranging from 0.0 to 100.0 for all four control rods. The old Nixie tube display gave dimensionless units ranging from 100 to approximately 950. Additionally, all of the position indicators are installed inside the console. The external Nixie tube box has been removed.

Rod position indication is derived from a shaft-coupled potentiometer on each rod drive unit. Previously, these potentiometers were 10K ohm. Full travel of the rod resulted in about 7.5 revolutions of the potentiometer. A regulated voltage was placed across each potentiometer. One side of the potentiometer was connected to a positive voltage while the other was connected to a negative voltage. The voltage on the slider of the potentiometer, referenced to common, was displayed on the panel meter as rod position. Adjusting the negative voltage to the potentiometer changed the zero offset. Adjusting the positive voltage changed the span. In this arrangement, the indication was affected, to some extent, by resistance changes in all three wires to the potentiometer.

The new system uses a 1 K ohm potentiometer. A current regulated at 5 mAmps is sent through the potentiometer. This results in a 3.75 volt change at the slider for full travel of the rod. This signal is be filtered to remove any line AC component and sent through a voltage follower stage to prevent loading. Display span is adjusted on the output of the voltage follower. The reference side of the panel meter is connected to an adjustable voltage for zero offset. In this arrangement, the indication is only affected by changes in resistance of the return side wire. Based on the standard resistance for #22 wire, a temperature change of 0°C to 75°C will change the indication by less than 0.06%.

(b) Safety Evaluation

The relationship between the previous rod position indication (Nixie tubes) and the proposed method was found knowing the full down and full up position values on each scale. Full scale for the previous method was approximately 100 to 950 (slightly different for each rod) while the new method displays the same full range as 0.0 to 100.0. To ensure that this relationship between the scales holds true, a complete set of rod calibrations for one core configuration was performed per OSTROP 9. The validity of the conversion was verified over the entire range on all four rods. Only one set of rod calibrations was performed, as the change of rod position indication effected the rod worth curves for the other core configurations similarly. As with all annual calibrations, the Reactor Supervisor had final say as to whether the rod worth curve produced was acceptable as compared with the rod calibration history for the given core configuration.

The required operating voltages for the system come from the dual 12V power supply that supplies the Power Range Monitor. The total load on the power supply, with the new rod position indicators, is still less than 50% of rated. To verify that all console high voltages are functioning properly, a console check was performed per OSTROP 15.XI after the rewiring was completed. Power for the panel meters was isolated from the rest of the circuitry by a DC-to-DC converter and regulated to 9V by the circuit.

There was no expected (or observed) increase in the failure rate of the new rod position indicators over what already exists. In fact, Nixie tubes are increasingly hard and expensive to replace, as they are becoming somewhat dated. Failure of either system (previous or current) results in the same loss of proper rod position indication. Also in both cases, only the display is affected, not the rod mechanism itself. Regardless, the failure mode and result would be identical.

(4) *Demineralizer Pump Coil Replacement and Rewiring*

(a) Description

On August 13, 1999, the coil in the motor controller for the demineralizer pump burned out. Presumably, this occurred sometime during the previous night. The reactor operations staff proposed to replace the coil and change the wiring for the control power source.

The motor controller did receive power from the pump power circuit emanating from power panel "G" in room D-106. The console supplies control power. Control power was altered so that it comes from the pump power circuit, rather than the console. Additionally, a control switch was added in room D-104A to perform the function of the knife switch (manual disconnect). The new control switch, as opposed to the knife switch, is designed for frequent use. The knife switch remains and is used, as intended, for pump maintenance only.

(b) Safety Evaluation

Changing the wiring and the motor controller of the demineralizer pump had no expected or observed effect on core reactivity.

The replacement coil was a direct replacement of the existing coil and did not increase the likelihood or frequency of failure. In the old configuration, the coil remained energized continuously. With the new wiring configuration, the coil is de-energized when the pump is off. This should significantly increase its lifetime. Additionally, there is no need to have control power energized when the very device it is controlling is off.

The wiring change was necessitated by the multiple power sources leading into the pump controller enclosure. Making this change reduces the likelihood of an accident during maintenance. To verify that all console high voltages were functioning properly, a console check was performed per OSTROP 15.XI after the rewiring was completed.

(5) In-Core Irradiation Tube Modification

(a) Description

During a daily survey on August 13, 1999, a radiation beam was discovered emanating from the In-Core Irradiation Tube (ICIT). This beam was created by the shallow angles that make up the vertical offset. The ICIT was to be modified in order to reduce the radiation beam to levels consistent with the Radiation Center's principle of ALARA. The ICIT has been re-designed with the same offset bend configuration as the Cadmium Lined In-Core Irradiation Facility (CLICIT).
Future experiments also required a modified end cap. The purpose of the cap is to prevent ^{41}Ar created in the tube from entering the Reactor Bay. An NPT fitting on the side allows the ^{41}Ar to be vented to the Argon Manifold. A second end cap was designed to allow BNC cables to pass through the top while still maintaining the ability to vent ^{41}Ar out of the tube through the NPT fittings. As in the old end cap, the BNC end cap will be fitted with O-rings to provide a seal with the tube.

Current procedures for the handling of the ICIT were acceptable and were not modified for this change. Procedures for encapsulation of electronic devices were modified.

(b) Safety Evaluation

The proposed ICIT and BNC end cap are made of the same materials (6061-T6 aluminum) as the old ICIT. Core excess measurements for the old ICIT showed no measurable difference between the ICIT core configuration and the SHDFE core configuration. A core excess measurement was taken for the new ICIT but no change in reactivity different than that which was already observed in the SHDFE core configuration was expected or observed. A pressure/soap leak check was performed as well as storing the tube in the Bulk Shield Tank overnight to verify the watertight integrity of the tube.

The new BNC end cap performs as well as the end caps on the ICIT and CLICIT. No increase in failure rate was expected or observed. The one difference between the cap designs was that the old caps are composed of a single piece of machined aluminum whereas the BNC end cap is composed of three parts that are bolted (six bolts) together.

The offset bends on the new ICIT significantly reduced the amount of radiation streaming observed with the original tube configuration. A radiation survey was performed above the facility with reactor power at 1 MW prior to use with experiments to ensure that the facility met the Radiation Center's commitment to ALARA.

(6) *Changes in the schematics for Control Rod Position Indication*

(a) Description

After installation of the new rod position indication system, AC line noise was observed on the input to the circuit. Although line AC noise was anticipated, the originally designed filter system did not remove all that was observed. After some troubleshooting, a solution was found.

The answer was to "beef up" specific capacitors from 0.1 to 2.2 μfarad and place them in parallel with 50 kΩ bleed-off resistors. New capacitors were also added. This modification has reduced the noise to an unobservable level without observably affecting rod indication.

(b) Safety Evaluation

After the troubleshooting modification was done, the linearity of the indicated was verified by physically measuring the rise of the control rod versus indicated values. Core excess and a set of rod curves for the SHDFE core configuration showed that total rod worths and core excesses were within normal parameters.

This did not alter the intent of the safety evaluation performed for the original rod position indication. However, the circuit needed to be modified which necessitated this review.

2. 10 CFR 50.59 Changes to Reactor Procedures

There were three changes to reactor procedures which were reviewed, approved and performed under the provisions of 10 CFR 50.59 during the reporting period.

(1) Revision of OSTROP 6, *Administrative and Personnel Procedures*

(a) Description

Two changes were necessary to update OSTROP 6. First, the title of Radiation Protection Technologist was recently changed to Assistant Health Physicist. Second, the Radiation Center has not had an operable X-ray machine for a number of years. References to X-ray machine operator requirements on the part of the Health Physics staff were deleted.

(b) Safety Evaluation

These changes represent only minor text editing. These changes in no way reduce or alter the intent of the OSTROP.

(2) Revision of OSTROP 17, *Reactor Room Ventilation Procedures*

(a) Description

As a result of annual audits performed during the Reactor Operations Committee meeting on November 19, 1999, a number of changes to OSTROP 17 were recommended. These were:

- In Section A, remove "NOTE: The reactor room ventilation system operates continuously and for the most part will be on most of the time." This is contradictory and not needed.

- In Section A.2.b, include the entire paragraph. When this OSTROP was last updated, part of this paragraph was not included.
- In Section B.2.c.4, replace "After an appropriate time delay,..." with "After approximately 1 minute,..."
- In Figure 17.3, remove the reference to the cadmium rabbit. This was removed several years ago.

Additionally, Reactor Operations proposed the following two changes:

- Update the format to that of the other OSTROPs.
- In the beginning under General Information, add "It is a license requirement that the ventilation system be operating while the reactor is operating."

(b) Safety Evaluation

These changes represent only text editing. These changes in no way reduce or alter the intent of the OSTROP or the OSTR Safety Analysis Report.

3. 10 CFR 50.59 Changes to Reactor Experiments

There were no changes to reactor experiments during this reporting period.

E. Surveillance and Maintenance

1. Non-Routine Maintenance

July 29, 1999	Replaced the belts on the reactor bay exhaust fan.
August 13, 1999	Rewired the thermal column door electrical plug to a shortened length of cable.
August 20, 1999	Rewired central power to the demineralizer pump and replaced its motor control coil.
September 3, 1999	Completed construction of the revised ICIT Facility.
September 28, 1999	Replaced the slow drive motor on the Stack Monitor.

October 14, 1999	Removed the old ICIT Facility from the reactor tank and placed it in storage pit #2.
November 5, 1999	Replaced the regulating control rod drive system gear box.
November 12, 1999	Transferred the SPOOF Program from Fortram source code to Excel spreadsheet format.
November 18, 1999	Performed an underwater camera inspection and video taping of the lower reactor tank and core area components.
November 29, 1999 to December 1, 1999	Disassembled the beam port #3 blockhouse and returned beam port #3 to its original configuration.
December 14, 1999	Installed timer to automatically start and stop the equalizer charge on the Inverter battery bank.
December 17, 1999	Maintenance performed on the Inverter Charger/Rectifier Circuit.
December 21, 1999	Completed painting the reactor bay (over 9,000 square feet, including trim).
December 22, 1999	Replaced the regulatory control rod drive gear box (with older generation spare).
December 27, 1999	Replaced the regulating control rod drive gear box (with the latest generation spare).
January 13, 2000	Replaced a failed neon voltage regulator tube in the 60 cycle test circuit of the Stack Monitor particulate channel.
February 10, 2000	Asbestos crew removed all the insulation from the secondary water pipes on the reactor building roof.
February 16, 2000	Approved that the reactor top continuous air monitor filter will no longer be routinely analyzed by gamma spectroscopy.
February 22, 2000	Replaced area radiation monitor #11.
March 3, 2000	Completed manufacture of the new ICIT and CLICIT facilities.

March 16, 2000	Replaced the Nixie tube control rod position indicators with new LCD displays.
March 23, 2000	Modified the new rod position indication system to completely remove AC line noise on the input to the circuit.
April 12, 2000	Honed the inside surfaces of the new ICIT and CLICIT facilities.
June 6, 2000	Began work in the reactor building on the domestic water repiping job.

2. Routine Surveillance and Maintenance

The OSTR has an extensive routine surveillance and maintenance (S&M) program. Examples of typical S&M checklists are presented in Figures IV.E.1 through IV.E.4. Items marked with an asterisk (*) are required by the OSTR Technical Specifications.

F. Reportable Occurrences

There was one reportable occurrence during the reporting period. The event involved a failure to post and control access to a high radiation area. The occurrence was self-identified and addressed in detail in a report to the NRC dated September 8, 1999

Table IV.A.1

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	August 1, 1976 Through June 30, 1977	July 1, 1977 Through June 30, 1978	July 1, 1978 Through June 30, 1979	July 1, 1979 Through June 30, 1980	July 1, 1980 Through June 30, 1981	July 1, 1981 Through June 30, 1982	July 1, 1982 Through June 30, 1983	July 1, 1983 Through June 30, 1984
Operating Hours (critical)	875	819	458	875	1255	1192	1095	1205
Megawatt Hours	451	496	255	571	1005	999	931	943
Megawatt Days	19.0	20.6	10.6	23.8	41.9	41.6	38.8	39.3
Grams ^{235}U Used	24.0	25.9	13.4	29.8	52.5	52.4	48.6	49.3
Hours at Full Power (1 MW)	401	481	218	552	998	973	890	929
Numbers of Fuel Elements Added or Removed (-)	85	0	2	0	0	1	0	0
Number of Irradiation Requests	44	375	329	372	348	408	396	469

See footnotes following the table.

Table IV.A.1 (Continued)

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	July 1, 1984 Through June 30, 1985	July 1, 1985 Through June 30, 1986	July 1, 1986 Through June 30, 1987	July 1, 1987 Through June 30, 1988	July 1, 1988 Through June 30, 1989	July 1, 1989 Through June 30, 1990	July 1, 1990 Through June 30, 1991	July 1, 1991 Through June 30, 1992
Operating Hours (critical)	1205	1208	1172	1352	1170	1136	1094	1158
Megawatt Hours	946	1042	993	1001	1025	1013	928	1002
Megawatt Days	39.4	43.4	41.4	41.7	42.7	42.2	38.6	41.8
Grams ^{235}U Used	49.5	54.4	51.9	52.3	53.6	53.0	48.5	52.4
Hours at Full Power (1 MW)	904	1024	980	987	1021	1009	909	992
Numbers of Fuel Elements Added or Removed (-)	0	0	0	-2	0	-1,+1	-1	0
Number of Irradiation Requests	407	403	387	373	290	301	286	297

See footnotes following the table.

Table IV.A.1 (Continued)

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	July 1, 1992 Through June 30, 1993	July 1, 1993 Through June 30, 1994	July 1, 1994 Through June 30, 1995	July 1, 1995 Through June 30, 1996	July 1, 1996 Through June 30, 1997	July 1, 1997 Through June 30, 1998	July 1, 1998 Through June 30, 1999	July 1, 1999 Through June 30, 2000
Operating Hours (critical)	1180	1248	1262	1226	1124	1029	1241	949
Megawatt Hours	1026	1122	1117	1105	985	927	1115	852
Megawatt Days	42.7	46.7	46.6	46.0	41.0	38.6	46.5	35.5
Grams ^{235}U Used	53.6	58.6	58.4	57.8	51.5	48.5	58.3	44.6
Hours at Full Power (1 MW)	1000	1109	1110	1101	980	921	1109	843
Numbers of Fuel Elements Added or Removed (-)	0	0	0	-1[(5)]	-1, +1[(7)]	0	-1[(5)]	0
Number of Irradiation Requests	329	303	324	268	282	249	231	234

(1) The reactor was shutdown on July 26, 1976 for one month in order to completely refuel the reactor with a new FLIP fuel core.
(2) No fuel elements were added, but one fueled follower control rod was replaced.
(3) Two fuel elements were removed due to cladding deformation.
(4) One fuel element removed due to cladding deformation and one new fuel element added.
(5) One fuel element removed for core excess adjustment.
(6) No fuel elements were added, but the instrumented fuel element was replaced.
(7) One fuel element removed due to cladding deformation and one used fuel element added.

Table IV.A.2

OSTR Operating Statistics with the Original (20% Enriched) Standard TRIGA Fuel Core

Operational Data for 20% Enriched Core	**Mar 8, 67 Through Jun 30, 68**	**Jul 1, 68 Through Jun 30, 69**	**Jul 1, 69 Through Mar 31, 70**	**Apr 1, 70 Through Mar 31, 71**	**Apr 1, 71 Through Mar 31, 72**	**Apr 1, 72 Through Mar 31, 73**	**Apr 1, 73 Through Mar 31, 74**	**Apr 1, 74 Through Mar 31, 75**	**Apr 1, 75 Through Mar 31, 76**	**Apr 1, 76 Through Jul 26, 76**	**TOTAL: March 67 Through July 76**
Operating Hours (critical)	904	610	567	855	598	954	705	563	794	353	6903
Megawatt Hours	117.2	102.5	138.1	223.8	195.1	497.8	335.9	321.5	408.0	213.0	2553.0
Megawatt Days	4.9	4.3	5.8	9.3	8.1	20.7	14.1	13.4	17.0	9.0	106.4
Grams ^{235}U Used	6.1	5.4	7.2	11.7	10.2	26.0	17.6	16.8	21.4	10.7	133.0
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

(1) Reactor went critical on March 8, 1967 (70 element core; 250kW). Note: This period length is 1.33 years as initial criticality occurred in March of 1967.
(2) Reactor shutdown August 22, 1969 for one month for upgrading to 1MW (did not upgrade cooling system). Note: This period length is only 0.75 years as there was a change in the reporting period from July-June to April-March.
(3) Reactor shutdown June 1, 1971 for one month for cooling system upgrading.
(4) Reactor shutdown July 26, 1976 for one month for refueling reactor with a new full FLIP fuel core. Note: This period length is 0.33 years.

Table IV.A.3

Present OSTR Operating Statistics

Operational Data for FLIP Core	**Annual Values**	**Cumulative Values for FLIP Core**
MWH of energy produced	852	21,848
MWD of energy produced	35.5	910.4
Grams ^{235}U used	44.6	1,142.5
Number of fuel elements added to (+) or removed from (-) the core	0	80 + 3 FFCR(1)
Number of pulses	38	1,339
Hours reactor critical	949	26,793
Hours at full power (1 MW)	843	21,441
Number of startup and shutdown checks	256	6,065
Number of irradiation requests processed(2)	234	8,104
Number of samples irradiated	2,501	99,620

(1) Fuel Follower Control Rod. These numbers represent the core loading at the end of this reporting period.

(2) Each irradiation request could authorize from 0 to 160 samples. The number of samples per irradiation request averaged 15.7 during the current reporting period.

Table IV.A.4

OSTR Use Time in Terms of Specific Use Categories

OSTR Use Category	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
Teaching (departmental and others)(1)	790	12,302
OSU research(2)	137	8,584
Off-campus research(2)	884	14,376
Forensic services	10	231(3)
Reactor preclude time	983	18,627
Facility time(4)	94	7086
Visitor demonstration(5)	7	325
TOTAL REACTOR USE TIME	2,905(6)	61,531

(1) See Tables III.A.2 and III.D.1 for teaching statistics.

(2) See Table III.A.3 for research statistics.

(3) Prior to the 1981-1982 reporting period, forensic services were grouped under another use category and the cumulative hours have been compiled beginning with the 1981-1982 report.

(4) The time OSTR spent operating to meet NRC facility license requirements.

(5) This is the time that the reactor was used specifically for visitor open-house (demonstration) events. The remainder of the visitors viewed the reactor during times when the reactor was being operated for regularly scheduled research and teaching.

(6) Total reactor use time includes all multiple use hours added separately.

Table IV.A.5

OSTR Multiple Use Time[(1)]

Number of Users	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
Two	227	3,854
Three	36	1,197
Four	12	446
Five	1	115
Six	0	45.5
Seven	0	11
TOTAL MULTIPLE USE TIME	276[(2)]	5,668.5[(3)]

(1) Multiple use time is that time when two or more irradiation requests are being concurrently fulfilled by operation of the reactor.

(2) This represents 29% of the total hours the reactor was critical during this reporting period.

(3) This represents 21% of the total hours the reactor was critical since startup with FLIP fuel in August of 1976.

Figure IV.A.1 OSTR Annual Energy Production Vs. Time (Annual Reporting Period)

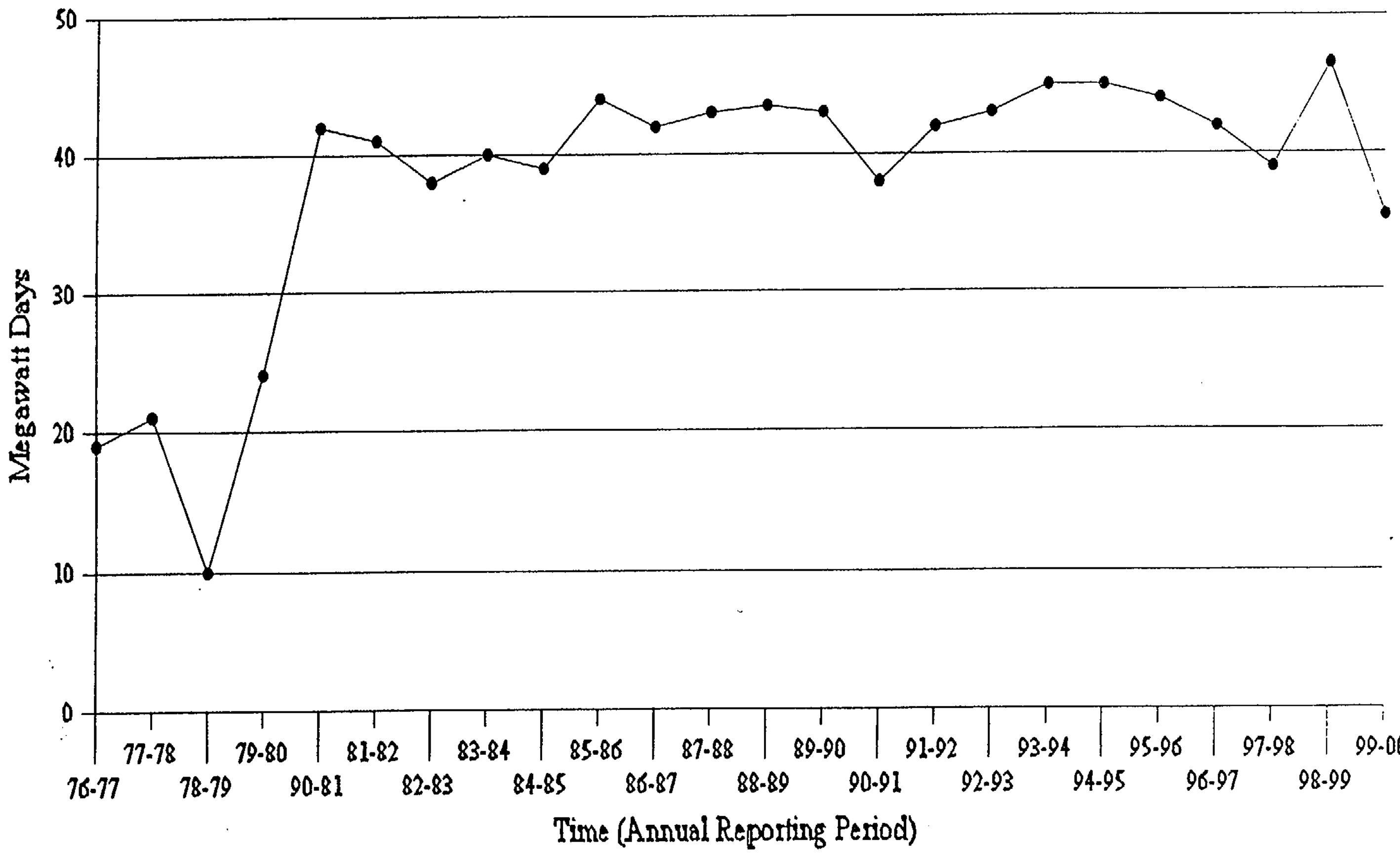


Table IV.B.1

Use of OSTR Reactor Experiments[1]

Reactor Experiment Number[2]	Research	Teaching	Forensic	Facility Time[3]	TOTAL
A-1	2	29	0	22	53
B-3	136	33	3	N/A	172
B-11	1	0	0	N/A	1
B-31	1	0	0	N/A	1
B-32	7	0	0	N/A	7
TOTAL	147	62	3	22	234

---

(1) This table displays the number of times reactor experiments were used for a particular purpose.

(2) The following tabulation gives the number of each reactor experiment used and its corresponding title:

- A-1 Normal TRIGA Operation
- B-3 Irradiation of Materials in the Standard OSTR Irradiation Facilities
- B-11 Irradiation of Materials Involving Specific Quantities of Uranium and Thorium in the Standard OSTR Irradiation Facilities
- B-31 TRIGA Flux Mapping
- B-32 Argon Production Facility

(3) The number of times the OSTR operated to meet NRC facility license requirements.

Table IV.C.1

Unplanned Reactor Shutdowns and Scrams

Type of Event	Number of Occurrences	Cause of Event
Safety Channel Power Scram	1	The scram set point on the safety channel was reached while balancing rods at 1MW.
Manual Scram	3	Stack monitor filter failure alarm. The filter was replaced and reactor operation was resumed.
Period Scram	1	Operator withdrew too much control rod while performing a control rod calibration procedure.
Manual Scram	1	Operator observed that the regulating rod drive system was sticking. The reactor was scrammed and the rod drive assembly was inspected. Regulating rod drive gear box was replaced.
Manual Scram	1	Shutdown was prompted by the failure of the pneumatic transfer system to properly return a rabbit sample from the reactor. Lubricating a transfer system solenoid valve corrected the problem.

Figure IV.E.1
Monthly Surveillance and Maintenance (Sample Form)

OSTROP 13 SURVEILLANCE & MAINTENANCE FOR THE MONTH OF

SURVEILLANCE & MAINTENANCE TO BE PERFORMED	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED **	DATE COMPLETED	REMARKS & INITIALS
*1 FUNCTIONAL CHECK OF REACTOR WATER LEVEL ALARMS & GREEN LIGHT ALARM	MAXIMUM MOVEMENT ± 3 INCHES	UP:______INCHES DN:______INCHES ANN:______ GREEN LIGHT:______				
2 MEASUREMENT OF THE REACTOR PRIMARY WATER pH	MIN: 5 MAX: 8.5					
3 MEASUREMENT OF THE BULK SHIELD TANK WATER pH	MIN: 5 MAX: 8.5					
4 EMERGENCY POWER SYSTEM BATTERY CHECKS	LIQUID: ~1"DN					
INVERTER	S.G.: >1.250					
	FUNCTIONAL CHECK					
GENERATOR	S.G.: >1.250					
	VOLTS ≥ 12.6V DC					
5 EVACUATION HORN & P.A. EMERGENCY SYSTEM BATTERY CHECKS	LIQUID: FULL					
	S.G.: >1.250					
	VOLTS ≥ 12.6V DC					
	CORR: NONE					
6 INSPECTION OF THE BRUSHES ON THE PNEUMATIC TRANSFER SYSTEM BLOWER MOTOR	CHANGE WHEN ¼" LEFT					
7 REVIEW REACTOR SUPERVISOR'S LOG	CURRENT					
8 CHANGE LAZY SUSAN FILTER	FILTER CHANGED					
9 LUBRICATE THE TRIGA TUBE LOADING TOOL (REEL)	USE OIL GUN	NEED OIL?______				
10 REACTOR TOP CAM OIL LEVEL CHECK	OSTROP 13.10	NEED OIL?______				
11 PROPANE TANK LIQUID LEVEL CHECK (%FULL)	> 50%					
*12 BULK WATER TEMPERATURE ALARM CHECK	FUNCTIONAL					
13 PRIMARY PUMP BEARINGS OIL LEVEL CHECK	OSTROP 13.13	NEED OIL?______				

* License Requirement

** Date not to be exceeded is only applicable to marked (*) items. It is equal to the time completed last month plus six weeks.

Rev. 3/98

Figure IV.E.2
Quarterly Surveillance and Maintenance (Sample Form)

OSTROP 14 **SURVEILLANCE & MAINTENANCE FOR THE *QUARTER* OF ________/________/________ 19____**

	SURVEILLANCE & MAINTENANCE TO BE PERFORMED	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED**	DATE COMPLETED	REMARKS & INITIALS
* 1	REACTOR OPERATION COMMITTEE (ROC) AUDIT OF REACTOR OPERATIONS FOR ____/____/____ QUARTER	QUARTERLY					
* 2	QUARTERLY ROC MEETING	QUARTERLY					
‡ 3	FUEL ELEMENT RADIATION LEVEL MEASUREMENTS IN WATER	≥23 R/hr @ 2' IN WATER					
4	INSPECTION OF THE SOLENOID VALVES IN THE PNEUMATIC TRANSFER SYSTEM	FUNCTIONAL					
5	PNEUMATIC TRANSFER SYSTEM INSERTION TIME CHECK	≤6 SECONDS					
6	ROTATING RACK CHECK FOR UNKNOWN SAMPLES	RACK SHOULD BE EMPTY					
7	FUNCTIONAL CHECK OF EMERGENCY LIGHTS (SEE CHECKSHEET)	FUNCTIONAL					
8	WATER MONITOR ALARM CHECK	FUNCTIONAL					
9	STACK MONITOR CHECKS (OIL DRIVE MOTORS, H.V. READINGS)	MOTORS OILED					
		PART: 1150 V ±50	VOLTS				
		GAS: 900 V ±50	VOLTS				
10	(NOT BEING USED)						
11	ARM SYSTEM ALARM CHECKS	FUNCTIONAL					

CHAN	1	2	3	4	5	6	7	8	9	10	11	12	13	14
AUD														
LIGHT														
PANEL														
ANN														

‡ Physical Security Plan Requirement
* License Requirement
** Date not to be exceeded is only applicable to marked (*) items. It is equal to the date completed last quarter plus four months.

Figure IV.E.2 (Continued)

Quarterly Surveillance and Maintenance (Sample Form)

OSTROP 14 (CONTINUED) SURVEILLANCE & MAINTENANCE FOR THE *QUARTER* OF ________/________/________ 19____

	SURVEILLANCE & MAINTENANCE TO BE PERFORMED	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED**	DATE COMPLETED	REMARKS & INITIALS
12	OPERATOR LOG	a) ≥4 hours: at console (RO) or as Rx. Sup. (SRO) b) Complete Operating Exercise	a) TIME	b) OPERATING EXERCISE			
	NAME						
13	CHECK FILTER TAPE SPEED ON STACK MONITOR	1"/HR ± 0.2					
14	INCORPORATE 50.59 & ROCAS INTO DOCUMENTATION	QUARTERLY					
15	(NOT BEING USED)						
16	FUNCTIONAL CHECK OF EVACUATION ALARMS	ALL FUNCTIONAL					
17	(NOT BEING USED)						
18	STACK MONITOR ALARM CIRCUIT CHECKS	ALARM ON CONTACT					
19	ALARM TESTING OF VITAL AREA DOUBLE DOORS	FUNCTIONAL					

‡ Physical Security Plan Requirement
* License Requirement
** Date not to be exceeded is only applicable to marked (*) items. It is equal to the date completed last quarter plus four months.

Figure IV.E.3
Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP.15

SEMI-ANNUAL SURVEILLANCE AND MAINTENANCE FOR ____________________

No.	SURVEILLANCE & MAINTENANCE TO BE PERFORMED		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED**	DATE COMPLETED	REMARKS & INITIALS
*1	FUNCTIONAL CHECKS OF REACTOR INTERLOCKS	a) NEUTRON SOURCE COUNT RATE INTERLOCK	NO WITHDRAW	a1				
			≥5 cps	a2				
		b) TRANSIENT ROD AIR INTERLOCK	NO PULSE	b				
		c) PULSE PROHIBIT ABOVE 1 kW	≥1 kW	c				
		d) TWO ROD WITHDRAWAL PROHIBIT	1 only	d				
		e) PULSE MODE ROD MOVEMENT INTERLOCK	NO MOVEMENT	e				
		f) MAXIMUM PULSE REACTIVITY INSERTION LIMIT	≤ $2.50	f				
		g) PULSE INTERLOCK ON RANGE SWITCH	NO PULSE	g				
*2	SAFETY CIRCUIT TEST	PERIOD SCRAM	≥3 sec					
*3	CONTROL ROD WITHDRAWAL, INSERTION & SCRAM TIMES	TRANS / SAFE / SHIM / REG						
		a) SCRAM	≤2 sec	a				
		b) WITHDRAWAL	≤50 sec	b				
		c) INSERTION	≤50 sec	c				
*4	PULSE COMPARISON (PREVIOUS PULSE):	PULSE # ______ $ ______ ______ MW ______ °C	≤20% CHANGE	PULSE # ____ $ ____ ____ MW ____ °C				
*5	REACTOR BAY VENTILATION SYSTEM SHUTDOWN TEST		DAMPERS CLOSE IN ≤5 SECONDS	4TH FLOOR ____ 1ST FLOOR ____				
*6	CALIBRATION OF THE FUEL ELEMENT TEMPERATURE CHANNEL		±2°C					
*7	MATERIALS BALANCE REPORT/FUEL MANAGEMENT		REPORTS DONE/ - EVEN BURNUP		APRIL 15 OCTOBER 15	APRIL 30 OCTOBER 30		
*8	CLEANING & LUBRICATION OF TRANSIENT ROD CARRIER INTERNAL BARREL		3-IN-1 or GUN OIL	CLEANED ____ OILED ____				
*9	LUBRICATION OF BALL-NUT DRIVE ON TRANSIENT ROD CARRIER		3-IN-1 or GUN OIL	MOLY KOTE ____ OILED ____				
10	LUBRICATION OF THE ROTATING RACK BEARINGS		10 W OIL	OILED ____				
11	CONSOLE CHECK LIST (OSTROP 15.11)		OSTROP 15.11					
12	CONSTANT AIR MONITOR RECORDER MAINTENANCE							

* License Requirements.

** Date not to be exceeded is only applicable to marked (*) items. It is equal to the date last time plus 7½ months.

Rev. 11/92

Figure IV.E.3 (Continued)

Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP 15 (continued)

SEMI-ANNUAL SURVEILLANCE AND MAINTENANCE FOR ______________ -

	SURVEILLANCE & MAINTENANCE TO BE PERFORMED		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED**	DATE COMPLETED	REMARKS & INITIALS
13	Deleted							
14	STANDARD CONTROL ROD MOTOR CHECKS			OILED ____				
15	Deleted							
16	ION CHAMBER RESISTANCE MEASUREMENTS WITH MEGGAR INDUCED VOLTAGE	A. SAFETY CHANNEL	NONE (Info Only)					
		B. % POWER CHANNEL	NONE (Info Only)					
17	FISSION CHAMBER RESISTANCE CALCULATION $R = \frac{800V}{\Delta I}$	@ 100 V. I = ________AMPS @ 900 V. I = ________AMPS ΔI = ________AMPS R = ________Ω	NONE (Info Only)					
18	FUNCTIONAL CHECK OF HOLDUP TANK WATER LEVEL ALARMS		OSTROP 15.18	HIGH ____ FULL ____ GREEN LIGHT ____				

* License Requirements.

** Date not to be exceeded is only applicable to marked (*) items. It is equal to the date last time plus 7½ months.

Rev. 11/94

Figure IV.E.4

Annual Surveillance and Maintenance (Sample Form)

OSTROP 16.0   ANNUAL Surveillance and Maintenance for the Year ________   Page 1

SURVEILLANCE AND MAINTENANCE TO BE PERFORMED			LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED**	DATE COMPLETED	REMARKS & INITIALS
*1	BIENNIAL INSPECTION OF CONTROL RODS:	a) FFCRS	OSTROP 12.0					
		b) TRANS						
*2	ANNUAL REPORT (DUE JUNE 30 + 75 DAYS)		NOV 1		OCT 1	NOV 1		
*3	CONTROL ROD CALIBRATION:	a) SAFE	OSTROP 9.0					
		b) SHIM						
		c) REG						
		d) TRANS						
*4	REACTOR POWER CALIBRATION		OSTROP 8.0					
*5	CALIBRATION OF REACTOR TANK WATER TEMPERATURE METERS		OSTROP 16.5					
*6	CONTINUOUS AIR MONITOR CALIBRATION:	a) Particulate Monitor	RCHPP 18.0					
		b) Gas Monitor						
*7	STACK MONITOR CALIBRATION:	a) Particulate Monitor	RCHPP 18 & 26					
		b) Gas Monitor						
*8	AREA RADIATION MONITOR CALIBRATION		RCHPP 18.0					
*9	WATER MONITOR CALIBRATION		RCHPP 18.0					
10	REACTOR TANK AND CORE COMPONENT INSPECTION		NO POWDERY WHITE SPOTS					
*11	SNM PHYSICAL INVENTORY		OSTROP 20.0					
*12	EMERGENCY RESPONSE PLAN DRILL							
*13	STANDARD CONTROL ROD DRIVE INSPECTION		OSTROP 16.13					
*14	OSU POLICE AND SECURITY RETRAINING							
*15	50.59 REPORT		NOV 15		OCT 15	NOV 15		
*16	INTRUSION ALARM RESPONSE DRILL (OSU POLICE AND SECURITY)		RESPONSE ≤5 MIN					

* License Requirements.

** Date not to be exceeded is only applicable to marked (*) items. It is equal to the date completed last year plus 15 months. For biennial license requirements, it is equal to the date completed last time plus 2½ years.

Rev. 11/92

Figure IV.E.4 (Continued)
Annual Surveillance and Maintenance (Sample Form)

OSTROP 16.0 (continued) ANNUAL Surveillance and Maintenance for the Year __________ Page 2_

	SURVEILLANCE AND MAINTENANCE TO BE PERFORMED	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED**	DATE COMPLETED	REMARKS & INITIALS
17	EMERGENCY POWER INVERTER TEST	OSTROP 22.0					
18	REPLACE P.A. & EVAC SYSTEM LEAD-ACID BATTERIES	EVERY 4 YEARS					

*19 REACTOR OPERATOR LICENSE CONDITIONS

	ANNUAL				BIENNIAL		EVERY 6 YEARS				
	REQUALIFICATION				MEDICAL		NRC REQUAL EXAM		LICENSE		
	WRITTEN EXAMINATIONS		OPERATING TEST						APPLICATION		EXPIRATION DATE
NAME	DUE DATE	DATE PASSED	DUE DATE	DATE PASSED	DUE DATE	DATE COMPLETED	DUE DATE	DATE PASSED	DUE DATE	DATE MAILED	

	SURVEILLANCE AND MAINTENANCE TO BE PERFORMED	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED**	DATE COMPLETED	REMARKS & INITIALS
20	FUEL ELEMENT INSPECTION FOR SELECTED ELEMENTS (B1, B2, B3, B5, B6, C3, C5, D5, D6)	PASS GO/NO GO TEST		Pulse # ________ Date ________	Pulse # ________ Date ________		
*21	DECOMMISSIONING COST UPDATE	N/A	N/A				
22	FUNCTIONAL TEST OF THE REACTOR WATER LOW LEVEL ALARM	MAXIMUM MOVEMENT ~3 INCHES	___INS ___ANN				

23	NAME	ANNUAL - CPR		EVERY 3 YEARS - FIRST AID	
		REMINDER DATE	EXPIRY DATE	REMINDER DATE	EXPIRY DATE

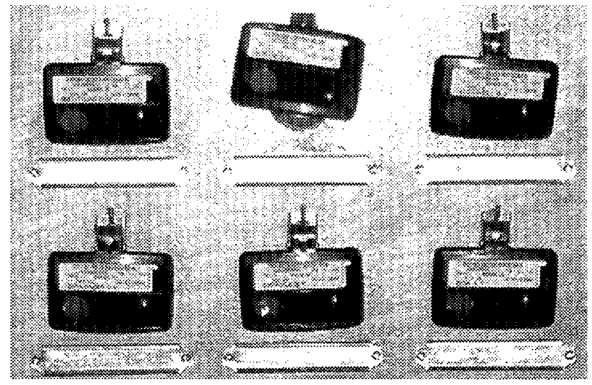
* License Requirements.

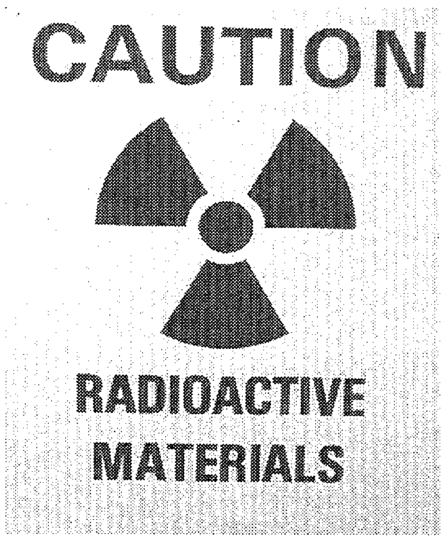
** Date not to be exceeded is only applicable to marked (*) items. It is equal to the date completed last year plus 15 months. For biennial license requirements, it is equal to the date completed last time plus 2½ years

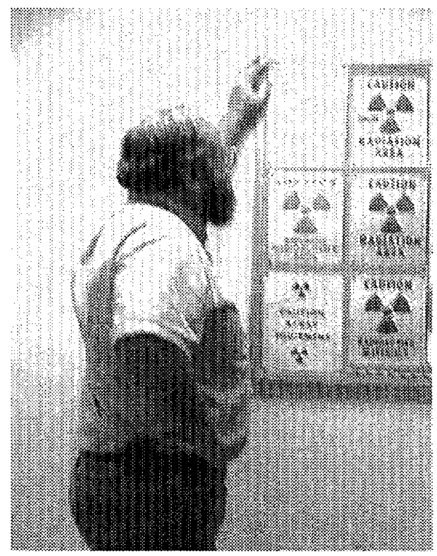
ev. 5/94

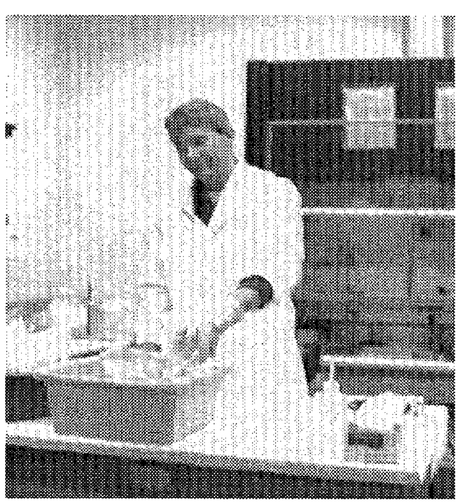
Part V

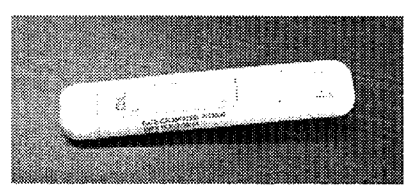
Protection

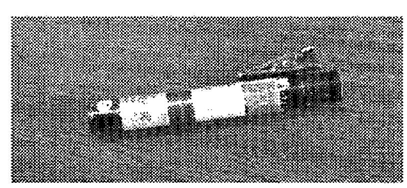












Part V

PROTECTION

A. Introduction

This section of the report deals with the radiation protection program at the OSU Radiation Center. The purpose of this program is to ensure the safe use of radiation and radioactive material in the Center's teaching, research, and service activities, and in a similar manner to ensure the fulfillment of all regulatory requirements of the state of Oregon, the U.S. Nuclear Regulatory Commission, and other regulatory agencies. The comprehensive nature of the program is shown in Table V.A.1, which lists the program's major radiation protection requirements and the performance frequency for each item.

The radiation protection program is implemented by a staff consisting of a Senior Health Physicist, a Health Physicist, an Assistant Health Physicist, and several part-time Health Physics Monitors (see Part II.F). Assistance is also provided by the reactor operations group, the neutron activation analysis group, the Scientific Instrument Technician, and the Radiation Center Director.

The data contained in the following sections have been prepared to comply with the current requirements of Nuclear Regulatory Commission (NRC) Facility License No. R-106 (Docket No. 50-243) and the Technical Specifications contained in that license. The material has also been prepared in compliance with Oregon Office of Energy Rule No. 345-30-010, which requires an annual report of environmental effects due to research reactor operations. A summary of required data for the OSTR is provided in Part I.E for quick reference.

Within the scope of Oregon State University's radiation protection program, it is standard operating policy to maintain all releases of radioactivity to the unrestricted environment and all exposures to radiation and radioactive materials at levels which are consistently "as low as reasonably achievable" (ALARA).

B. Environmental Releases

The annual reporting requirements in the OSTR Technical Specifications state that the licensee (OSU) shall include "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." The liquid and gaseous effluents released, and the solid waste generated and transferred are discussed briefly below. Data regarding these effluents are also summarized in detail in the designated tables.

1. Liquid Effluents Released

a. Liquid Effluents Released

Oregon State University has implemented a policy to reduce the volume of radioactive liquid effluents to an absolute minimum. For example, water used during the ion exchanger resin change is now recycled as reactor makeup water. Waste water from Radiation Center laboratories and the OSTR is collected at a holdup tank prior to release to the sanitary sewer. Whenever possible, liquid effluent is analyzed for radioactivity content at the time it is released to the collection point. However, liquids are always analyzed for radioactivity before the holdup tank is discharged into the unrestricted area (the sanitary sewer system). For this reporting period, the Radiation Center and reactor made two liquid effluent releases to the sanitary sewer. All Radiation Center and reactor facility liquid effluent data pertaining to these releases are contained in Table V.B.1.a.

b. Liquid Waste Generated and Transferred

Liquid waste generated from decontamination of TRIGA tubes and glassware and from laboratory experiments is transferred by the campus Radiation Safety Office to its waste processing facility. Aqueous wastes are absorbed and disposed of as radioactive solid waste. Liquid scintillation fluid is shipped off campus in bulk and in vials for disposal. The annual summary of liquid waste generated and transferred is contained in Table V.B.1.b.

2. Airborne Effluents Released

Airborne effluents are discussed in terms of the gaseous component and the particulate component.

a. Gaseous Effluents

Gaseous effluents from the reactor facility are monitored by the reactor stack effluent monitor. Monitoring is continuous, i.e., prior to, during, and after reactor operations. It is normal for the reactor facility stack effluent 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 the day. All gaseous effluent data for this reporting period are summarized in Table V.B.2.

b. Particulate Effluents

Particulate effluents from the reactor facility are also monitored by the reactor facility stack effluent monitor.

Evaluation of the detectable particulate radioactivity in the stack effluent confirmed its origin as naturally-occurring radon daughter products, within a range of approximately 3×10^{-11} μCi/ml to 1×10^{-9} μCi/ml. This particulate radioactivity is predominantly ^{214}Pb and ^{214}Bi, which is not associated with reactor operations.

There was no release of particulate effluents with a half life greater than eight days and therefore the reporting of the average concentration of radioactive particulates with half lives greater than eight days is not applicable.

3. Solid Waste Released

Data for the radioactive material in the solid waste generated and transferred during this reporting period are summarized in Table V.B.3 for both the reactor facility and the Radiation Center. Solid radioactive waste is routinely transferred to the OSU Radiation Safety Office. Until this waste is disposed of by the Radiation Safety Office, it is held along with other campus radioactive waste on the University's state of Oregon radioactive materials license.

Solid radioactive waste is disposed of by the University Radiation Safety Office by transfer to the University's radioactive waste disposal vendor, Allied Ecology Services, Inc., for burial at its installation located near Richland, Washington.

C. Personnel Doses

The OSTR annual reporting requirements specify that the licensee shall present a summary of the radiation exposure received by facility personnel and visitors. For the purposes of this report, the summary includes all Radiation Center personnel who may have received exposure to radiation. These personnel have been categorized into six groups: facility operating personnel, key facility research personnel, facilities services maintenance personnel, students in laboratory classes, police and security personnel, and visitors.

Facility operating personnel include the reactor operations and health physics staff. The dosimeters used to monitor these individuals include quarterly X-ray, beta, and gamma [Xβ(γ)] film or TLD badges, quarterly track-etch/albedo neutron dosimeters, either monthly or quarterly TLD (finger) extremity dosimeters, and pocket ion chambers.

Key facility research personnel consist of Radiation Center staff, faculty, and graduate students who perform research using the reactor, reactor-activated materials, or using other research facilities present at the Center. The individual dosimetry requirements for these personnel will vary with the type of research being conducted, but will generally include a monthly or quarterly $X\beta(\gamma)$ film badge and TLD (finger) extremity dosimeters. If the possibility of neutron exposure exists, researchers are also monitored with a track-etch/albedo neutron dosimeter.

Facilities Services maintenance personnel are normally issued a gamma sensitive electronic dosimeter as their basic monitoring device. A few Facilities Services personnel who routinely perform maintenance on mechanical or refrigeration equipment are issued a quarterly $X\beta(\gamma)$ TLD badge and other dosimeters as appropriate for the work being performed.

Students attending laboratory classes are issued quarterly $X\beta(G)$ TLD badges, TLD (finger) extremity dosimeters, and track-etch/albedo or other neutron dosimeters, as appropriate.

Students or small groups of students who attend a one-time laboratory demonstration and do not handle radioactive materials are usually issued a gamma sensitive electronic dosimeter. These results are not included with the laboratory class students.

OSU police and security personnel are issued a quarterly $X\beta(\gamma)$ TLD badge to be used during their patrols of the Radiation Center and reactor facility.

Visitors, depending on the locations visited, may be issued a gamma sensitive electronic dosimeters. OSU Radiation Center policy does not normally allow people in the visitor category to become actively involved in the use or handling of radioactive materials.

An annual summary of the radiation doses received by each of the above six groups is shown in Table V.C.1. There were no personnel radiation exposures in excess of the limits in 10 CFR 20 or state of Oregon regulations during the reporting period.

D. Facility Survey Data

The OSTR Technical Specifications require an annual summary of the radiation levels and levels of contamination observed during routine surveys performed at the facility. The Center's comprehensive area radiation monitoring program encompasses the Radiation Center as well as the OSTR, and therefore monitoring results for both facilities are reported.

1. Area Radiation Dosimeters

Area monitoring dosimeters capable of integrating the radiation dose are located at strategic positions throughout the reactor facility and Radiation Center. All of these dosimeters contain at least a standard personnel-type beta-gamma film or TLD pack. In addition, for key locations in the reactor facility and for certain Radiation Center laboratories a CR-39 plastic track-etch neutron detector has also been included in the monitoring package. Figure V.D.1 shows the locations of the dosimeters in the reactor building and Radiation Center.

The total dose equivalent recorded on the various reactor facility dosimeters is listed in Table V.D.1 and the total dose equivalent recorded on the Radiation Center area dosimeters is listed in Table V.D.2. Generally, the characters following the MRC (Monitor Radiation Center) designator show the room number or location.

2. Routine Radiation and Contamination Surveys

The Center's program for routine radiation and contamination surveys consists of daily, weekly, and monthly measurements throughout the TRIGA reactor facility and Radiation Center. The frequency of these surveys is based on the nature of the radiation work being carried out at a particular location or on other factors which indicate that surveillance over a specific area at a defined frequency is desirable.

The primary purpose of the routine radiation and contamination survey program is to assure regularly scheduled surveillance over selected work areas in the reactor facility and in the Radiation Center, in order to provide current and characteristic data on the status of radiological conditions. A second objective of the program is to assure frequent on-the-spot personal observations (along with recorded data), which will provide advance warning of needed corrections and thereby help to ensure the safe use and handling of radiation sources and radioactive materials. A third objective, which is really derived from successful execution of the first two objectives, is to gather and document information which will help to ensure that all phases of the operational and radiation protection programs are meeting the goal of keeping radiation doses to personnel and releases of radioactivity to the environment "as low as reasonably achievable" (ALARA).

The annual summary of radiation and contamination levels measured during routine facility surveys for the applicable reporting period is given in Table V.D.3.

E. Environmental Survey Data

The annual reporting requirements of the OSTR Technical Specifications include "an annual summary of environmental surveys performed outside the facility."

1. Gamma Radiation Monitoring

a. On-site Monitoring

Monitors used in the on-site gamma environmental radiation monitoring program at the Radiation Center consist of the reactor facility stack effluent monitor described in Section V.B.2 and nine environmental monitoring stations. These stations consist of a polyethylene bottle placed inside a PVC tube attached to the reactor building perimeter fence at a height of four feet (see Figure V.E.1).

Each fence environmental station is equipped with an OSU supplied and processed TLD area monitor (normally three Harshaw ^{7}LiF TLD-700 chips per ^{7}Li monitor in a plastic "LEGO" mount). These monitors are exchanged and processed quarterly. The total number of TLD samples for the reporting period was 108 (9 stations x 3 chips per station per quarter x 4 quarters per year). A summary of this TLD data is shown in Table V.E.1.

During this reporting period, each fence environmental station utilized an LIF TLD monitoring packet supplied and processed by ICN Worldwide Dosimetry Service (ICN), Costa Mesa, California. Each ICN packet contained three LIF TLDs and was exchanged quarterly for a total of 108 samples during the reporting period (9 stations x 3TLDs per station x four quarters). The total number of ICN TLD samples for the reporting period was 90. A summary of the ICN TLD data is also shown in Table V.E.1.

Monthly measurements of the direct gamma dose rate (μrem/h) were also made at each fence monitoring station. These measurements were made with a Bicron micro-rem per hour survey meter containing a 1" x 1" NaI detector.

A total of 108 μrem h^{-1} measurements were taken (9 stations per month x 12 months per year). The total calculated dose equivalent was determined by averaging the 12 separate μrem h^{-1} measurements and multiplying this average by 8760 hours per year. A summary of this data is shown in Table V.E.1.

From Table V.E.1 it is concluded that the doses recorded by the dosimeters on the TRIGA facility fence can be attributed to natural background radiation, which is about 110 mrem per year for Oregon (Refs. 1, 2).

b. Off-site Monitoring

The off-site gamma environmental radiation monitoring program consists of twenty monitoring stations surrounding the Radiation Center (see Figure V.E.2) and one station located 5 miles to the south near the Corvallis Airport.

Each off-site radiation monitoring station is equipped with an OSU-supplied and processed TLD monitor. Each monitor consists of three Harshaw ^{7}LiF TLD-700 chips in a plastic "LEGO" mount. The mount is placed in a polyethylene bottle inside a PVC tube which is attached to the station's post about four feet above the ground (MRCTE 21 and MRCTE 22 are mounted on the roof of the EPA Laboratory and National Forage Seed Laboratory, respectively). These monitors are exchanged and processed quarterly, and the total number of TLD samples during the current one-year reporting period was 240 (20 stations x 3 chips per station per quarter x 4 quarters per year). A summary of the OSU off-site TLD data is provided in Table V.E.2. The total number of ICN TLD samples for the reporting period was 144 (12 station x 3 TLDs per station x 4 quarters). The total number of ICN TLD samples for the reporting period was 128. A summary of ICN TLD data for the off-site monitoring stations is also given in Table V.E.2.

In a manner similar to that described for the on-site fence stations, monthly measurements of the direct gamma exposure rate in microrem per hour (μrem h^{-1}) are made at each of the twenty off-site radiation monitoring stations. As noted before, these measurements are made with a Bicron micro-rem per hour survey meter containing a 1" x 1" NaI detector. A total of 240 μrem h^{-1} measurements were made during the reporting period (21 stations per month x 12 months per year). The total dose equivalent for each station was determined by averaging the 12 separate μrem h^{-1} measurements and multiplying this average by 8760 hours per year. A summary of these data is given in Table V.E.2.

After a review of the data in Table V.E.2, it is concluded that, like the dosimeters on the TRIGA facility fence, all of the doses recorded by the off-site dosimeters can be attributed to natural background radiation, which is about 110 mrem per year for Oregon (Refs. 1, 2).

2. Soil, Water, and Vegetation Surveys

The soil, water, and vegetation monitoring program consists of the collection and analysis of a limited number of samples in each category on a quarterly basis. The program monitors highly unlikely radioactive material releases from either the TRIGA reactor facility or the OSU Radiation Center, and also helps indicate the general trend of the radioactivity concentration in each of the various substances sampled. See Figure V.E.2 for the locations of the sampling stations for grass (G), soil (S), water (W) and rainwater (RW) samples. Most locations are within a 1000 foot radius of the reactor facility and the Radiation Center. In general, samples are collected over a local area having a radius of about ten feet at the positions indicated in Figure V.E.2.

There are a total of 22 quarterly sampling locations: four soil locations, four water locations (when water is available), and fourteen vegetation locations. The total number of samples possible during the reporting period is 88 (16 soil samples, 16 water samples, and 56 vegetation samples).

The annual average concentration of total net beta radioactivity (minus tritium) for samples collected at each environmental soil, water, and vegetation sampling location (sampling station) is listed in Table V.E.3. Calculation of the total net beta disintegration rate incorporates subtraction of only the counting system background from the gross beta counting rate, followed by application of an appropriate counting system efficiency.

The annual average concentrations were calculated using sample results which exceeded the lower limit of detection (LLD), except that sample results which were less than or equal to the LLD were averaged in at the corresponding LLD concentration. Table V.E.4 gives the average LLD concentration and the range of LLD values for each sample category for the current reporting period.

As used in this report, the LLD has been defined as the amount or concentration of radioactive material (in terms of μCi per unit volume or unit mass) in a representative sample, which has a 95% probability of being detected.

Identification of specific radionuclides is not routinely carried out as part of this monitoring program, but would be conducted if unusual radioactivity levels above natural background were detected. However, from Table V.E.3 it can be seen that the levels of radioactivity detected were consistent with naturally occurring radioactivity and comparable to values reported in previous years.

F. Radioactive Material Shipments

A summary of the radioactive material shipments originating from the TRIGA reactor facility, NRC license R-106, is shown in Table V.F.1. A similar summary for shipments originating from the Radiation Center's state of Oregon radioactive materials license ORE 90005 is shown in Table V.F.2. A summary of radioactive material shipments exported under Nuclear Regulatory Commission general license 10 CFR 110.23 is shown in Table V.F.3.

G. References

1. 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).

2. 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.A.1

Radiation Protection Program Requirements and Frequencies

FREQUENCY	RADIATION PROTECTION REQUIREMENT
Daily/Weekly/Monthly	Perform routine area radiation/contamination monitoring.
Monthly	Perform routine response checks of radiation monitoring instruments. Monitor radiation levels (μrem h^{-1}) at the environmental monitoring stations. Collect and analyze TRIGA primary, secondary, and make-up water. Exchange personnel dosimeters and inside area monitoring dosimeters, and review exposure reports. Inspect laboratories. Check emergency safety equipment. Perform neutron generator contamination survey. Calculate previous month's gaseous effluent discharge.
As Required	Process and record solid waste and liquid effluent discharges. Prepare and record radioactive material shipments. Survey and record incoming radioactive materials receipts. Perform and record special radiation surveys. Perform thyroid and urinalysis bioassays. Conduct orientations and training. Issue radiation work permits and provide health physics coverage for maintenance operations.
Quarterly	Prepare, exchange and process environmental TLD packs. Collect and process environmental soil, water, and vegetation samples. Conduct orientations for classes using radioactive materials. Collect and analyze sample from reactor stack effluent line. Exchange personnel dosimeters and inside area monitoring dosimeters, and review exposure reports.
Semi-Annual	Leak test and inventory sealed sources. Conduct floor survey of corridors and reactor bay. Inventory and inspect Radiation Center equipment located in the Corvallis Fire Department Haz/Mat van and at Good Samaritan Hospital.
Annual	Calibrate portable radiation monitoring instruments and personnel pocket ion chambers. Calibrate reactor stack effluent monitor, continuous air monitors, remote area radiation monitors, water monitor, and air samplers. Measure face air velocity in laboratory hoods and exchange dust-stop filters and HEPA filters as necessary. Inventory and inspect Radiation Center emergency equipment. Conduct facility radiation survey of the ^{60}Co irradiators. Conduct personnel dosimeter training. Perform contamination smear survey of Radiation Center ventilation stacks. Update decommissioning logbook.

Table V.B.1.a

Monthly Summary of Liquid Effluent Releases to the Sanitary Sewer(1,2)

(OSTR Contribution Shown in ( ) and Bold Print)

Date of Discharge (Month and Year)	Total Quantity of Radioactivity Released (Curies)	Detectable Radionuclides in the Waste	Specific Activity For Each Detectable Radionuclide in the Waste, Where the Release Concentration Was $>1 \times 10^{-7}$ μCi/cm³ (μCi ml⁻¹)	Total Quantity of Each Detectable Radionuclide Released in the Waste (Curies)	Average Concentration of Released Radioactive Material at the Point of Release (μCi ml⁻¹)	Percent of Applicable Monthly Average Concentration for Released Radioactive Material (%) (3)	Total Volume of Liquid Effluent Released Including Diluent (4) (gal)
May 2000	3.9×10^{-5}	^3H	3.9×10^{-6}	3.9×10^{-5}	3.9×10^{-6}	0.04%	2,618
OSTR Contribution to Above	(1.5×10^{-6})	(^3H)	(1.5×10^{-7})	(1.5×10^{-6})	(1.5×10^{-7})	0.002%	50
Annual Total for Radiation Center	3.9×10^{-5}	^3H	3.9×10^{-6}	3.9×10^{-5}	3.9×10^{-6}	0.04%	2,618
OSTR Contribution to Above	(1.5×10^{-6})	(^3H)	(1.5×10^{-7})	(1.5×10^{-6})	(1.5×10^{-7})	0.002%	50

(1) OSU has implemented a policy to reduce to the absolute minimum radioactive wastes disposed to the sanitary sewer. There were no liquid effluent releases during months not listed.

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

(3) Based on values listed in 10 CFR 20, Appendix B to 20.1001 - 20.2401, Table 3, which are applicable to sewer disposal.

(4) The total volume of liquid effluent plus diluent does not take into consideration the additional mixing with the over 250,000 gallons per year of liquids and sewage normally discharged by the Radiation Center complex into the same sanitary sewer system.

(5) Less than the lower limit of detection at the 95% confidence level.

Table V.B.1.b

Annual Summary of Liquid Waste Generated and Transferred

Origin of Liquid Waste	**Volume of Liquid Waste Packaged[1] (gallons)**	**Detectable Radionuclides in the Waste**	**Total Quantity of Radioactivity in the Waste (Curies)**	**Dates of Waste Pickup for Transfer to the Waste Processing Facility**	**Dates of Shipment from Oregon State University**
TRIGA Reactor Facility	15	^{3}H, ^{60}Co, ^{122}Sb, ^{124}Sb, ^{125}Sb, ^{152}Eu	1.2×10^{-6}	---	8/12/99, 10/6/99, 3/10/00, 5/25/00
Radiation Center Laboratories	35	^{3}H, ^{14}C, ^{22}Na, ^{32}P, ^{51}C, ^{54}Fe, ^{64}Cu, ^{65}Zn, ^{131}I, ^{137}Cs, ^{222}Rn	5.9×10^{-5}	7/30/99, 3/4/00, 5/12/00	8/12/99, 10/6/99, 3/10/00, 5/25/00
TOTAL	50	^{3}H, ^{14}C, ^{22}Na, ^{32}P, ^{51}Cr, ^{59}Fe, ^{60}Co, ^{64}Cu, ^{65}Zn, ^{122}Sb, ^{124}Sb, ^{125}Sb, ^{131}I, ^{137}Cs, ^{152}Eu, ^{222}Rn	6×10^{-5}	---	---

(1) TRIGA and Radiation Center liquid waste is picked up by the Radiation Safety Office for transfer to its waste processing facility for final packaging.

(2) The short-lived waste was held by the Radiation Safety Office for decay.

Table V.B.2

Monthly Summary of Gaseous Effluent Releases(1)

Date of Discharge (Month and Year)	Total Estimated Radioactivity Released (Curies)	Total Estimated Quantity of Argon-41 Released(2) (Curies)	Estimated Average Atmospheric Diluted Concentration of Argon-41 at Point of Release (Reactor Stack) ($\mu Ci/ml^{-1}$)	Percent of the Applicable MPC for Diluted Concentration of Argon-41 at Point of Release (Reactor Stack) (%)
July 99	0.33	0.33	2.52E-08	0.63
August 99	0.29	0.29	2.20E-08	0.55
September 99	0.22	0.22	1.73E-08	0.43
October 99	0.57	0.57	4.35E-08	1.09
November 99	0.39	0.39	3.09E-08	0.77
December 99	0.30	0.30	2.33E-08	0.58
January 00	0.55	0.55	4.18E-08	1.05
February 00	0.45	0.45	3.84E-08	0.96
March 00	0.45	0.45	3.50E-08	0.88
April 00	0.26	0.26	2.08E-08	0.52
May 00	0.38	0.38	2.95E-08	0.74
June 00	0.21	0.21	1.72E-08	0.43
ANNUAL VALUE	4.41	4.41	2.87E-08	0.72

(1) Airborne effluents from the OSTR contained no detectable particulate radioactivity resulting from reactor operations, and there were no releases of *any* radioisotopes in airborne effluents in concentrations greater than 20% of the applicable effluent concentration. (20% is a value taken from the OSTR Technical Specifications.)

(2) Routine gamma spectroscopy analysis of the gaseous radioactivity in the OSTR stack discharge indicated the only detectable radionuclide was argon-41.

Table V.B.3

Annual Summary of Solid Waste Generated and Transferred

Origin of Solid Waste	Volume of Solid Waste Packaged(1) (Cubic Feet)	Detectable Radionuclides in the Waste	Total Quantity of Radioactivity in Solid Waste (Curies)	Dates of Waste Pickup for Transfer to the OSU Waste Processing Facility	Dates of Shipment from Oregon State University(2)
TRIGA Reactor Facility	23(3)	^{46}Sc, ^{47}Sc, ^{51}Cr, ^{54}Mn, ^{58}Co, ^{60}Co, ^{124}Sb, ^{152}Eu, ^{140}La	4.8×10^{-4}	7/30/99, 8/24/99, 3/11/00, 5/12/00,	8/12/99, 10/6/99, 5/25/00
Radiation Center Laboratories	39	^{3}H, ^{14}C, ^{24}Na, ^{46}Sc, ^{47}Sc, ^{56}Mn, ^{59}Fe, ^{60}Co, ^{68}Ge, ^{82}Br, ^{90}Sr, ^{122}Sb, ^{124}Sb, ^{131}I, ^{137}Cs, ^{222}Rn, ^{226}Ra, ^{238}U	3.2×10^{-5}	7/27/99, 7/28/99, 8/17/99, 2/3/00, 3/20/00, 5/2/00	8/12/99, 10/6/99, 3/10/00, 5/25/00
TOTAL	62	See Above	5.1×10^{-4}	---	---

(1) TRIGA and Radiation Center laboratory waste is picked up by the Radiation Safety Office for transfer to its waste processing facility for final packaging.

(2) Solid radioactive waste is shipped to Allied Ecology Services, Inc.

(3) Includes 3 ft^3 of dewatered resin beads.

Table V.C.1

Annual Summary of Personnel Radiation Doses Received

Personnel Group	Average Annual Dose[1]		Greatest Individual Dose[1]		Total Person-mrem For the Group[1]	
	Whole Body (mrem)	Extremities (mrem)	Whole Body (mrem)	Extremities (mrem)	Whole Body (mrem)	Extremities (mrem)
Facility Operating Personnel	78	112	208	310	1247	1790
Key Facility Research Personnel	19	14	46	64	261	189
Facilities Services Maintenance Personnel	14	N/A	30	N/A	98	N/A
Laboratory Class Students	8	2	37	49	604	138
Campus Police and Security Personnel	7	N/A	37	N/A	216	N/A
Visitors	<1	N/A	302[2]	N/A	549[2]	N/A

(1) "N/A" indicates that there was no extremity monitoring conducted or required for the group.

(2) Elevated reading due to cell phone interference on the electronic dosimeter.

Table V.D.1

Total Dose Equivalent Recorded on Area Dosimeters Located
Within the TRIGA Reactor Facility

Monitor I.D.	TRIGA Reactor Facility Location (See Figure V.D.1)	Total Recorded Dose Equivalent[(1)(2)]	
		$x\beta(\gamma)$ (mrem)	Neutron (mrem)
MRCTNE	D104: North Badge East Wall	286	ND
MRCTSE	D104: South Badge East Wall	85	ND
MRCTSW	D104: South Badge West Wall	276	ND
MRCTNW	D104: North Badge West Wall	92	ND
MRCTWN	D104: West Badge North Wall	141	ND
MRCTEN	D104: East Badge North Wall	409	ND
MRCTES	D104: East Badge South Wall	717	ND
MRCTWS	D104: West Badge South Wall	264	ND
MRCTTOP	D104: Reactor Top Badge	279	ND
MRCTHXS	D104A: South Badge HX Room	319	ND
MRCTHXW	D104A: West Badge HX Room	105	ND
MRCD-302	D302: Reactor Control Room	172	ND
MRCD-302A	D302A: Reactor Supervisor's Office	28	N/A
MRCBP1	D104: Beam Port Number 1	145	ND
MRCBP2	D104: Beam Port Number 2	187	ND
MRCBP3	D104: Beam Port Number 3	464	ND
MRCBP4	D104: Beam Port Number 4	280	ND

(1) The total recorded dose equivalent values do not include natural background contribution and, reflect the summation of the results of four quarterly beta-gamma dosimeters or four quarterly fast neutron dosimeters for each location. A total dose equivalent of "ND" indicates that each of the dosimeters during the reporting period was less than the vendor's gamma dose reporting threshold of 10 mrem or that each of the fast neutron dosimeters was less than the vendor's threshold of 10 mrem. "N/A" indicates that there was no neutron monitor at that location.

(2) These dose equivalent values do not represent radiation exposure through an exterior wall directly into an unrestricted area.

Table V.D.2

Total Dose Equivalent Recorded on Area Dosimeters
Located Within the Radiation Center

Monitor I.D.	Radiation Center Facility Location (See Figure V.D.1)		Total Recorded Dose Equivalent[1]	
			$x\beta(\gamma)$ (mrem)	Neutron (mrem)
MRCA100	A100:	Receptionist's Office	ND	N/A
MRCBRF	A102H:	Front Personnel Dosimetry Storage Rack	93	N/A
MRCA120	A120:	Stock Room	31	N/A
MRCA120A	A120A:	NAA Temporary Storage	ND	N/A
MRCA126	A126:	Campus RSO's Isotope Receiving Lab	240	N/A
MRCCO-60	A128:	^{60}Co Irradiator Room	379	N/A
MRCA130	A130:	Shielded Exposure Room	31	N/A
MRCA132	A132:	TLD Equipment Room	26	N/A
MRCA134-2	A134:	Graduate Student Office	187	N/A
MRCA138	A138:	Health Physics Laboratory	21	N/A
MRCA146	A146:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCB100	B100:	Gamma Analyzer Room (Storage Cave)	10	N/A
MRCB114	B114:	α Lab (^{226}Ra Storage Facility)	1,347	ND
MRCB119-1	B119:	Source Storage Room	156	N/A
MRCB119-2	B119:	Source Storage Room	248	N/A
MRCB119A	B119A:	Sealed Source Storage Room	4,793	2,133
MRCB120	B120:	Instrument Calibration Facility	62	N/A
MRCB122-2	B122:	Radioisotope Storage Hood	178	N/A
MRCB122-3	B122:	Radioisotope Research Laboratory	30	N/A
MRCB124-1	B124:	Radioisotope Research Lab (Hood)	14	N/A
MRCB124-2	B124:	Radioisotope Research Laboratory	24	N/A
MRCB124-6	B124:	Radioisotope Research Laboratory	35	N/A
MRCB128	B128:	Instrument Repair Shop	31	N/A
MRCC100	C100:	Radiation Center Director's Office	10	N/A
MRCC106A	C106A:	Staff Lunch Room	24	N/A
MRCC106B	C106:	Solvent Storage Room	39	N/A
MRCC106-H	C106H:	East Loading Dock	84	N/A

See footnotes following the table.

Table V.D.2 (continued)

Total Dose Equivalent Recorded on Area Dosimeters
Located Within the Radiation Center

Monitor I.D.	Radiation Center Facility Location (See Figure V.D.1)		Total Recorded Dose Equivalent[1]	
			$x\beta(\gamma)$ (mrem)	Neutron (mrem)
MRCC118	C118:	Radiochemistry Laboratory	42	N/A
MRCC120	C120:	Student Counting Laboratory	38	N/A
MRCF100	F100:	APEX Facility	ND	N/A
MRCF102	F102:	APEX Control Room	ND	N/A
MRCB125N	B125:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCB125S	B125:	Gamma Analyzer Room	ND	N/A
MRCC124	C124:	Student Computer Laboratory	68	N/A
MRCC130-1	C130:	Radioisotope Laboratory (Hood)	16	N/A
MRCC134	C134:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCD100	D100:	Reactor Support Laboratory	218	N/A
MRCD102	D102:	Pneumatic Transfer Terminal Lab	122	ND
MRCD102-H	D102H:	1st Floor Corridor at D102	53	ND
MRCD106-H	D106H:	1st Floor Corridor at D106	89	N/A
MRCD200	D200:	Reactor Administrators's Office	321	ND
MRCD202	D202:	Senior Health Physicist's Office	186	ND
MRCBRR	D200H:	Rear Personnel Dosimetry Storage Rack	33	N/A
MRCD204	D204	Health Physicist Office	107	ND
MRCF104	F104:	ATHRL	26	ND
MRCD300	D300:	3rd Floor Conference Room	104	ND

(1) The total recorded dose equivalent values do not include natural background contribution and, except as noted, reflect the summation of the results of 4quarterly beta-gamma dosimeters or four quarterly fast neutron dosimeters for each location. A total dose equivalent of "ND" indicates that each of the dosimeters during the reporting period was less than the vendor's gamma dose reporting thresholdof 10 mrem or that each of the fast neutron dosimeters was less than the vendor's threshold of 10 mrem. "N/A" indicates that there was no neutron monitor at that location.

Table V.D.3

Annual Summary of Radiation Levels and Contamination Levels Observed Within the Reactor Facility and Radiation Center During Routine Radiation Surveys

Accessible Location (See Figure V.D.1)	Whole Body Radiation Levels (mrem h^{-1})		Contamination Levels[1] (dpm/100 cm^2)	
	Average	**Maximum**	**Average**	**Maximum**
TRIGA Reactor Facility:				
Reactor Top (D104)	<1	100	<500	<500
Reactor 2nd Deck Area (D104)	3	31	<500	<500
Reactor Bay SW (D104)	<1	11	<500	<500
Reactor Bay NW (D104)	<1	9	<500	<500
Reactor Bay NE (D104)	<1	4	<500	<500
Reactor Bay SE (D104)	<1	2	<500	<500
Class Experiments (D104, D302)	<1	1	<500	<500
Demineralizer Tank--Outside Shielding (D104A)	<1	6	<500	<500
Particulate Filter--Outside Shielding (D104A)	<1	2	<500	<500
Radiation Center:				
NAA Counting Rooms (A146, B100, C134)	<1	<1	<500	<500
Health Physics Laboratory (A138)	<1	2	<500	<500
^{60}Co Irradiator Room and calibration rooms (A128, A130, B120)	<1	1	<500	<500
Radiation Research Labs (B108, B114, B122, B124, C130, C132A)	<1	<1	<500	<500
Radioactive Source Storage (A120A, B119, B119A)	<1	2	<500	<500
Student Chemistry Laboratory (C118)	<1	8	<500	<500
Student Counting Laboratory (C120)	<1	<1	<500	<500
Operations Counting Room (B136, C123)	<1	2	<500	<500
Pneumatic Transfer Laboratory (D102)	<1	4	<500	<500
TRIGA Tube Wash Room (D100)	<1	1	<500	<500

(1) <500 dpm/100 cm^2 = Less than the lower limit of detection for the portable survey instrument used.

Table V.E.1

Total Dose Equivalent at the TRIGA Reactor Facility Fence

Fence Environmental Monitoring Station (See Figure V.E.1)	Total Recorded Dose Equivalent (Including Background) Based on ICN TLDs[1] (mrem)	Total Recorded Dose Equivalent (Including Background) Based on OSU TLDs[2][3] (mrem)	Total Calculated Dose Equivalent (Including Background) Based on the Annual Average $\mu rem\ h^{-1}$ Dose Rate[3] (mrem)
MRCFE-1	78 ± 2	72 ± 5	62 ± 16
MRCFE-2	73 ± 1	60 ± 2	60 ± 12
MRCFE-3	68 ± 2	61 ± 2	58 ± 20
MRCFE-4	81 ± 2	72 ± 4	66 ± 20
MRCFE-5	73 ± 1	61 ± 3	62 ± 31
MRCFE-6	77 ± 2	60 ± 2	55 ± 24
MRCFE-7	73 ± 2	64 ± 2	62 ± 20
MRCFE-8	73 ± 3	60 ± 2	55 ± 22
MRCFE-9	72 ± 2	58 ± 3	54 ± 16

(1) Average Corvallis area natural background using ICN TLDs totals 64 ± 8 mrem for the same period.

(2) OSU fence totals include a measured natural background contribution of 62 ± 3 mrem.

(3) ± values represent the standard deviation of the total value at the 95% confidence level.

Table V.E.2

Total Dose Equivalent at the Off-Site Gamma Radiation Monitoring Stations

Off-Site Radiation Monitoring Station[(1)] (See Figure V.E.2)	Total Recorded Dose Equivalent (Including Background) Based on ICN TLDs[(2)] (mrem)	Total Recorded Dose Equivalent (Including Background) Based on OSU TLDs[(3)(4)] (mrem)	Total Calculated Dose Equivalent (Including Background) Based on the Annual Average µrem/h Exposure Rate[(4)] (mrem)
MRCTE-2L	---	66 ± 11[(5)]	39 ± 12
MRCTE-3	79 ± 2	58 ± 3	62 ± 16
MRCTE-4	74 ± 2	71 ± 9	50 ± 20
MRCTE-5L	---	56 ± 4	65 ± 24
MRCTE-6	77 ± 2	63 ± 5	59 ± 20
MRCTE-7L	---	50 ± 8	60 ± 27
MRCTE-8	81 ± 2	56 ± 2	74 ± 33
MRCTE-9	79 ± 2	49 ± 2	57 ± 20
MRCTE-10	71 ± 2	65 ± 14	53 ± 20
MRCTE-12	78 ± 1	57 ± 3	58 ± 25
MRCTE-13L	---	59 ± 6	58 ± 27
MRCTE-14L	---	54 ± 7	39 ± 12
MRCTE-15	65 ± 2	49 ± 5	44 ± 14
MRCTE-16L	---	73 ± 9	60 ± 20
MRCTE-17	71 ± 1	58 ± 5	55 ± 25
MRCTE-18L	---	64 ± 9	53 ± 18
MRCTE-19	86 ± 7	63 ± 5	64 ± 24
MRCTE-20L	---	59 ± 2	60 ± 10
MRCTE-21	63 ± 3	79 ± 12	42 ± 14
MRCTE-22	67 ± 3	49 ± 1	48 ± 20

(1) Monitoring stations coded with an "L" contained one standard OSU TLD pack only. Stations not coded with an "L" contained, in addition to the OSU TLD pack, one ICN TLD monitoring pack.

(2) Average Corvallis area natural background using ICN TLDs totals 64 ± 8 mrem for the same period.

(3) OSU off-site totals include a measured natural background contribution of 62 ± 3 mrem.

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

(5) Second quarter TLD pack lost. The total mrem includes one quarter that is the average of three quarters.

Table V.E.3

Annual Average Concentration of the Total Net Beta Radioactivity (Minus ^3H) for Environmental Soil, Water, and Vegetation Samples

Sample Location (See Figure V.E.2)	Sample Type	Annual Average Concentration of the Total Net Beta (Minus ^3H) Radioactivity[1]	Reporting Units
1-W	Water	4.17E-08 ± 3.22E-08	$\mu Ci\ ml^{-1}$
4-W	Water	3.48E-08 ± 5.83E-09	$\mu Ci\ ml^{-1}$
11-W	Water	3.36E-08 ± 2.90E-09	$\mu Ci\ ml^{-1}$
19-RW	Water	4.20E-08 ± 3.43E-08	$\mu Ci\ ml^{-1}$
3-S	Soil	4.21E-05 ± 4.47E-05	$\mu Ci\ g^{-1}$ of dry soil
5-S	Soil	4.95E-05 ± 3.14E-05	$\mu Ci\ g^{-1}$ of dry soil
20-S	Soil	3.46E-05 ± 1.55E-05	$\mu Ci\ g^{-1}$ of dry soil
21-S	Soil	6.24E-05 ± 2.24E-05	$\mu Ci\ g^{-1}$ of dry soil
2-G	Grass	3.37E-04 ± 2.11E-04	$\mu Ci\ g^{-1}$ of dry ash
6-G	Grass	1.54E-04± 1.56E-04	$\mu Ci\ g^{-1}$ of dry ash
7-G	Grass	2.75E-04 ± 3.39E-04	$\mu Ci\ g^{-1}$ of dry ash
8-G	Grass	3.04E-04 ± 1.39E-04	$\mu Ci\ g^{-1}$ of dry ash
9-G	Grass	3.09E-04 ± 2.67E-04	$\mu Ci\ g^{-1}$ of dry ash
10-G	Grass	1.90E-04 ±1.71E-04	$\mu Ci\ g^{-1}$ of dry ash
12-G	Grass	3.02E-04 ± 2.96E-04	$\mu Ci\ g^{-1}$ of dry ash
13-G	Grass	2.61E-04 ±3.84E-04	$\mu Ci\ g^{-1}$ of dry ash
14-G	Grass	1.77E-04 ± 2.00E-04	$\mu Ci\ g^{-1}$ of dry ash
15-G	Grass	1.79E-04 ± 2.21E-04	$\mu Ci\ g^{-1}$ of dry ash
16-G	Grass	1.51E-04 ± 2.36E-04	$\mu Ci\ g^{-1}$ of dry ash
17-G	Grass	1.64E-04 ± 7.42E-05	$\mu Ci\ g^{-1}$ of dry ash
18-G	Grass	1.91E-04 ± 1.17E-054	$\mu Ci\ g^{-1}$ of dry ash
22-G	Grass	2.78E-04 ± 1.99E-04	$\mu Ci\ g^{-1}$ of dry ash

(1) ± values represent the standard deviation of the average value at the 95% confidence level.

(2) Less than lower limit of detection value shown.

Table V.E.4

Average LLD Concentration and Range of LLD Values for
Soil, Water, and Vegetation Samples

Sample Type	Average LLD Value	Range of LLD Values	Reporting Units
Soil	1.67E-05	1.19E-05 *to* 2.25E-05	μCi g^{-1} of dry soil
Water	3.80E-08	3.18E-08 *to* 6.82E-08	μCi cm^{-3}
Vegetation	3.27E-05	7.23E-06 *to* 6.93E-05	μCi g^{-1} of dry ash

Table V.F.1

Annual Summary of Radioactive Material Shipments Originating From the TRIGA Reactor Facility's NRC License R-106

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	Yellow II	Yellow III	Total
OSU Oceanography Corvallis, OR	8.49×10^{-6}	0	3	0	3
OSU Physics Corvallis, OR	4.35×10^{-5}	3	4	0	7
OSU Electrical and Computer Engineering Corvallis, OR	1.20×10^{-6}	2	0	0	2
Berkeley Geochronology Center Berkeley, CA	4.45×10^{-6}	9	0	0	9
University of California Berkeley, CA	4.29×10^{-5}	0	5	0	5
University of Arizona Tucson, AZ	7.14×10^{-7}	1	0	0	1
Stanford University Stanford, CA	7.12×10^{-6}	3	0	0	3
Idaho State University Pocatello, ID	2.99×10^{-5}	2	6	0	8
University of Washington Seattle, WA	1.52×10^{-7}	1	0	0	1
University of California Santa Barbara, CA	6.63×10^{-6}	5	1	0	6
University of Wyoming Laramie, WY	5.91×10^{-8}	1	0	0	1
University of Wisconsin Madison, WI	1.47×10^{-8}	1	0	0	1
SUNY-Plattsburgh Plattsburgh, NY	5.68×10^{-7}	2	0	0	2
Columbia University Pallisades, NY	1.80×10^{-6}	4	0	0	4
Union College Schenectady, NY	1.70×10^{-6}	4	0	0	4
Sandia National Laboratory Albuquerque, NM	1.64×10^{-6}	2	0	0	2
Lawrence Livermore National Laboratory Livermore, CA	3.7×10^{-6}	1	0	0	1
TOTALS	1.55×10^{-4}	41	19	0	60

Table V.F.2

Annual Summary of Radioactive Material Shipments Originating From the Radiation Center's State of Oregon License ORE 90005

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	White I	Yellow II	Total
Lawrence Berkeley National Laboratory Berkeley, CA	1.19×10^{-7}	2	2	0	4
University of Notre Dame Notre Dame, IN	1.33×10^{-9}	1	0	0	1
Totals	1.20×10^{-7}	3	2	0	5

Table V.F.3

Annual Summary of Radioactive Material Shipments Exported
Under NRC General License 10 CFR 110.23

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	Yellow II	Yellow III	Total
Vrije Universiteit Amsterdam, The Netherlands	1.38×10^{-6}	2	1	0	3
Scottish Universities Research and Reactor Centre Scotland, UK	3.64×10^{-6}	0	1	0	1
University of Geneva Geneva, Switzerland	2.57×10^{-6}	3	1	0	4
University of Waikato Hamilton, New Zealand	4.23×10^{-7}	0	1	0	1
University of Queensland Brisbane, Australia	1.64×10^{-5}	0	3	0	3
Uppsala University Uppsala, Sweden	1.16×10^{-7}	1	0	0	1
Synetix Alberta, Canada	4.15×10^{-1}	0	0	27	27
FAPIG Research and Reactor Centre Yokosuka, Japan	3.34×10^{-8}	1	0	0	1
Universite Paris-Sud Paris, France	2.05×10^{-6}	0	1	0	1
TOTALS	4.15×10^{-1}	7	8	27	42

Figure V. D. 1

TRIGA Facility and Radiation Center Area Dosimeter Locations

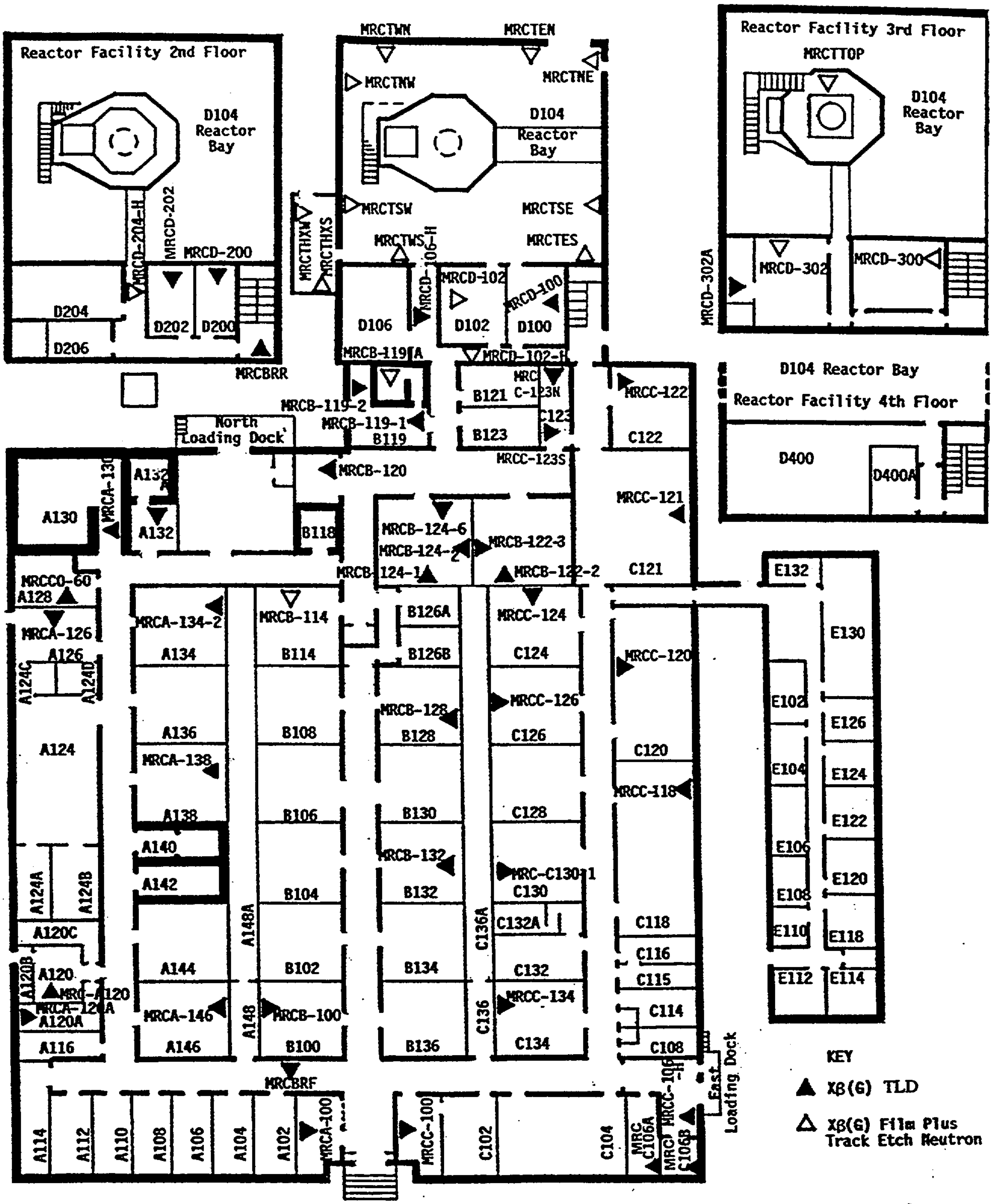


Figure V. E. 1

Area Radiation Monitor Locations for the
TRIGA Reactor, and on the TRIGA Reactor Area Fence

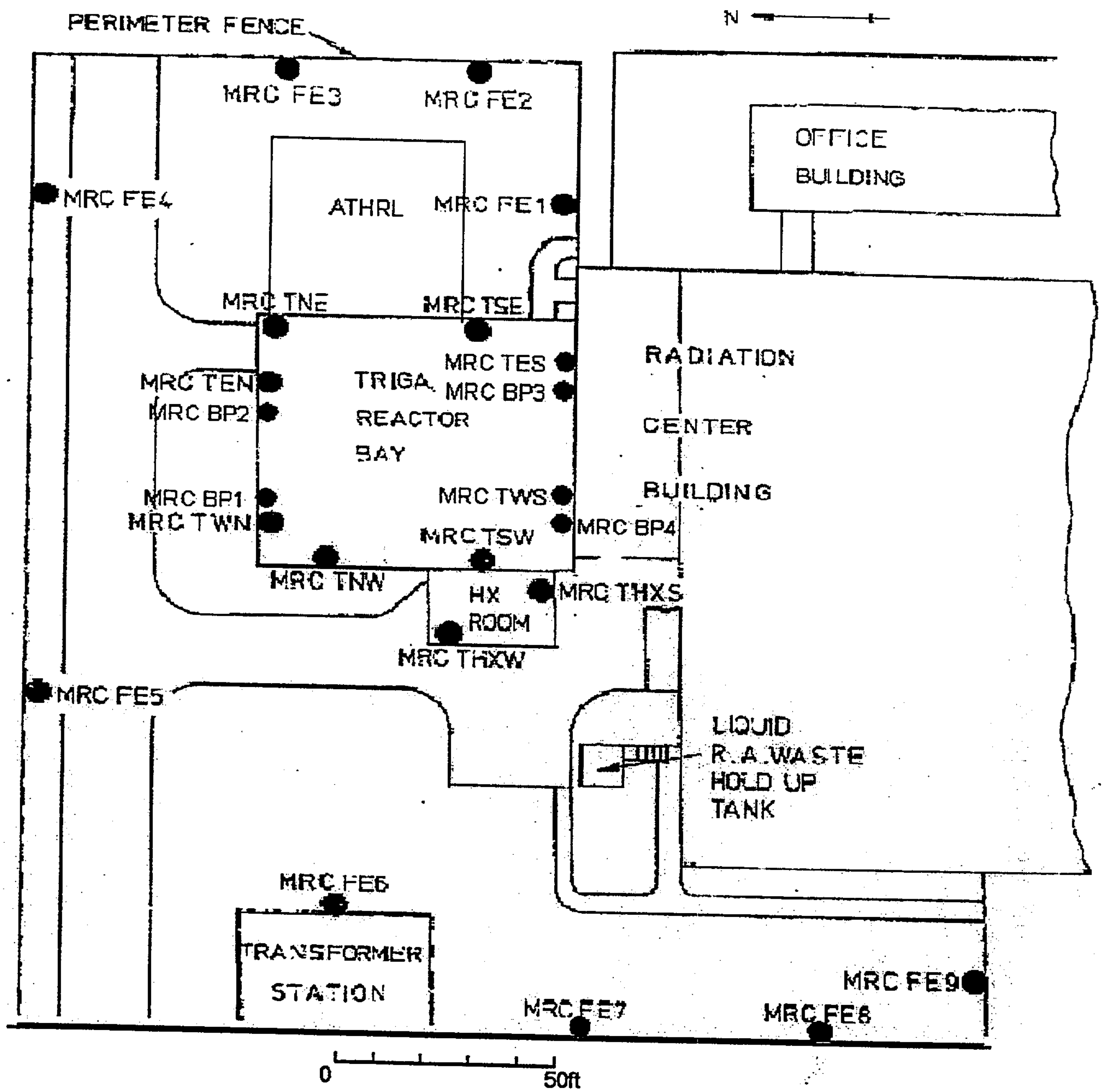
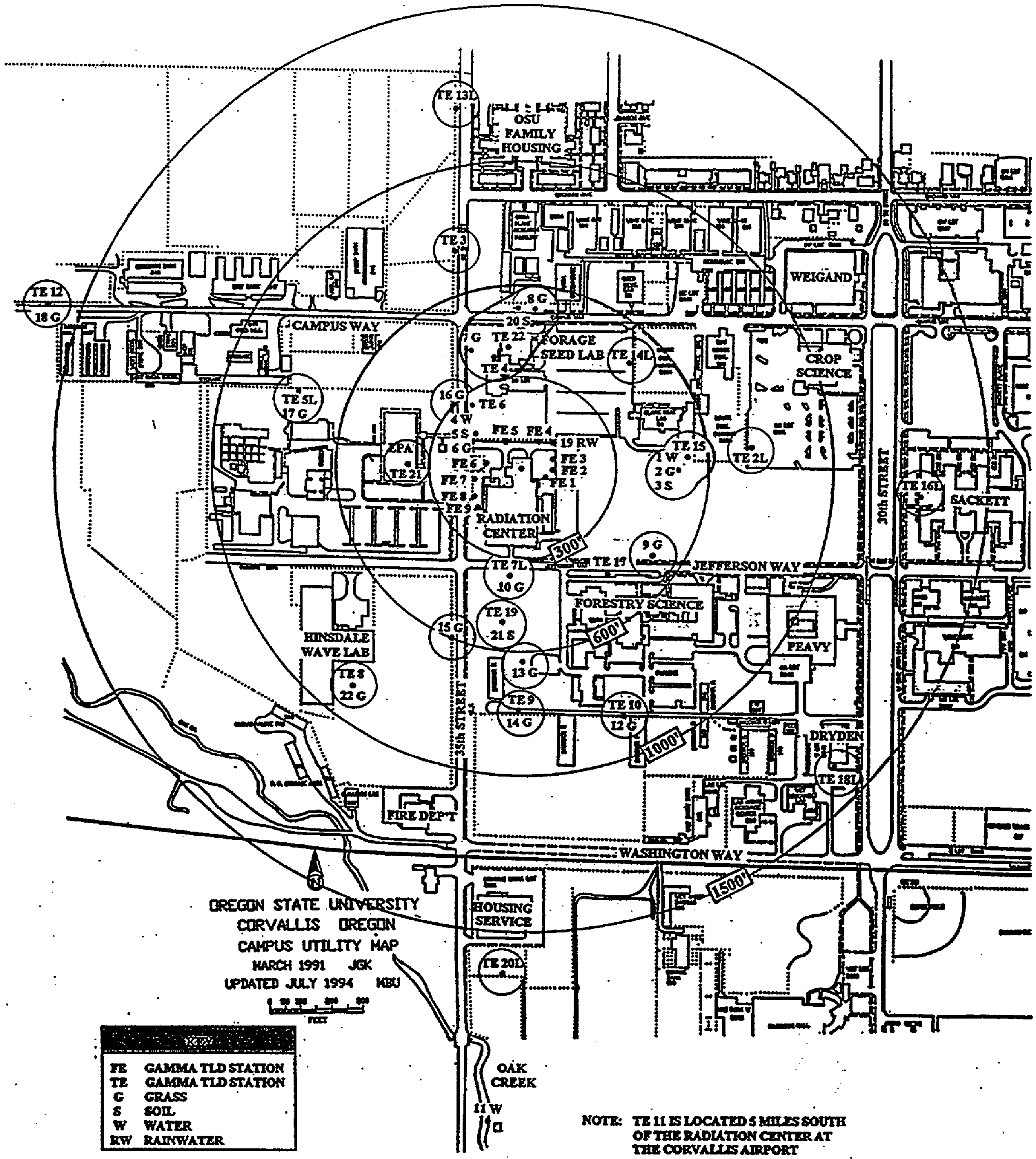


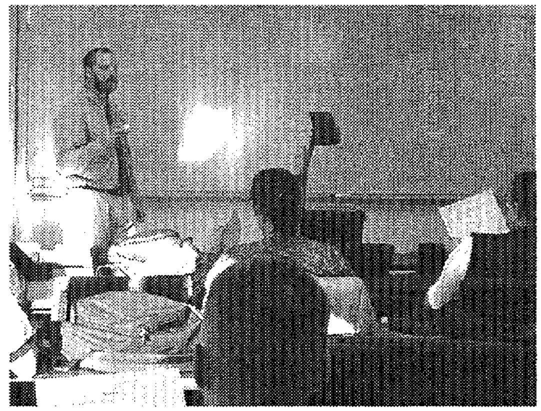
Figure V. E. 2

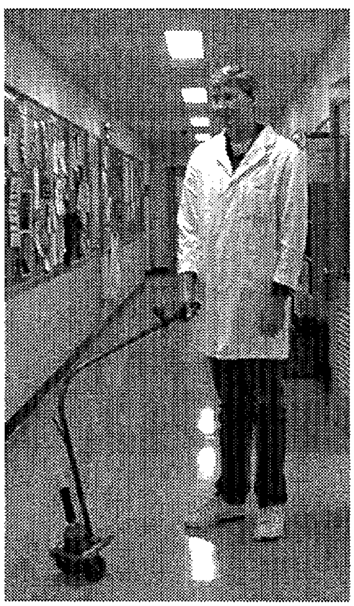
Monitoring Stations for the OSU TRIGA Reactor

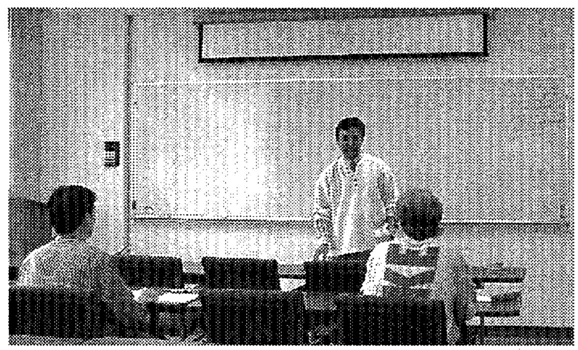


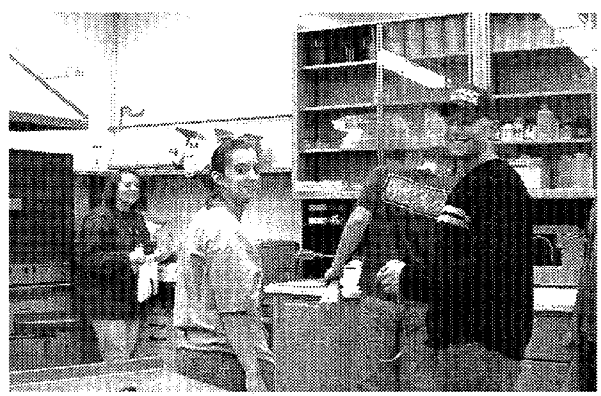
Part VI

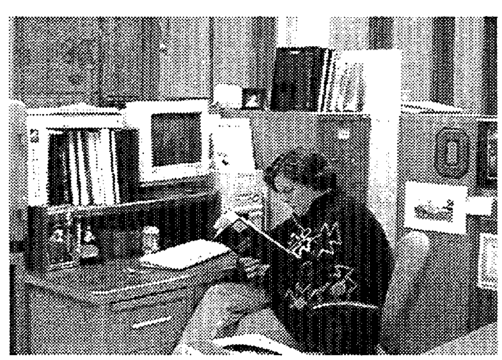
Work











Part VI

WORK

A. Summary

The Radiation Center offers a wide variety of resources for teaching, research, and service related to radiation and radioactive materials. Some of these are discussed in detail in other parts of this report. The purpose of this part is to summarize the teaching, research, and service efforts carried out during the current reporting period.

B. Teaching

The most important responsibility of the Radiation Center and the reactor is to support OSU's academic programs. Implementation of this support occurs through direct involvement of the Center's staff and facilities in the teaching programs of various departments and through participation in University research programs. For example, during the current reporting period, the Radiation Center accommodated 99 academic classes involving a number of different academic departments from OSU and other Oregon universities. The OSU teaching programs (not including research) utilized 790 hours of reactor time. Tables III.A.1 and III.D.1 plus Section VI.C.5 provide more detailed information on the use of the Radiation Center and reactor for instruction and training.

C. Research and Service

Almost all Radiation Center research and service work is tracked by means of a project database. When a request for facility use is received, a project number is assigned, a project cover sheet is generated, and the project is added to the database. The database includes such information as the project number, data about the person and institution requesting the work, information about students involved, a description of the project, Radiation Center resources needed, the Radiation Center project manager, estimated costs and billing information for the project, and the funding source.

Table VI.C.1 provides a summary of institutions and agencies which used the Radiation Center during this reporting period. This table also includes additional information about the number of academic personnel involved, the number of students involved, and the number of uses logged for each organization. Details on graduate student research which used the Radiation Center are given in Table VI.C.2.

The major table in this section is Table VI.C.3. This table provides a listing of the research and service projects carried out during this reporting period and lists information relating to the personnel and institution involved, the type of project, and the funding agency. Projects which used the reactor are indicated by an asterisk. In addition to identifying specific projects carried out during the current reporting period, Part VI also highlights major Radiation Center capabilities in research and service. These unique Center functions are described in Sections VI.C.1 through VI.C.8.

1. Neutron Activation Analysis

Neutron activation analysis (NAA) stands at the forefront of techniques for the quantitative multi-element analysis of major, minor, trace, and rare elements. The principle involved in NAA consists of first irradiating a sample with neutrons in a nuclear reactor such as the OSTR to produce specific radionuclides. After the irradiation, the characteristic gamma rays emitted by the decaying radionuclides are quantitatively measured by suitable semiconductor radiation detectors, and the gamma rays detected at a particular energy are usually indicative of a specific radionuclide's presence. Computerized data reduction of the gamma ray spectra then yields the concentrations of the various elements in samples being studied. With sequential instrumental NAA it is possible to measure quantitatively about 35 elements in small samples (5 to 100 mg), and for activable elements the lower limit of detection is on the order of parts per million or parts per billion, depending on the element.

The Radiation Center's NAA laboratory has analyzed the major, minor, and trace element content of tens of thousands of samples covering essentially the complete spectrum of material types and involving virtually every scientific and technical field.

While some researchers perform their own sample counting on their own or on Radiation Center equipment, the Radiation Center provides a complete NAA service for researchers and others who may require it. This includes sample preparation, sequential irradiation and counting, and data reduction and analysis.

Data on NAA research and service performed during this reporting period are included in Table VI.C.3.

2. Forensic Studies

Neutron activation analysis can also be advantageously used in criminal investigations. The principle underlying such application usually involves matching trace element profiles in objects or substances by NAA. This in turn can help identify materials or products (e.g., identify the manufacturer of a given object), and in some cases can match bullets and other materials recovered from a victim to similar materials obtained from suspects. Materials which have been analyzed by the Radiation Center for forensic purposes include bullets, metals, paint, fuses, coats, glass, meat, and salts.

Forensic studies performed in this reporting period are included in the listings in Tables VI.C.1 and VI.C.3.

3. Irradiations

As described throughout this report, a major capability of the Radiation Center involves the irradiation of a large variety of substances with gamma rays and neutrons. Detailed data on these irradiations and their use during this reporting period are included in Part III as well as in Section C of this part.

4. Radiological Emergency Response Services

The Radiation Center has an emergency response team capable of responding to all types of radiological accidents. This team directly supports the City of Corvallis and Benton County emergency response organizations and medical facilities. The team can also provide assistance at the scene of any radiological incident anywhere in the state of Oregon on behalf of the Oregon Radiation Protection Services and the Oregon Office of Energy.

The Radiation Center maintains dedicated stocks of radiological emergency response equipment and instrumentation. These items are located at the Radiation Center, at the Good Samaritan Hospital, and in the Linn/Benton Region 5 HAZMAT vehicle.

During the current reporting period, the Radiation Center emergency response team conducted several training sessions and exercises, but was not required to respond to any actual incidents.

During the past year, Radiation Center personnel attended training sessions, participated in drills and exercises, and provided advice relating to emergency response to a radiological incident at the Hanford Site in southwestern Washington, but no one was required to respond to a real Hanford emergency.

5. Training and Instruction

In addition to the academic laboratory classes and courses discussed in Parts III.A.2, III.D, and VI.B, and in addition to the routine training needed to meet the requirements of the OSTR Emergency Response Plan, Physical Security Plan, and operator requalification program, the Radiation Center is also used for special training programs. Radiation Center staff are well experienced in conducting these special programs and regularly offer training in areas such as research reactor operations, research reactor management, research reactor radiation protection, radiological emergency response, reactor behavior (for nuclear power plant operators), neutron activation analysis, nuclear chemistry, and nuclear safety analysis.

Special training programs generally fall into one of several categories: visiting faculty and research scientists; International Atomic Energy Agency fellows; special short-term courses; or individual reactor operator or health physics training programs. During this reporting period there were a large number of such people as shown in Part II.B.

As has been the practice since 1985, Radiation Center personnel annually present a HAZMAT Response Team Radiological Course. This year the course was held at the Oregon State University Radiation Center.

6. Radiation Protection Services

The primary purpose of the radiation protection program at the Radiation Center is to support the instruction and research conducted at the Center. However, due to the high quality of the program and the level of expertise and equipment available, the Radiation Center is also able to provide health physics services in support of the OSU Radiation Safety Office and to assist other state and federal agencies. The Radiation Center does not compete with private industry, but supplies health physics services which are not readily available elsewhere. In the case of support provided to state agencies, this definitely helps to optimize the utilization of state resources.

The Radiation Center is capable of providing health physics services in any of the areas which are discussed in Part V. These include personnel monitoring, radiation surveys, sealed source leak testing, packaging and shipment of radioactive materials, calibration and repair of radiation monitoring instruments (discussed in detail in Section VI.C.7), radioactive waste disposal, radioactive material hood flow surveys, and radiation safety analysis and audits.

The Radiation Center also provides services and technical support as a radiation laboratory to the Oregon State Health Division (OSHD) in the event of a radiological emergency within the state of Oregon. In this role, the Radiation Center will provide gamma ray spectrometric analysis of water, soil, milk, food products, vegetation, and air samples collected by OSHD radiological response field teams. As part of the ongoing preparation for this emergency support, the Radiation Center participates in inter-institution drills.

7. Radiological Instrument Repair and Calibration

While repair of nuclear instrumentation is a practical necessity, routine calibration of these instruments is a licensing and regulatory requirement which must be met. As a result, the Radiation Center operates a radiation instrument repair and calibration facility which can accommodate a wide variety of equipment.

The Center's scientific instrument repair facility performs maintenance and repair on all types of radiation detectors and other nuclear instrumentation. Since the

Radiation Center's own programs regularly utilize a wide range of nuclear instruments, components for most common repairs are often on hand and repair time is therefore minimized.

In addition to the instrument repair capability, the Radiation Center has a facility for calibrating essentially all types of radiation monitoring instruments. This includes typical portable monitoring instrumentation for the detection and measurement of alpha, beta, gamma, and neutron radiation, as well as instruments designed for low-level environmental monitoring. Higher range instruments for use in radiation accident situations can also be calibrated in most cases. Instrument calibrations are performed using radiation sources certified by the National Institute of Standards and Technology (NIST) or traceable to NIST.

Table VI.C.4 is a summary of the instruments which were calibrated in support of the Radiation Center's instructional and research programs and the OSTR Emergency Plan, while Table VI.C.5 shows instruments calibrated for other OSU departments and non-OSU agencies. Table VI.C.6 shows instruments repaired for non-Radiation Center departments and agencies. It should be noted that the Radiation Center only calibrates and repairs instruments for local, state and federal agencies.

8. Consultation

Radiation Center staff are available to provide consultation services in any of the areas discussed in this Annual Report, but in particular on the subjects of research reactor operations and use, radiation protection, neutron activation analysis, neutron radiography, radiological emergency response, and radiotracer methods.

Records are not normally kept of such consultations, as they often take the form of telephone conversations with researchers encountering problems or planning the design of experiments. Many faculty members housed in the Radiation Center have ongoing professional consulting functions with various organizations, in addition to sitting on numerous committees in advisory capacities.

9. Public Relations

The continued interest of the general public in the TRIGA reactor is evident by the number of people who have toured the facility. In addition to many unscheduled visitors and interested individuals who stopped in without appointments because they were in the vicinity, a total of 125 scheduled tours including 1,326 people were given during this reporting period. See Table VI.F.1 for statistics on scheduled visitors.

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

	Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
(1)	*Oregon State University Corvallis, OR USA	47	33	27	169[2]
	Albany Democrat-Herald Albany, OR USA	1	0	0	1
	AVI Bio Pharma Corvallis, OR USA	1	0	0	1
	*Oregon Department of Justice Salem, OR USA	1	0	0	3
	Oregon Office of Energy Salem, OR USA	3	0	0	28
	Sigma Pharmaceuticals, Inc Corvallis, OR USA	1	0	0	1
	*University of Oregon Eugene, OR USA	1	1	0	1
	US Environmental Protection Agency Corvallis, OR USA	2	0	0	5
	*USDOE Albany Research Center Albany, OR USA	2	0	0	3
	Valley Landfills Corvallis, OR USA	1	0	0	1
	Corvallis Fire Department Corvallis, OR USA	1	0	0	4
	Good Samaritan Hospital Corvallis, OR USA	1	0	0	8
	Oregon Department of Transportation Salem, OR USA	1	0	0	2
	Oregon Public Utilities Commission Salem, OR USA	1	0	0	7

* Project which involves the OSTR.
(1) Use by Oregon State University does not include any teaching activities or classes accommodated by the Radiation Center.
(2) This number does not include ongoing projects being performed by residents of the Radiation Center such as the APEX project, others in the Department of Nuclear Engineering or Department of Chemistry or projects conducted by Dr. W. D. Loveland, which involve daily use of Radiation Center facilities.

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
USDA Agricultural Research Service Corvallis, OR USA	1	0	0	1
Army Corp of Engineers Portland, OR USA	1	0	0	3
ESCO Corporation Portland, OR USA	1	0	0	6
Occupational Health Lab Portland, OR USA	1	0	0	1
Oregon Health Sciences University Portland, OR USA	1	0	0	24
Oregon Medical Laser Center Portland, OR USA	1	0	0	25
Portland State University Portland, OR USA	2	2	1	2
Radiation Protection Services Portland, OR USA	1	0	0	0
Oregon State Health Division Portland, OR USA	1	0	0	35
Rogue Community College Grants Pass, OR USA	1	0	0	1
Umpqua Research Company Myrtle Creek, OR USA	1	0	0	0
US Environmental Protection Agency Newport, OR USA	2	0	0	0
*Idaho State University Pocatello, ID USA	4	4	8	7
Kirner Consulting, Inc 6108 Nahane West NE, WA USA	1	0	0	1

* Project which involves the OSTR.
(1) Use by Oregon State University does not include any teaching activities or classes accommodated by the Radiation Center.
(2) This number does not include ongoing projects being performed by residents of the Radiation Center such as the APEX project, others in the Department of Nuclear Engineering or Department of Chemistry or projects conducted by Dr. W. D. Loveland, which involve daily use of Radiation Center facilities.

Table VI.C.1
Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
*University of Washington Seattle, WA USA	1	1	0	1
*Berkeley Geochronology Center Berkeley, CA USA	1	0	4	18
*California State University at Northridge Northridge, CA USA	1	1	1	2
*Lawrence Livermore National Laboratory Livermore, CA USA	1	0	0	1
*Montana State University Bozeman, MT USA	2	2	1	3
*Stanford University Stanford, CA USA	2	2	3	4
*Tru-Tec Edmonton, Alberta CANADA	1	0	0	1
*University of California at Berkeley Berkeley, CA USA	3	3	3	5
*University of California at Santa Barbara Santa Barbara, CA USA	2	1	5	5
*Brigham Young University Provo, UT USA	2	2	2	2
*University of Wyoming Laramie, WY USA	1	1	2	1
Colorado School of Mines Golden, CO USA	1	1	0	1
*Colorado State University Fort Collins, CO USA	1	1	0	1
*Sandia National Laboratory Albuquerque, NM USA	1	0	0	4
*University of Minnesota St. Paul, MN USA	1	1	0	3

* Project which involves the OSTR.
(1) Use by Oregon State University does not include any teaching activities or classes accommodated by the Radiation Center.
(2) This number does not include ongoing projects being performed by residents of the Radiation Center such as the APEX project, others in the Department of Nuclear Engineering or Department of Chemistry or projects conducted by Dr. W. D. Loveland, which involve daily use of Radiation Center facilities.

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
*Texas Tech University Lubbock, TX USA	3	2	2	3
*Tracerco Houston, TX USA	1	0	0	6
*Trinity University San Antonio, TX USA	1	1	0	1
*University of Wisconsin Madison, WI USA	1	1	1	2
*Southern Indiana University Evansville, IN USA	1	1	0	1
*University of New Orleans New Orleans, LA USA	1	1	2	1
*ARCADIS Geraghty & Miller, Inc Durham, NC USA	1	0	0	2
Becton Dickenson Technologies Research Triangle Park, NC USA	1	0	0	1
*Columbia University Palisades, NY USA	3	3	6	4
*George Washington University Washington, DC USA	1	1	1	1
*North Carolina State University Raleigh, NC USA	1	1	0	1
*Plattsburgh State University Plattsburgh, NY USA	3	3	0	3
Research Foundation of SUNY Buffalo, NY USA	1	0	0	1
*Syracuse University Syracuse, NY USA	1	1	0	1
Tissue Science Germantown, MD USA	1	0	0	1

* Project which involves the OSTR.

(1) Use by Oregon State University does not include any teaching activities or classes accommodated by the Radiation Center.

(2) This number does not include ongoing projects being performed by residents of the Radiation Center such as the APEX project, others in the Department of Nuclear Engineering or Department of Chemistry or projects conducted by Dr. W. D. Loveland, which involve daily use of Radiation Center facilities.

Table VI.C.1
Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
*University of Georgia Aiken, SC USA	3	3	1	9
*University of Rochester Rochester, NY USA	1	1	1	1
*Union College Schenectady, NY USA	0	2	5	3
*University of Florida Gainesville, FL USA	0	2	2	4
*FAPIG Radiation Research Laboratory Ltd. Yokosuka Kanagawa, JAPAN	1	0	0	1
*Scottish Universities Research and Reactor Centre East Kilbride, SCOTLAND	1	1	15	2
*Universite Paris-Sud Paris, FRANCE	1	1	0	1
*Vrije Universiteit De Boelelaan, NETHERLANDS	1	1	4	2
*University of Geneva Geneva, SWITZERLAND	1	1	4	7
*University of Oslo Oslo, NORWAY	1	1	0	1
*The University of Waikato Hamilton, NEW ZEALAND	1	1	1	2
*University of Queensland Brisbane, Queensland AUSTRALIA	1	1	0	4
Totals:	142	86	102	459

* Project which involves the OSTR.
(1) Use by Oregon State University does not include any teaching activities or classes accommodated by the Radiation Center.
(2) This number does not include ongoing projects being performed by residents of the Radiation Center such as the APEX project, others in the Department of Nuclear Engineering or Department of Chemistry or projects conducted by Dr. W. D. Loveland, which involve daily use of Radiation Center facilities.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Berkeley Geochronology Center				
Baxter, Ethan	PhD	Earth and Planetary Science	Becker	Kinetics of Isotopic Exchange in Metamorphic Reactions
Culler, Timothy	PhD	Earth and Planetary Science	Becker	Lunar Impact History from Analysis of Impact Melt Spherules
Kyoungwon, Min	MA	Earth and Planetary Science	Becker	Reduction of Systematic Errors in 40Ar/39Ar Geochronology
Knight, Kimberly	MA	Earth and Planetary Science	Becker	Geochemical and Isotopic Insights into Continental Flood Basalts
Brigham Young University				
Hae Hae, Kevin	MS	Geology	Kowallis	Subsidence and Uplift History of the Uinta Basin from Apatite Fission Track Analysis
Pulsipher, Tamalyn	MS	Geology	Keith	Possible Correlation of Mineralized Intrusive Unit from the Cu Porphyry at Bingham Mine, Utah with Nearby Volcanic Units
California State University at Northridge				
Devlahovich, Vincent	MS	Geological Sciences	Weigand	Geochemistry of volcanic rocks associated with the Miocene San Onofre Breccia, southern California
Columbia University				
Becker, Mona	PhD	Geosciences, SUNY Stony Brook	Hemming	Uranium incorporation in tufa and implications for age constraints on the Miocene Barstow Formation, California

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Machlus, Malka	PhD	Earth and Environmental Sciences	Hemming	Cyclostratigraphy of the Green River Formation, Wyoming
Machlus, Malka	PhD	Earth Sciences	Hemming	Milankovitch cyclicity in the Eocene Green River Formation, including dating tuff beds within the formation by Ar-Ar dating.
McDaniel, Diane	PhD	Earth Sciences	Hemming	Assessment of Correlation between Climatic Changes and Differences in Provenance in the Amazon Drainage Basin.
Young, Amy	PhD	UCLA Geology	Turrin	Petrology and geochemical evolution of the Damavand trachyandesite volcano in northern Iran.
Zimmerman, Susan	PhD	Earth and Environmental Sciences	Hemming	Rapid Climate Change in Great Basin Lakes
Idaho State University				
Casper, Jason	MS	Geology	Hughes	The Volcanic Evolution of Circular Butte
Gibbons, Greg	MS	Physics	Hughes	Examination of Europium Abundance in Sediments from the Columbia and Snake Rivers
Hitchcock, Paul	MS	Geology	Hughes	Characterization of Fissures in the Great Rift, Eastern Snake River Plain: Implications for the Nature and Timing of Dike Injection in Basaltic Lava Plains

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Pickett, Katherine	MS	Geology	Hughes	Geochemistry and Volcanology of the Blackfoot Lava Fields, Southeastern Idaho
Pope, Arron	MS	Geology	Hughes	Geology of South Hawkins Basin Volcanic Center and Elkhorn Range, Southern Idaho
Oregon State University				
Asghar, Sabooh	MS	Nuclear Engineering	Reyes	Core Makeup Tank Recirculation, Drainage, and Condensation Behavior
Bergman, Josh	MS	Nuclear Engineering	Binney	Investigation of Radioactive Stents for Prevention of Restenosis
Choi, Jin Young	PhD	Agricultural Chemistry	Kerkvliet	Undecided
Colpo, Sarah	MS	Nuclear Engineering	Reyes	Counter Current Flow Limitation in the APEX Facility's Pressurizer Surge Line
Dearstyne, Erica	PhD	Agricultural Chemistry	Kerkvliet	Fate of T Cells in TCDD-Treated Mice: Anergy of Apoptsis?
Geiger, Sebastian	MS	Geosciences	Haggerty	Diffusion in Geologic Materials
Kang, Sung Mo	MS	Forest Products	Morrell	Fungi Colonization of Douglas Fir Sapwood and their Role in Biological Discoloration

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Lee, Tracy	MS	Physics	Gardner	Oxygen Vacancy Concentration Dependence on Processing and Sintering Conditions in ZrO2 Studied using Pac Spectroscopy
Mankowski, Mark	MS	Forest Products	Morrell	Biology of Carpenter Ants in the Pacific Northwest and its Relationship with Fungal Decay in Buildings
Povetko, Oleg	MS	Nuclear Engineering	Higley	Long-Lived Radionuclide Migration through Soils
Prell, Rodney	PhD	Agricultural Chemistry	Kerkvliet	Role of B7 Co-stimulation in TCDD Immunotoxicity
Richardson, Eric	MS	Nuclear Engineering	Palmer	Production of Hydrogen Filters Using Thin Pure Metal Foils
Ruby, Carl	PhD	Agricultural Chemistry	Kerkvliet	Involvement of NFKB in TCDD Immunotoxicity
Rusher, Christopher	MS	Nuclear Engineering	Reyes	Level Swell in a Boiling Pool
Shepherd, David	PhD	Agricultural Chemistry	Kerkvliet	A T-Cell Receptor-Transgenic Model for Immunoticity Testing
Sinton, Christopher	PhD	Oceanography	Duncan	Age and Composition of Two Large Igneous Provinces: The North Atlantic Volcanic Rifted Margin and the Caribbean Plateau
Stapels, Christopher	PhD	Physics	Krane	Gamma ray spectroscopy of Ho-167

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Strohecker, Mark	MS	Nuclear Engineering	Reyes	Flow Modeling of the APEX Facility's IRWST
Trappe, Matt	MS	Forest Science	Trappe	Ecology of Craterellus Tubaeformis
Vorderstrasse, Beth	PhD	Agricultural Chemistry	Kerkvliet	Dendritic Cells: Role in TCDD-Induced Suppression of CTL Activity
Wachs, Dan	MS	Nuclear Engineering	Reyes	Prediction and Modeling of Thermal Stratification in the Cold Legs of the OSU APEX Facility
Yarwood, Rockie	PhD	Microbiology	Bottomley	2, 4-D Degradation by Soil Micro-organisms
Zyromski, Lissa	PhD	Chemistry	Loveland	Measurement of Fusion Enhancements with Neutron-rich Stable and Radioactive Projectiles
Portland State University				
Pretorius, Megan	MS	Geology	Streck	Petrology of Three Successively Emptied Ash-Flow Tufts from the San Luis Caldera
Scottish Universities Research and Reactor Centre				
Barry, T.	PhD	Leicester University	Pringle	Mongolian Basalts/Tectonics
Blecher, J.	PhD	Oxford University	Pringle	Aden Volcanic Differentiation
Carn, S.	PhD	Cambridge University	Pringle	Indonesian Volcanics
Chambers, L.	PhD	Edinburgh University	Pringle	North Atlantic Tertiary Province

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Dixon, H.	PhD	Bristol University	Pringle	Subglacial Volcanics
Harford, C.	PhD	Bristol University	Pringle	Montserrat Volcanic Hazards
Heath, E.	PhD	Lancaster University	Pringle	St. Vincent Volcano Hazards
May, G.	PhD	Aberdeen University	Pringle	Chilean Basins
McElderry, S.	PhD	Liverpool University	Pringle	Chilean Tertiary Faulting
Najman, Y.	PhD	Edinburgh University	Pringle	Himalayan Foredeep
Purvis, M.	PhD	Edinburgh University	Pringle	Turkish Basin Tectonics
Shelton, R.	PhD	Queens University	Pringle	North Channel Basin Evolution
Sowerbutts, A.	PhD	Edinburgh University	Pringle	Sardinia Evolution
Steele, G.	PhD	Aberdeen University	Pringle	Cerro Rico Silver
White, R.	PhD	Leicester University	Pringle	Caribean Crustal Growth
Stanford University				
Stockli, Daniel	PhD	Geological and Environmental Sciences	Dumitru	Timing of Extensional Faulting in the Northern Basin and Range Province, and the Structured and Thermal Transition to the Central Sierra Nevada

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Zhou, Da	PhD	Geological and Environmental Sciences	Dumitru	Amalgamation and Uplift History of the Tian Shan, Western China
The University of Waikato				
Hung Ho, Ming	Ph.D.	Earth Sciences	Kamp	Thermo-tectonic History of Marlborough, New Zealand
Union College				
Bernet, Matthias	PhD	Geology and Geophysics (Yale University)	Garver	Fission Track Ages of Detrital Zircon from the European Alps: Deciphering Exhumation
University of California at Berkeley				
Cole, James	MS	Nuclear Engineering	Olander	Volatilization of Uranium in the Presence of Organic Material
Patin, Joshua	PhD	College of Chemistry	Nitsche	Study of 3n reactions
University of California at Santa Barbara				
Calvert, Andy	PhD	Geological Sciences	Gans	Tectonic Studies in Eastern-Most Russia
Nauert, Jon	MS	Geological Sciences	Gans	Volcanism in the Eldorado Mountains, Southern Nevada
University of Geneva				
Bachmann, Olivier	PhD	Mineralogy	Webb	Volcanic, petrologic, and geochronologic studies of the Fish Canyon magmatic system, Colorado
Parat, Fleurice	PhD	Mineralogy	Webb	Petrology and geochronology of the Eagle Mountain volcanic center, San Juan Mountains, Colorado

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Rapaille, Cedric	PhD	Mineralogy	Webb	Le Filon de Messejana (Espagne et Portugal): Pétrologie et Géochronologie
Thon-That, Thao	PhD	Mineralogy	Webb	40Ar/39Ar Dating of Young Tephra in the Ionian Sea
University of Georgia				
Tostavorky, Tracy	MS	Radiation Biology, Colorado State University	Hinton	Kinetics of Cs, Cr, Cd, and Hg in Aquatic Invertebrates
University of New Orleans				
Wilson, Judy	MS	Geology and Geophysics	Johnson	Evolution of the South Sister Magmatic System
University of Rochester				
Weaver, Karrie	MS	Earth and Environmental Sciences	Basu	Composition of the Kerguelen Plume as Determined by Its Earliest Melts
University of Wisconsin				
Relle, Monica	MS	Geology and Geophysics	Singer	
University of Wyoming				
Kirkwood, Robert	MS	Geology and Geophysics	Murphy	
Leier, Andrew	MS	Geology and Geophysics	Murphy	
Vrije Universiteit				
Beintema, Kike	PhD	Department of Structural Geology	Wijbrans	The Kinematics and Evolution Major Structural Units of the Archean Pilbara Craton, Western Australia

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Carrapa, Barbara	MA	Isotope Geochemistry	Wijbrans	The tectonic record of detrital minerals on sun-orogenics clastic sediments
Kuiper, Klaudia	PhD	Isotope Geochemistry	Wijbrans	Intercalibration of astronomical and radioisotopic timescales

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
321	Murphy	University of Wyoming	Fission Track Dating	Thermal column irradiations of apatite and zircon samples for fission track production to determine rock age.	University of Wyoming
335	Kowallis	Brigham Young University	Fission Track Dating	Dating of natural rocks and minerals via fission track methodology.	National Science Foundation
444	Duncan	Oregon State University	Ar-40/Ar-39 Dating of Oceanographic Samples	Production of Ar-39 from K-39 to measure radiometric ages on basaltic rocks from ocean basins.	OSU Oceanography Department
481	Winans	Oregon Health Sciences University	Instrument Calibration	Calibration of radiation survey instruments.	Oregon Health Sciences University
488	Farmer	Oregon State University	Instrument Calibration	Calibration of portable radiation survey instruments for radiation users on OSU campus.	OSU Radiation Center
519	Martin	US Environmental Protection Agency	Instrument Calibration	Calibration of portable radiation survey meters using the standard RC protocol.	USEPA-Corvallis
521	Vance	University of Washington	Fission Track Studies	Thermal column irradiation of zircon and other samples to induce fission tracks in catcher foils for dating.	University of Washington
547	Boese	US Environmental Protection Agency	Survey Instrument Calibration	Calibration of GM and other portable survey meters as per standard OSU protocol.	USEPA, Cincinnati, OH
664	Reese	Oregon State University	Instrument Calibration	Calibration of radiation survey instruments.	OSU Radiation Center
665	Reese	Oregon State University	Instrument Calibration	Calibration of radiation survey instruments.	OSU Radiation Center

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
708	Reyes	Oregon State University	AP600 Long-Term Cooling Test	Fabricate and test scale model of section of Westinghouse AP600 reactor cooling system.	US Nuclear Regulatory Commission
815	Morrell	Oregon State University	Sterilization of Wood Samples	Sterilization of wood samples to 2.5 Mrads in Co-60 irradiator for fungal evaluations.	OSU Forest Products
920	Becker	Berkeley Geochronology Center	Ar-39/Ar-40 Age Dating	Production of Ar-39 from K-39 to determine ages in various anthropologic and geologic materials.	Berkeley Geochronology Center
930	McWilliams	Stanford University	Ar-40/Ar-39 Dating of Geological Samples	Irradiation of mineral grain samples for specified times to allow Ar-40/Ar-39 dating.	Stanford University Geophysics Department
931	Kerkvliet	Oregon State University	TCDD Effects on T-Cell Activation	Co-60 irradiation of spleen cells from mice to study the effects of TCDD on T-cell activation using T-h cell clones.	OSU Environmental and Molecular Toxicology
932	Dumitru	Stanford University	Fission Track Dating	Thermal column irradiation of geological samples for fission track age-dating.	Stanford University Geology Department
995	Bottomley	Oregon State University	Herbicide Mineralization in Agricultural Soils	Soil sterilization in the Co-60 irradiator.	OSU Crop and Soil Science
1018	Gashwiler	Occupational Health Lab	Calibration of Nuclear Instruments	Calibrate radiation survey meters.	Occupational Health Laboratory
1020	Gans	University of California at Santa Barbara	Tectonic Studies in Eastern-Most Russia	Irradiation for Ar-40/Ar-39 dating using the CLICIT or dummy fuel element.	National Science Foundation

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1072	Rasmussen	Army Corps of Engineers	Instrument Calibration	Calibration of radiation detection instruments.	U.S. Army Engineer District, Portland.
1073	Pringle	Scottish Universities Research and Reactor Centre	Argon 40/39 Dating of Rock Minerals	Age dating of various materials using the Ar-40/Ar-39 ratio method.	Scottish Universities Research and Reactor Centre
1074	Wijbrans	Vrije Universiteit	40Ar-39 Ar Dating of Rocks and Minerals	40Ar-39Ar dating of rocks and minerals.	Vrije Universiteit, Amsterdam
1075	Lederer	University of California at Berkeley	Activation Analysis Experiment for NE Class	Irradiation of small, stainless steel discs for use in a nuclear engineering radiation measurements laboratory.	University of California at Berkeley
1098	Loveland	Oregon State University	Fusion Enhancement with n-rich Projectiles	Measurement of fusion enhancements with n-rich stable and radioactive projectiles.	OSU Chemistry Department
1118	Larson	Oregon State University	Primary Phytoplankton Production Studies at Crater Lake	Evaluation of the primary production of phytoplankton in Crater Lake and lakes in Mount Rainier, Olympic, and North Cascades National Parks.	OSU Forest Resources
1125	Streck	Portland State University	Crystallization in Ignimbrite E, Gran Canary	Determination of mobility of trace elements during cooling of tuff E using INAA.	GEOMAR Inst. Germany
1127	Tsukahara	FAPIG Radiation Research Laboratory Ltd.	Kyoto Fission Track Age Dating	Irradiation of samples in the thermal column for fission track age dating.	FAPIG Radiation Research Laboratory

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1177	Garver	Union College	Fission Track Analysis of Rock Ages	Use of thermal column irradiations to perform fission track analysis to determine rock ages.	Union College, NY
1186	Fitzgerald	Syracuse University	Fission Track Dating	Thermal column irradiation of geological samples for fission track age-dating.	University of Arizona
1187	Sivaramakrishnan	Oregon State University	Radiation Effects on Gallium Arsenide	Determination of irradiation effects (gamma, alpha, beta and neutron) on semiconductors, particularly gallium arsenide.	OSU Electrical & Computing Engineering
1188	Salinas	Rogue Community College	Photoplankton Growth in Southern Oregon Lakes	C-14 liquid scintillation counting of radiotracers produced in a photoplankton study of southern Oregon lakes: Miller Lake, Lake of the Woods, Diamond Lake, and Waldo Lake.	Rogue Community College
1191	Vasconcelos	University of Queensland	Ar-39/Ar-40 Age Dating	Production of Ar-39 from K-39 to determine ages in various anthropologic and geologic materials.	Earth Sciences, University of Queensland
1206	Hughes	Idaho State University	Chemical Correlation of Volcanic Units on INEEL	NAA of basaltic rocks to evaluate local and regional stratigraphy beneath facilities at INEEL to determine aquifer system geometry.	Idaho Water Resources Research Inst.
1225	Roden-Tice	Plattsburgh State University	Fission Track Analysis of Apatite and Zircon	Analysis of the thermal history of Triassic basins in Connecticut using fission track age dating methods.	OSU Radiation Center

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1267	Hemming	Columbia University	Geochronology by Ar/Ar Methods	Snake River plain sanidine phenocrysts to evaluate volcanic stratigraphy; sandine and biotite phenocrysts from a late Miocene ash, Mallorca to more accurately constrain stratigraphic horizon; hornblends and feldspar from the Amazon to assess climatic changes and differences in Amazon drainage basin provenance.	Columbia University
1270	Higley	Oregon State University	Multiple Mode Radiography	Investigation of long-lived radionuclide migration through soils using a variety of techniques, including thin-section neutron radiography.	OSU Radiation Center
1288	DiPietro	Southern Indiana University	Geochemistry of Plutonic Rocks from Pakistan	Study evaluating the petrogenesis and evolution of plutonic rocks in active tectonic settings.	NSF Collaborative Research Project
1300	Buckovic	Oregon State University	Geochemical Assay of Co, Ni, and Mn in Laterite Soil	Determination of the geochemical variability of cobalt, nickel, and manganese in laterite soils of Southeastern Cameroon.	Geovic, Ltd.
1302	Niles	Oregon Office of Energy	Calibration of Emergency Response Instruments	Routine calibration of radiological monitoring instruments associated with the Oregon Office of Energy's programs supporting HazMat and other emergency response teams.	Oregon Office of Energy
1341	Schmitt	Oregon State University	INAA of Deep Sea Drilling Project samples	INAA of Deep Sea Drilling Project samples	USDOE (Reactor Sharing)

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1342	Lutes	ARCADIS Geraghty & Miller, Inc	Bromide determination in pine needles	Characterization of bromide (present from natural sources and fumigation with bromomethane) concentration in biological material that will be incinerated. Analysis needed for environmental impact statement.	ARCADIS Geraghty & Miller
1346	Schutfort	Oregon State University	Analysis of Arsenic on Membrane Filters	Gathering of preliminary data on detection limit of arsenic in groundwater using extraction filters to preconcentrate As on filter membranes.	USDOE (Reactor Sharing)
1350	Vergin	Oregon State University	Sterilization of Micropipets and Labware	Irradiation of micropipets and other laboratory equipment used in the study of DNA.	OSU Microbiology Department
1351	Dalrymple	Oregon State University	Age Dating of Lunar Samples	Use of Ar-40/Ar-39 ratio methodology to date lunar rock samples about 4 billion years old.	OSU Oceanography Department
1352	Niles	Oregon Office of Energy	General Consultation	Radiological and radioactive material transport consulting services	Oregon Office of Energy
1353	Kamp	The University of Waikato	Fission Track Thermochronology of New Zealand	Determination of history and timing of denudation of basement terranes in New Zealand and thermal history of late Cretaceous-Cenozoic sedimentary basins.	University of Waikato
1354	Paris	Radiation Protection Services	Radiological Instrument Calibration	Routine calibration of radiological monitoring instruments.	Oregon Health Division

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1357	Krane	Oregon State University	Neutron Cross Section Measurements	Irradiation and gamma spectrometry of germanium, gadolinium, and other elements to determine thermal capture cross sections of certain radionuclides.	OSU Radiation Center
1359	Niles	Oregon Office of Energy	State Laboratory Support	Maintenance of state radiological monitoring support capability, including QA, counting standards and calibrations of gamma spectrometer systems for measuring low lradioactivities in environmental and foodstuff samples.	Oregon Office of Energy
1365	Schutfort	Oregon State University	Quality Assurance Program	Irradiation of various samples for QA, including Au and Mn solutions both with and without cadmium covers to determine neutron flux ratios.	OSU Radiation Center
1366	Scaillet	Universite Paris-Sud	Ar-Ar Geochronology	Determination of geological samples via Ar-Ar radiometric dating.	Universite Paris-Sud
1373	Haggerty	Oregon State University	Diffusion in Geologic Materials	Liquid scintillation counting of tritium to research diffusion of water through geologic materials.	OSU Radiation Center
1374	Ream	Oregon State University	Ancient DNA	Extraction of DNA from archaeological artifacts (gloves and gelatin). Irradiation is done to destroy DNA that is not ancient.	OSU Microbiology Department

INAA = Instrumental Neutron Activation Analysis

REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1375	Gardner	Oregon State University	PAC spectroscopy of W2ZrO8	Activation of Hafnium in W2ZrO8 crystal in order to perform perturbed angle correlation spectroscopy.	OSU Radiation Center
1376	Proebsting	Oregon State University	Genetics of Peas	Produce deletion mutants of peas on the SN and NP genes	OSU Horticulture
1377	Williamson	Oregon State University	Bioremediation Bottle Sterilization	Destruction of Cells in Bioremediation Bottle Study	OSU Civil Engineering
1378	McBirney	University of Oregon	Petrology of the Skaergaard Intrusion, East Greenland	Determination of trace elements to evaluate behavior of components during crystallization and differentiation of magmas at shallow depths of earth's crust and mantle.	USDOE (Reactor Sharing)
1379	Feeley	Montana State University	Petrogenesis of Shoshonitic Series Magmas: Evidence from the Type Locality	Examination and modeling of variations in rare earth element concentrations of Shoshonitic series magmas from the Eocene Sunlight volcano, WY for reference for comparison to other similar eruption areas, particularly in back-arc regions of active subduction zones.	USDOE (Reactor Sharing)
1380	Barnes	Texas Tech University	Correlation of Cretaceous and Tertiary granites in a Nevadan core complex	Detailed sampling of granite rocks in deepest levels of East Humboldt Range for geochemical analysis and statistical testing of correlation with Ruby Mountains to test basement age theories, structure, and current concepts of granite generation.	USDOE (Reactor Sharing)

INAA = Instrumental Neutron Activation Analysis   REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1381	Fodor	North Carolina State University	Hawaiian magmatism: geochemistry of basalt and gabbro xenoliths and their plagioclase	Evaluation of trace-element abundances in Hawaiian basaltic and gabbroic rocks that occur as xenoliths in Koolau and Mauna Kea volcanoes	USDOE (Reactor Sharing)
1382	Smith	Trinity University	Origin of silicic magmas in Costa Rica	Determination of the origin of the high-silica magmas that occur in Costa Rica	USDOE (Reactor Sharing)
1383	Hughes	Idaho State University	INAA of Geologic Materials to Support Graduate Level Courses and Thesis Research	Support of student research projects for Quantatative Geochemistry Laboratory and Neutron Activation Analysis graduate courses	USDOE (Reactor Sharing)
1384	Mueller	University of Florida	Origin of the Little Belt Mountains	Identification and geochemical characterization of Proterozoic rocks in Little Belt Mountains to better constrain time nature of collision between these two cratons.	USDOE (Reactor Sharing)
1386	Johnson	Texas Tech University	Geochemistry of the Late Jurassic Wallowa batholith, Blue Mountains, northeastern Oregon	Characterization of Blue Mountains province, northeastern Oregon, to evaluate relative roles of crust and mantle in generation of pre-accretion magmas.	USDOE (Reactor Sharing)
1389	Michalek	Umpqua Research Company	PVC with Glass Wool and 35 ml Sorbent Material	PVC pipe with glass wool and sorbent material	Umpqua Research Company
1390	Bottomley	Oregon State University	Soil Study	Soil Study	OSU Crop and Soil Science
1397	Buckley	Oregon Medical Laser Center	Sterilization of various biological materials	Sterilization of various biological materials for St. Vincents Hospital, Portland	Oregon Medical Laser Institute

INAA = Instrumental Neutron Activation Analysis

REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1399	Olander	University of California at Berkeley	Volatilization of uranium material	Irradiation of vapor from depleted uranium loaded on resin and heated to high temperatures in reducing atmosphere. U-235 in vapor deposits fissions; U-238 absorbs neutrons. Gamma ray spectrometry determines amount of uranium volatilized.	University of California at Berkeley
1403	Klingensmith	University of California at Santa Barbara	Testing of Metal Specimens	Testing of activated metal specimens for full range of isotopes.	University of California at Santa Barbara
1404	Riera-lizarau	Oregon State University	Evaluation of wheat DNA	Gamma irradiation of wheat seeds	OSU Crop and Soil Science
1405	Pastorek	Oregon State University	CH 462 - Integrated Laboratory Program	Integrated laboratory program using INAA to determine abundance of sodium, aluminum, and potassium in zeolite.	OSU Radiation Center
1406	Pate	Tracerco	Production of Argon-41	Production of Argon-41 for various field uses	Tracerco
1407	Roden-Tice	Plattsburgh State University	Apatite and Zircon Fission Track Dating	Apatite and zircon fission track dating to determine thermal and uplift histories of Hartford Basin sedimentary rocks and Bronson Hill terrrane crystalline rocks, CT.	Plattsburgh State University
1408	Gerdemann	USDOE Albany Research Center	Analysis of titanium powder	Measurement of sodium and chlorine in titanium powder.	USDOE Albany Research Center
1409	Keith	Brigham Young University	Characterization of Bingham Porphyry System, UT	Characterization of Bingham porphyry Cu-Au-Mo deposit, Utah	USDOE (Reactor Sharing)

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1410	Johnson	University of New Orleans	Evolution of magma chamber beneath South Sister Volcano, OR	Trace element and isotopic study to evaluate recent magma chamber processes. Development of a volcanic hazard report	USDOE (Reactor Sharing)
1413	Webb	University of Geneva	Argon Geochronology	Ar-39/Ar-40 dating of pure mineral and whole rock separates.	University of Geneva
1414	Weigand	California State University at Northridge	Petrology of volcanic rocks associated with the Miocene San Onofre Breccia, southern California	Characterization and comparison of volcanic rocks in Miocene San Onofre Breccia on Santa Cruz Island and San Onofre Breccia on Santa Catalina Island.	USDOE (Reactor Sharing)
1415	McGinness	ESCO Corporation	Calibration of Instruments	Instrument calibration	ESCO Corporation
1416	Rowan	Colorado State University	Tracer Studies in Trout	Irradiate to activate Cs-133	USDOE (Reactor Sharing)
1417	Loveland	Oregon State University	Production of Radionuclides for LBNL	Various radionuclides will be produced for research to be conducted at LBNL.	OSU Chemistry / Loveland DOE
1418	Hinton	University of Georgia	Determination of Cesium in Fish Muscle and Lake Flora	Determination of cesium concentration in freeze-dried and ashed fish muscle and plant samples from Pond #4, Savannah River Site.	USDOE (Reactor Sharing)
1419	Krane	Oregon State University	Nuclear Structure of N=90 Isotones	Study of N=90 isotone structure (Sm-152, Gd-154, Dy-156) from decays of Eu-152, Eu-152m, Eu-154, Tb-154, and Ho-156. Samples will be counted at LBNL.	OSU Physics Department

INAA = Instrumental Neutron Activation Analysis   REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1421	Krane	Oregon State University	Measurement of Pb-208 capture cross section	Measurement of Pb-208 capture cross section by activation technique by looking at beta decay of Pb-209.	OSU Physics Department
1422	Harnish	Colorado School of Mines	Actinide Studies	Actinide studies of sediment samples	Colorado School of Mines
1423	Turrin	Columbia University	40Ar/39Ar Analysis	Petrology and geochemical evolution of the Damavand trachyandesite volcano in Northern Iran.	Columbia University
1424	Yasinko	Tru-Tec	Argon 41 Production	Irradiation of argon gas to produce argon 41.	Tru-Tec
1425	Gardner	Oregon State University	Measuring Impurity Levels in ZrO2	INAA of pure, undoped zirconium oxide to measure oxygen vacancies which affects ionic conductivity.	OSU Radiation Center
1426	Roberts	Tissue Science	Gamma Sterilization of Heterografts	Tissue sterilzation	Tissue Science
1427	Posey	Sandia National Laboratory	Radiation Testing of Electronic Parts	Electronic parts are pulsed to test their susceptability to radiation fields.	Sandia National Laboratory
1428	Palmer	Oregon State University	Production of hydrogen filters using thin pure metal foils	Irradiation of Pd, Ti, Cr, Fe, Cu, and Ag foils to measure radiation effects.	OSU Radiation Center
1429	Stone	Valley Landfills	Monitoring of Radioactive Landfill Samples	Landfill samples are monitored for isotopic analysis.	Valley Landfills

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1430	Bottomley	Oregon State University	Atrazine Remediation in a Wetland Environment	Characterization of fate of atrazine in wetland mesocoms and a constructed wetland; investigation of presence of atrazine degrading microorganisms in rhizosphere soil.	ATX412-T407
1431	Stein	AVI Bio Pharma	Instrument Calibrations		AVI Bio Pharma
1432	Trappe	Oregon State University	Sterilization of Soil Samples		OSU Forest Sciences
1433	Hughes	Idaho State University	Examination of europium abundance in river sediments	Examination of europium abundance in sediments from the Columbia and Snake Rivers	Idaho State University Physics
1434	Taylor	Oregon Department of Justice	ODJ Case # CDA0006-99	Analysis of 22 ammunition for triple homocide	ODJ
1435	Carstens	Oregon State University	Golf Ball Irradiation	Irradiate golf balls in the Gammacell to 0.25, 0.5, 1, 3, and 5 Mrads	OSU Radiation Center
1436	Basu	University of Rochester	Composition of Kerguelen Plume as Determined by Its Early Melts	Analyses for Rb/Sr and Sm/Nd to determine degree of crustal contamination and isotopic composition of lower mantle plume source in eastern and central Indian alkalic dikes.	USDOE (Reactor Sharing)
1437	Binney	Oregon State University	INAA Software Development	Development of software for NAA systems, including application of interference correction algorithms to GammaVision data.	UDOSE Reactor Sharing
1438	Eliason	University of Minnesota	Lichen Analysis by INAA		USDOE (Reactor Sharing)

INAA = Instrumental Neutron Activation Analysis REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1439	Feeley	Montana State University	Petrogenesis of Copper Lakes Intrusive Series, Sunlight Basin, WY	Examination and modeling of variations in chemical compositions of Eocene intrusive rocks exposed in Copper Lakes Basin, WY.	USDOE (Reactor Sharing)
1440	Hinton	University of Georgia	Cesium analyses	Determination of cesium concentrations in environmental systems	USDOE (Reactor Sharing)
1441	Hinton	University of Georgia	Determination of Cesium in Plankton	Analysis of cesium abundance in plankton samples to provide information on biological uptake in food chain using stable activable tracer Cs-133 in a pond at Savannah River Site.	USDOE (Reactor Sharing)
1442	Hughes	Idaho State University	NAA of Geologic Materials to Support Student Research	Support of graduate and undergraduate research, graduate courses, and pilot research projects covering wide range of geologic topics with emphasis on petrology and geochemistry.	USDOE (Reactor Sharing)
1443	Johnson	Texas Tech University	Geochemistry of Bald Mtn Batholith and Fish Lake Complex, NE OR	Determination of petrogenesis of Bald Mountain batholith and Fish Lake Complex using INAA	USDOE (Reactor Sharing)
1444	Mueller	University of Florida	Proterozoic Evolution of the Little Belt Mountains	Characterization of tectonic environment of exposed rocks in Little Belt Mountains using INAA.	USDOE (Reactor Sharing)
1445	Streck	Portland State University	Interpretation of igneous processes at San Luis Caldera, CO	Investigation of magmatic processes leading to formation of large rhyolite magma chambers by studying ash flow tuffs by INAA.	USDOE (Reactor Sharing)

INAA = Instrumental Neutron Activation Analysis   REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1446	Tollo	George Washington University	Petrology and geochemistry of Grenville-age basement, VA	Field mapping and petrological studies of a suite of igneous and metamorphic rocks by INAA.	USDOE (Reactor Sharing)
1447	Rose	Lawrence Livermore National Laboratory	Tritium Imbedding into Silicon	Silicon wafers are irradiated in a He-3 atmosphere to produce tritium, which will imbed into the silicon wafers.	Lawrence Livermore National Laboratory
1448	Krane	Oregon State University	Measurement of Tb-160 neutron capture cross section	Measurement of Tb-160 neutron capture cross section by irradiation of Tb-159 to produce Tb-161.	USDOE (Reactor Sharing)
1449	Binney	Oregon State University	Irradiation of Stents Used for Restenosis	A stent used in coronary implants was made radioactive to study its radiation properties.	OSU Radiation Center
1450	Krane	Oregon State University	Measurement of Au-194 neutron capture cross section	Measurement of Au-194 neutron capture cross section by irradiation of Hg-194	USDOE (Reactor Sharing)
1451	Krane	Oregon State University	Gamma ray spectroscopy of Ho-167	Study of Ho-167 decay to improve gamma ray spectrum information	OSU Physics Department
1454	Garver	Union College	Fission Track Dating for thermochronology and provenance analysis	Fission track analysis of zircon and apatite to determine thermotectonic evolution of orogenic systems.	USDOE (Reactor Sharing)
1455	Hemming	Columbia University	Dating volcanic ashes from Cenozoic lacustrine sections	Application of multiple geochronometers (Ar/Ar technique) to dating lacustrine sedimentary sections from western U.S.	USDOE (Reactor Sharing)

INAA = Instrumental Neutron Activation Analysis

REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1456	Roden-Tice	Plattsburgh State University	Thermal History of Adirondack Mtns, NY and Adjacent Areas	Analysis of apatites from southeastern New York, western Vermont, and northern Massachusetts for fission track ages.	USDOE (Reactor Sharing)
1458	Lunderberg	Albany Democrat-Herald	Food Irradiation: Bananas	Irradiate Bananas to 2 kGy	OSU Radiation Center
1459	Intini	Research Foundation of SUNY	Sterilization of Polyvinylsiloxane Templates	Gamma sterilization of PVS templates to make calcium sulfate disks for osteoblast proliferation test activity.	University at Buffalo, SUNY
1460	Hamby	Oregon State University	INAA of beans	Determination of iron and zinc in gorund pinto bean samples. Beans are intended as food material for rats in radiotracer experiments.	OSU Radiation Center
1461	Binney	Oregon State University	Irradiation of diamonds	Irradiation of diamonds for NE 457 experiment	OSU Radiation Center
1462	Binney	Oregon State University	Irradiation of bean seeds for OSU student	Irradiation of bean seeds for experiment	OSU Radiation Center
1463	Andresen	University of Oslo	Ar-Ar study of differential block movement, S. Norway	Sampling of white mica, amphibole, and K-feldspar in traverses across shear zone to determine exhumation history of high grade Bamble Blocks and medium grade Telemark Block	University of Oslo
1464	Slavens	USDOE Albany Research Center	Instrument Calibration		USDOE Albany Research Center
1465	Singer	University of Wisconsin	Ar-40/Ar-39 Dating of Young Geologic Materials	CLICIT irradiation of geological materials such as volcanic rocks from sea floor, etc. for Ar-40/Ar-39 dating.	University of Wisconsin

INAA = Instrumental Neutron Activation Analysis

REE = Rare Earth Elements

Table VI.C.3

Listing of Major Research and Service Projects Performed or In Progress at the Radiation Center and Their Funding Agencies

Project	User(s) Name	Organization Name	Project Title	Description	Funding
1467	Kirner	Kirner Consulting, Inc	Instrument Calibration	Instrument calibration	Kirner Consulting
1468	Nitsche	University of California at Berkeley	Chemistry 146 Experiment	Sample irradiation	University of California at Berkeley
1469	Wu	Oregon State University	INAA Experiment NE 457	Determination of halogen elements in biological samples.	OSU Radiation Center
1470	Lucero	Siga Pharmaceuticals, Inc	Instrument Calibration	Instrument Calibration	Siga Pharmaceuticals
1471	Bartlett	Oregon State University	Irradiation of Golf Balls	Irradiation of Golf Balls	OSU Radiation Center
1472	Wu	Oregon State University	Irradiation of Lily Bulbs	Irradiation of Golf Balls	OSU Radiation Center
1473	Alarcon	Becton Dickenson Technologies	Gamma Irradiations	Gamma Irradiation to 5k, 3k, & 2k.	Becton Dickenson Technologies

INAA = Instrumental Neutron Activation Analysis

REE = Rare Earth Elements

Table VI.C.4

Summary of the Types of Radiological Instrumentation Calibrated
to Support the OSU TRIGA Reactor and the Radiation Center

Type of Instrument	Number of Calibrations
Alpha Detectors	4
GM Detectors	44
Ion Chambers	11
Micro-R Meters	3
Personal Dosimeters	34
TOTAL	94

Table VI.C.5

Summary of Radiological Instrumentation Calibrated
to Support Other OSU Departments and Other Agencies

Department/Agency	Number of Calibrations
OSU Departments	
Agricultural Chemistry	6
Animal Science	3
Biochemistry/Biophysics	7
Botany and Plant Pathology	4
Chemistry	2
Civil Engineering	2
Crop Science	1
E.M.T.	7
Entomology	1
Exercise and Sport Science	1
Forest Science	3
Horticulture	3
Linus Pauling Institute	1
Microbiology	5
Nutrition and Food Management	0
Oceanic and Atmospheric Sciences	3
Pharmacy	6
Physics	4
Radiation Safety Office	14
Veterinary Medicine	5
Zoology	4
OSU Departments Total	82
Non-OSU Agencies	
Army Corps of Engineers	3
AVI Biopharma	1
Corvallis Fire Department	4
DOE Albany Research Center	2
ESCO Corporation	6
Good Samaritan Hospital	8
Kimer Consulting	1
Occupational Health Laboratory	1
Oregon Office of Energy	28
Oregon Department of Transportation	2
Oregon Health Sciences University	24
Oregon Public Utilities Commission	7
Oregon State Health Division	35
Siga Technologies	1
USDA Agricultural Research Service/Forest Service	1
U.S. Environmental Protection Agency	5
Valley Landfills, Inc.	1
Non-OSU Agencies Total	130

Table VI.C.6

Summary of Radiological Instrument Repair Activities for Non-Radiation Center Departments and Agencies

Date	Organization	Instrument	Calibrated?	Nature of Repair
8/2/99	Physics	Technical Associates PUG-1	Yields	Replace GM tube
8/3/99	Biochem/Biophysics	Research Products Intl.	Yes	Replace connector
8/9/99	Oregon Health Sciences University	Ludlum 3	No	Replace 3 ICs, fix battery compartment latch
10/1/99	Public Utilities Commission	Ludlum 6	Yes	Replace scale
10/1/99	Public Utilities Commission	Ludlum 6	Yes	Replace scale
10/19/99	Radiation Safety	Eberline E-120	Yes	Replace GM tube
10/28/99	Zoology	Ludlum 2	Yes	Replace GM tube
6/8/00	Radiation Safety	Ludlum 2	Yes	Replace GM tube
Total Number of Repairs			**8**	

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
7/1/99	20	Adventures in Learning
7/6/99	6	Teresa Bailey & Family
7/7/99	3	Oregon Attorney General
7/12/99	1	Jon Haddenham/START
7/16/99	1	Gary Jarka
7/19/99	13	World Affairs Council of Oregon
7/28/99	1	Becky Cole
8/3/99	14	HAZMAT
8/23/99	1	Dr. David Hamby
8/27/99	2	Sylvia and Chuck Libby
8/30/99	1	Phil Wroblicky
10/1/99	2	KVAL TV
10/1/99	17	NE 111 class
10/4/99	9	LBCC Class- Mulder
10/5/99	18	LBCC-Mulder
10/22/99	41	OSU alums
10/25/99	40	SMILE
10/28/99	32	5th graders, Newport, OR
10/28/99	1	Dale Doering
10/30/99	150	Beaver Open House
11/3/99	2	NE Class

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
11/4/99	18	LBCC Class
11/5/99	9	LBCC Class
11/6/99	150	Dad's Weekend
11/9/99	12	Community Consortium Services
11/24/99	4	Japanese visitors
11/29/99	10	NE Advisory Board
12/3/99	2	KBVR-TV
12/7/99	3	6th graders from Monroe
12/14/99	8	Center for Alternative Learning
1/10/00	3	ATHRL guests
1/11/00	15	CH 462 Class
1/13/00	15	CH 462 Class
1/14/00	15	Students-Bloss Hall
1/14/00	15	Students-Bloss Hall
1/20/00	20	Corvallis Water Systems
1/25/00	15	CH 462
1/27/00	3	External Review
2/1/00	10	Students-Hawley Hall
2/1/00	4	General Science Students
2/2/00	50	John King - Engr 331
2/4/00	50	John King - Engr 332 class

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
2/9/00	15	Finley Hall Students
2/11/00	25	Naval ROTC
2/18/00	15	LBCC
2/21/00	15	CH 225H Class
2/21/00	2	Peter and Marie Edwards
2/22/00	21	CH 225H
2/22/00	1	Rich Holdren-University Research Office
2/24/00	15	CH 225H
2/28/00	5	Students-Finley Hall
2/29/00	22	CH 222
2/29/00	15	CH 222
2/29/00	27	CH 222
2/29/00	18	CH222
3/1/00	2	Navy Visitors
3/1/00	12	CH222
3/1/00	18	CH 222
3/2/00	19	CH 222 Class
3/2/00	23	CH 222 Class
3/2/00	21	CH 222 Class
3/2/00	19	CH 222 Class
3/6/00	2	Ted and Sharon Reese

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
3/6/00	19	LBCC - Lab Experiment
3/7/00	24	CH 222
3/7/00	20	CH 222
3/7/00	27	CH 222
3/8/00	20	CH 222
3/8/00	23	CH 222
3/9/00	22	CH 222
3/9/00	17	CH 222
3/9/00	23	CH 222
3/9/00	17	CH 222
3/10/00	20	SMILE
3/17/00	3	Grammer Family
3/22/00	3	Nate Carstens Family
3/22/00	6	Reed Reactor
3/28/00	3	Guests
3/30/00	1	Randy Short
3/31/00	20	SMILE
3/31/00	20	SMILE
4/3/00	1	Mike Bamberger, Benton County
4/5/00	20	Crescent Valley High School
4/7/00	1	Joseph Prudell

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
4/11/00	8	Center for Alternative Learning
4/11/00	40	Youth Leadership Day
4/17/00	18	WOU Chemistry
4/18/00	10	WOU Chemistry
4/18/00	18	WOU Chemistry
4/21/00	27	LBCC
4/24/00	10	LBCC
4/25/00	19	LBCC
4/25/00	12	LBCC
4/25/00	3	Paul Ingham - AECL
4/27/00	2	Friends/Jose Reyes
5/2/00	2	US Army
5/2/00	6	Corvallis High School
5/3/00	12	StoneyBrook Lodge
5/3/00	10	Corvallis Fire Deptment
5/4/00	10	Corvallis Fire Deptment
5/6/00	62	Mom's Weekend
5/8/00	3	Idaho National Engineering and Environmental Laboratory
5/16/00	12	General Atomic
5/17/00	10	Corvallis Fire Deptment
5/19/00	40	Santiam Christian

Table VI.F.1

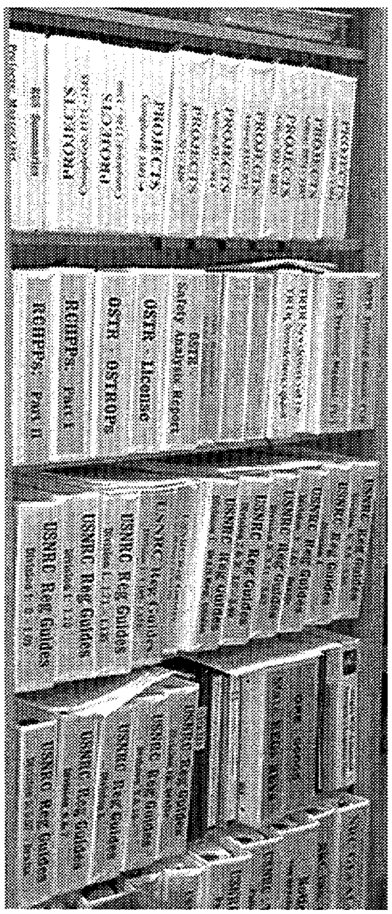
Summary of Visitors to the Radiation Center

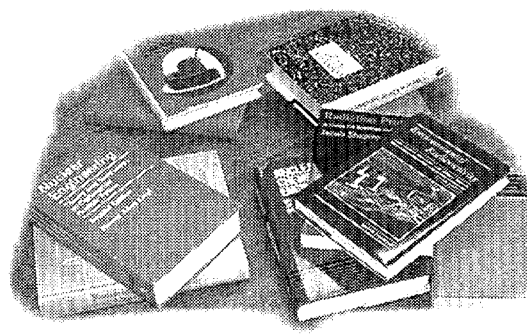
Date	No. of Visitors	Name of Group
5/31/00	14	West Albany High
6/1/00	9	Blodgett Students
6/2/00	5	Blodgett Students
6/6/00	10	Radiation Safety Committee
6/8/00	2	Alan Brittan
6/12/00	1	Jared Males
6/12/00	1	Keith Ebbers
6/22/00	1	Gary Yarrow

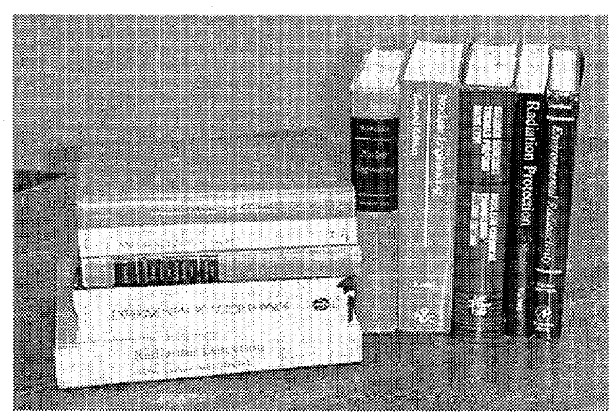
Total Tours: 113 **Total Visitors: 1805**

Part VII

Words







Part VII

WORDS

A. Documents Published or Accepted for Publication

* Andor L. W. Lips, Cassard, D., Sözbilir, H., Yilmaz, H., Wijbrans, J.R., (2000), Multistage exhumation of the Menderes Massif, western Anatolia (Turkey), Int J Earth Sci, DOI 10.1007/s005310000101.

* Bergman, J. and Binney, S., (2000), Detection of a Non-Uniform Activity Distribution on a Coronary Radioactive Stent Using Solid Organic Scintillation Techniques, Proceedings of the Topical Meeting on Radiation Protection for Our National Priorities: Medicine, the Environment, and the Legacy.

* Bertotti, G., Seward, D., Wijbrans, J.R., TerVoorde, M., Hurford, A.J., (1999), Crustal thermal regime prior to, during, and after rifting: A geochronological and modeling study of the Mesozoic South Alpine rifted margin, TECTONICS 18: (2) 185-200 1999.

* Binney, S., (1999), General Reactor Considerations for a BNCT Facility, American Nuclear Society 81, 118-119.

Binney, S., (2000), Investigation of Bremsstrahlung Effects in Shielding Calculations, BNFL Inc., Report ES-W375-NS00001,551 pp.

* Binney, S., Reese, S., and Schütfort, E., (1999), Research Uses of the Oregon State University TRIGA Reactor, Trans. American Nuclear Society 80, 89-90.

* Burwash, R.A., Krupicka, J., Wijbrans, J.R., (2000), Metamorphic evolution of the Precambrian basement of Alberta, AN MINERAL 38: 423-434 Part 2 APR 2000.

* Culler, T.S., Becker, T.A., Muller, R.A., and Renne, P.R., (2000), Lunar impact history from 40Ar/39Ar dating of glass spherules, Science 287: 1785-1788.

* Dingus, L., Clarke, J., Scott, G., Swisher III, C.C., Chiappe, L.M., and Coria, R.A., (2000), Stratigraphy and age of the Sauropod embryo-bearing rocks in the Neuquén Group (Late Cretaceous, Neuquén Province, Argentina), Am. Museum Noitates 3290: 1-11.

* Dumitru, T., (2000), Fission-track geochronology, Quaternary Geochronology: Applications of Age-Estimation Methods to Quaternary Geology and Paleoseismology, American Geophysical Union Reference Shelf, vol. 4.

* Dumitru, T.A., and Hendrix, M.S., (2001), Fission track record of north-vergent Jurassic intracontinental folding and thrusting in southern Mongolia, Paleozoic and Mesozoic Tectonic Evolution of Central and Eastern Asia: From Continental Assembly to Intracontinental Deformation, Geological Society of America Special Paper .

---

* Indicates OSTR use.

* Dumitru, T.A., Zhou, D., Chang, E., Graham, S.A., Hendrix, M.S., Sobel, E.R., and Carroll, A.R., (2001), Uplift, exhumation, and deformation in the Chinese Tian Shan, Paleozoic and Mesozoic Tectonic Evolution of Central and Eastern Asia: From Continental Assembly to Intracontinental Deformation, Geological Society of America Special Paper .

* Dunai, T.J., Wijbrans, J.R., (2000), Long-term cosmogenic He-3 production rates (152 ka-1.35 Ma) from Ar-40/Ar-39 dated basalt flows at 29 degrees N latitude, EARTH PLANET SC LETT 176: (1) 147-156 FEB 28 2000.

Dungan, M., Wulff, A., Thompson, R., (2000), A refined eruptive stratigraphy for the Tatara-San Pedro complex (36 deg S, Southern Volcnic Zone, Chilean Andes): Reconstruction methodology and implications for magmaevolution at long-lived arc volcanic centers, Journal of Petrology.

* Ernesto, M., Raposo, M.I.B., Marques, L.S., Renne, P.R., Diogo, L.A., de Min, A., (1999), Paleomagnetism, geochemistry and 40Ar/39Ar dating of the North-eastern Paraná Magmatic Province: tectonic implications, Journal of Geodynamics 28: 321-340.

* Evenson, W., Lu, J., Winz, M., Gardner, J., Zacate, M., Lee, T., Mommer, N., (1999), Stochastic PAC models for vacancy motions with trapping and detrapping, Hyperfine Interactions.

* Fitzgerald, P.G., (1999), Cretaceous - Cenozoic tectonic evolution of the Antarctic Plate, Terra Antartica Reports No. 3, 109-130, Siena, Italy.

* Fitzgerald, P.G., (2000), Tectonics and landscape evolution of the Antarctic plate since Gondwana breakup, with an emphasis on the West Antarctic rift system and the Transantarctic Mountains, Proceedings of the Eighth International Symposium on Antarctic Earth Sciences.

* Fitzgerald, P.G., Muñoz, J.A., Coney, P.J. and Baldwin, S.L., (1999), Asymmetric exhumation across the Pyrenean orogen: implications for the tectonic evolution of collisional orogens, Earth and Planetary Science Letters, 173, 157-170..

* Fodor, R.V., (2000), Plagioclase of Hawaiian tholeiitic and alkalic magma parentages: distinctions based on REE, Sr, Ba, Hf, and Ta, Mineralogy and Petrology 69: 213-225.

* Gabunia, L., Vekua, A., Ferring, R., Justus, A., Lordkipanidze, D., Swisher III, C.C., Tvalchrelidze, M., Antón, S.C., Bosinski, G., de Lumley, M.-A., Majsuradze, G., Mouskhelishvili, A., and Nioradze, M. , (2000), Earliest Pleistocene hominid cranial remains from Dmanisi, Republic of Georgia, taxonomy, geologic setting and age. , Science 288: 1019-1025.

* Ganqing, Xu and Kamp, P.J.J., (2000), Tectonics and denudation adjacent to the Xianshuihe Fault, eastern Tibetan Plateau: Constraints from fission track thermochronology, Journal of Geophysical Research.

* Indicates OSTR use.

* Gardner, J.A., Lee, T., Mommer, N., Karapetrova, E., Zacate, M.O., Platzer, R., Evenson, W.E., and Sommers, J.A., (1999), Dynamics and thermodynamics of tetragonal zirconia determined by 111-IN/CD TDPAC, Hyperfine Interactions.

* Hackley, P., and Tollo, R. P., (2000), Geologic Map of the Old Rag Mountain 7.5-minute Quadrangle, Virginia, Virginia Division of Mineral Resources Digital Bedrock Geologic Map, scale 1:24,000 with text.

* Heeremans, M., Wijbrans, J.A., (1999), Late Proterozoic tectonic events in southern Finland, constrained by Ar-40/Ar-39 incremental heating and single spot fusion experiments on K-feldspars, TERRA NOVA 11: (5) 216-222 OCT 1999.

Hemming, S.R., (1999), 40Ar-39Ar and radiogenic isotope approaches to tracing ice rafted detritus in the North Atlantic, GSA Annual Convention, Abstracts with Programs, p. A-374.

Hemming, S.R., and Rasbury, E.T., (2000), Pb isotope measurements of sanidine monitor standards: implications for provenance analysis and tephrachronology, Chemical Geology 165, 331-337.

Hemming, S.R., Bond, G.C., Broecker, W.S., Sharp, W.D., and Mendelson-Klas, M., (2000), Evidence from 40Ar/39Ar ages of individual hornblende grains from Orphan Knoll for varying Laurentide sources of iceberg discharges 22,000 to 10,000 14C yr BP, Quaternary Research.

Hemming, S.R., Goldstein, S.L., Bond, A., and Turrin, B.D., (2000), Radiogenic Ar Concentrations of De-carbonated Sediments Around South Africa Goldschmidt, .

Hemming, S.R., Gwiazda, R.H., Andrews, J.T., Broecker, W.S., Jennings, A.E., and Onstott, T., (2000), Provenance of Baffin Island Tills based on isotopic analysis of individual grains of feldspar and hornblende, Canadian Journal of Earth Sciences.

Hemming. S.R., and Rasbury, E.T., (1999), Lead-isotopic measurements of sanidine monitor standards: implications for provenance analysis and tephrochronology, Goldschmidt Ninth Annual V.M. Goldschmidt Conference, Cambridge, MA, Abstracts, p. 121.

Hilgen, FJ, Aziz, H.A., Krijgsman, W., Langereis, C.G., Lourens, L.J., Meulenkamp, J.E., Raffi, I., Steenbrink, J., Turco, E., Vugt, N.V., Wijbrans, J.R., Zachariasse, W.J., (1999), Present status of the astronomical (polarity) time-scale for the Mediterranean Late Neogene, PHILOS T ROY SOC A 357: (1757) 1931-1947 1999.

* Hughes, S.S. and McCurry, M., (2000), Geochemical evidence for time-space evolution of Snake River Plain rhyolites, Bonnichsen, B., White, C., and McCurry M., eds., Tectonic and magmatic evolution of the Snake River Plain volcanic province: Idaho Geological Survey Special Publication.

---

* Indicates OSTR use.

* Hughes, S.S., Smith, R.P., Hackett, W.R. and Anderson, S.R., (1999), Mafic volcanism and environmental geology of the eastern Snake River Plain, Hughes, S.S., and Thackray, G.D., eds., Guidebook to the Geology of Eastern Idaho: Idaho Museum of Natural History, p. 143-168.

* Hughes, S.S., Wetmore, P.H., and Casper, J.L., (2000), Evolution of Quaternary tholeiitic basalt eruptive centers on the eastern Snake River Plain, Idaho, Bonnichsen, B., White, C., and McCurry M., eds. Tectonic and magmatic evolution of the Snake River Plain volcanic province: Idaho Geological Survey Special Publication.

* Kalt, A., Corfu, F., Wijbrans, J.R., (2000), Time calibration of a P-T path from a Variscan high-temperature low-pressure metamorphic complex (Bayerische Wald, Germany), and the detection of inherited monazite, CONTRIB MINERAL PETR 138: (2) 143-163 FEB 2000.

* Kamp, P.J.J., (1999), Tracking crustal processes by FT thermochronology in a forearc high (Hikurangi Margin, New Zealand) involving Cretaceous subduction termination and mid-Cenozoic subduction initiation, Tectonophysics, 307, 313-343.

* Kamp, P.J.J., (2000), Thermochronology of the Torlesse accretionary complex, Wellington region, New Zealand, Journal of Geophysical Research.

* Kamp, P.J.J., Whitehouse, I.W.S. and Newman, J., (1999), Constraints on the thermal and tectonic evolution of the Greymouth coalfield, New Zealand Journal of Geology and Geophysics, 42, 447-467.

* Keillor, M., Binney, S., and Tobin, M., (2000), Passive Gamma Detection of Radioactive Sources Moving in Vehicle Traffic, Proceedings of the Topical Meeting on Radiation Protection for Our National Priorities: Medicine, the Environment, and the Legacy.

* Koppers, A.A.P., Staudige, H., Wijbrans, J.R., (2000), Dating crystalline groundmass separates of altered Cretaceous seamount basalts by the Ar-40/Ar-39 incremental heating technique, CHEM GEOL 166: (1-2) 139-158 MAY 1 2000.

* Kowallis, B.J., Swisher III, C.C., Carranza-Castaneda, Miller, W.E., and Tingey, D.G., (1999), Fission-track and single-crystal 40Ar/39Ar dates from volcanic ash layers in fossil-bearing Pliocene sediments in Central Mexico, Revista Mexicana de Ciencias Geologicas 15(2): 157-160.

* Krane, K.S., (2000), Thermal Neutron Capture Cross Sections of Long-Lived Nuclei Measured by Activation, Proceedings of the 10th International Symposium on Capture Gamma-Ray Spectroscopy and Related Topics.

Kuznetsov, A.V., van Veldhuizen, E.J., Westerberg, L., Lyapin, V.G., Aleklett, K., Loveland, W., Bondorf, J., Jakobsson, B., Whitlow, H.J., El Bouanani, M., (2000), A compact Ultra-High Vacuum (UHV) compatible instrument for time of flight-energy measurements of slow heavy reaction products, Nucl. Instru. Meth. Phys. Res. A.

* Indicates OSTR use.

* Lips, A.L.W., Wijbrans, J.R., White, S.H., (1999), New insights from 40Ar/39Ar laserprobe dating of white mica fabrics from the Pelion Massif, Pelagonian Zone, Internal Hellenides, Greece: Implications for the timing of metamorphic episodes and tectonic events in the Aegean region, Geol. Soc. London SP. 156, 457-474.

Loveland, W., (2000), Recent advances in understanding nuclear reactions, J. Radioanal. Nucl. Chem. 243, 147.

Loveland, W., and Seaborg, G.T., (Hall, N.,ed), (2000), The Search for New Elements, The New Chemistry, Cambridge University Press, Cambridge, pp 1-31.

Loveland, W., Ninov, V., Gregorich, K.E., Ghiorst, A., Hoffman, D.C., Lee, D.M., Nitsche, H., Swiatecki, W.J., Kirbach, U.W., Laue, C.A., Adams, J.L., Patin, J.B., Shaughnessy, D.A., Strellis, D.A., and Wilk, P.A., (1999), Observation of Superheavy Nuclei Produced in the Readction of 86Kr with 208Pb, Rev. Lett. 83, 1104.

* Marzoli, A., Melluso, L., Morra, V., Renne, P.R., Sgrosso, I., D'Antonio, M., L. Duarte Morais, E.A.A., Morais, E.A.A., and Ricci, G. , (1999), Geochronology and Petrology of Cretaceous Basaltic Magmatism in the Kwanza Basin (Western Angola), and Relationships with the Paraná-Etendeka Flood Basalt Province, Journal of Geodynamics 28: 341-356.

* Marzoli, A., Piccirillo, E.M., Renne, P.R., Bellien, G., Iacumin, M., Nyobe, J.B, and Tongwa, A.T., (2000), The Cameroon Volcanic Line Revisited: Petrogenesis of Continental Basaltic Magmas from Lithosopheric and Asthenospheric Mantle Sources, Journal of Petrology 41: 87-109.

McDaniel, D.K., Hemming, S.R., McLennan, S.M., and Hanson, G.N., (1999), Dissecting sedimentary provenance: a comprehensive analysis of marine sediments of the Amazon River system, GSA Annual Convention, Abstracts with Programs, p. A-375.

* Mertz, D.F., Swisher III, C.C., Franzen, J.L. Neuffer, F.O., and Lutz, H., (2000), Numerical sating of the Eckfeld maar fossil site, Eifel, Germany: a calibration mark for the Eocene time scale, Naturwissenschaften 87: 270-274.

* Miller, E.L., Dumitru, T.A., Brown, R.W., and Gans, P.B., (1999), Rapid Miocene slip on the Snake Range–Deep Creek Range fault system, east-central Nevada, Geological Society of America Bulletin, v. 111, p. 886-905.

* Min, K., Mundil, R., Renne, P.R., and Ludwig, K.R., (2000), A Test for Systematic Errors in 40Ar/39Ar Geochronology Through Comparison with U-Pb Analysis of a 1.1 Ga Rhyolite, Geochimica et Cosmochimica Acta 64(1): 73-98.

* Mommer, N., Lee T., and Gardner, J.A., (2000), Stability of monoclinic and tetragonal zirconia at low oxygen partial pressure, J. Mater. Research .

* Mommer, N., Lee, T., Gardner, J.A., and Evenson, W.E., (2000), Oxygen vacancy trapping in tetragonal ZrO2 studied by 111In/Cd perturbed angular correlation, Phys. Rev.

* Indicates OSTR use.

* Platzer, R., Dumkow, I.D., Gardner, J.A. and Tate, J., (1999), Oxygen dynamics in epitaxial YBa2Cu3O7-delta thin films, Hyperfine Interactions .

Rasbury, E. T., Hemming, S. R., Montañez, I. P., Pedone, V. A., Cole, J. M., Hanson, G. N., Becker, M., and Klas-Mendelson, M., (1999), Argon-argon and uranium-lead age constraints on the medial Miocene Barstow Formation, Mojave, California, Geological Societ of America Annual Convention, Abstracts with Programs, p. A-233.

* Renne, P.R., (2000), 40Ar/39Ar age of plagioclase from Acapulco meteorite and the problem of systematic errors in cosmochronology, Earth and Planetary Science Letters 175: 13-26.

* Renne, P.R., WoldeGabriel, G., Hart, W.K., Heiken, G., and White, T.D., (1999), Chronostratigraphy of the Miocene-Pliocene Sagantole Formation, Middle Awash Valley, Afar Rift, Ethiopia, Geological Society of America Bulletin 111: 869-885.

* Roden-Tice, M., Tice, S., Schofield, I., (2000), Evidence for differential unroofing in the Adirondack Mts., NY State, Journal of Geology, 108, 155-169.

* Rose, W.I., Conway, F.M., Pulliinger, C.R., Deino, A., and McIntosh, W.C., (1999), An improved age framework for late Quaternary silicic eruptions in northern Central America, Bulletin of Volcanology 61: 106-120.

* Schütfort, E. and Binney, S., (1999), Instrumental Neutron Activation Analysis of Carbonate Reference Standard Material NBS-1c (Argillaceous Limestone) and NBS-88a (Dolomite), Trans. American Nuclear Society 80, 56-57.

* Sharp, W.D., Tobisch, O.T., and Renne, P.R., (2000), Development of Cretaceous transpressional cleavage synchronous with batholith emplacement, central Sierra Nevada, California, Geological Society of America Bulletin 112 (7): 1059-1066.

Souliotis, G.A., Loveland, W., Zyromski, K.E., Wozniak, G.J., Morrissey, D.J., Liljenzin, J.O., and Aleklett, K. (Hamilton, J.H., Phillips, W.R., Carter, H.K., ed.), (2000), Charge and mass distributions of fission fragments from intermediate energy collisions of 238U projectiles. Generation of very neutron-rich nuclei, Fission and Properties of Neutron-Rich Nuclei, World, Singapore, pp. 478-484.

* Steenbrink, J., van Vugt, N., Hilgen, F.J., Wijbrans, J.R., Meulenkamp, J.E., (1999), Sedimentary cycles and volcanic ash beds in the Lower Pliocene lacustrine succession of Ptolemais (NW Greece): discrepancy between Ar-40/Ar-39 and astronomical ages , PALAEOGEOGR PALAEOCL 152: (3-4) 283-303 1999 .

Thon-That, T., Singer, B., Moelner, N., Rabassa, I., (1999), Datacion de lavas basalticas por 40Ar/39Ar y geologia galcial de la region del Lago Buenos Aires, provincia de Santa Cruz, Argentina, Revista de la Asociacion Geologica Argentina.

---

* Indicates OSTR use.

Tiyapun, K., and Binney, S., (2000), Production of Medical Radioisotopes in Accelerator Production of Tritium (APT), Proceedings of the Topical Meeting on Radiation Protection for Our National Priorities: Medicine, the Environment, and the Legacy.

* Tollo, R. P., Pogue, E., and Hackley, P, (2000), Geologic Map of the Thornton Gap 7.5-minute Quadrangle, Virginia, Virginia Division of Mineral Resources Digital Bedrock Geologic Map, scale 1:24,000 with text.

Trappe, Matt, (2000), A concise description of Craterellus tubaeformis mycorrhizae, Concise Descriptions of Ectomycorrhizae, Durall & Trowfymow, eds, UBC.

Turrin, B. D., and Hemming, S. R., (2000), 40Ar/39Ar ages from the Newark Basin and the Iberia continental margin, thermochronologic constraints on the kinematics of lithospheric extension and continental breakup, Geological Society of America Northeastern Section, Abstracts with Programs.

Webb, L., Hacker, B., Ratschbacher, L., McWilliams, O., Dong, S., (1999), Thermochronologic constraints on deformation and cooling history of high- and ultrahigh-pressure rocks in the Qinling-Dabie orogen, eastern China, Tectonics.

* Weber, J., Ferrill, D., Roden-Tice, M., (2000), Calcite and quartz microstructural geothermometry , Trinidad, Journal of Structural Geology.

* Willigers, B.J.A., Mengel, F.C., Bridgwater, D., (1999), Mafic dike swarms as absolute time markers in high-grade terranes: Ar-40/Ar-39 geochronological constraints on the Kangamiut dikes, West Greenland , GEOLOGY 27: (9) 775-778 1999 .

* Wilson, M., Wijbrans, J.R., Fokin, P.A., Nikishin, A.M., Gorbache, V.I., Nazarevich, B.P., (1999), Ar-40/Ar-39 dating, geochemistry and tectonic setting of Early Carboniferous dolerite sills in the Pechora basin, foreland of the Polar Urals, TECTONOPHYSICS, 313: (1-2) 107-118 NOV 10 1999 .

* Wright, K.E., McCurry, M., and Hughes, S.S., (2000), Petrology and geochemistry of the Neogene Tuff of McMullen Creek, central Snake River Plain, Bonnichsen, B., White, C., and McCurry M., eds., Tectonic and magmatic evolution of the Snake River Plain volcanic province: Idaho Geological Survey Special Publication.

* Yamei, H., Potts, R., Baoyin, Y., Zhengtang, G., Deino, A., Wei, W., Clark, J., Guangmao, X., Weiwen, H., (2000), Mid-Pliestocene Acheulean-like stone technology of the Bose Basi, South China, Science 287: 1622-1626.

* Zegers, T.E., Wijbrans, J.R., White, S.H., (1999), Ar-40/Ar-39 age constraints on tectonothermal events in the Shaw area of the eastern Pilbara granite-greenstone terrain (W Australia): 700 Ma of Archean tectonic evolution , TECTONOPHYSICS 311: (1-4) 45-81 1999 .

* Indicates OSTR use.

B. Documents Submitted for Publication

* Alves, M.A., Mommer, N., and Gardner, J.A., Random static electric field gradients and PAC line broadening, J. Mater. Research .

* Davis, L.L., Hughes, S.S., and Fleisher, C., Petrography and chemical characterization of glass formula 127: An alumina-borosilicate glass considered for storage of radioactive waste, Environmental Geology.

* Feeley, T.C., Cosca, M.A., Lindsay, C.R., Petrologic Evolution of the Eocene Washburn Volcano, Yellowstone National Park, USA, Journal of Petrology.

* Fodor, R.V., The roles of tonalite and diorite in Mauna Kea volcano, Hawaii: petrology of summit-region leucocratic xenoliths, Journal of Petrology.

* Fodor, R.V., Sial, A.N., and Gandhok, G., Petrology of spinel petridtite xenoliths from northeastern Brazil: lithosphere with a high geothermal gradient imparted by Fernando de Noronha plume, Lithos.

* Geist, D., Ellisor, R. E., Sims, E. N., and Hughes, S. S., Subsurface volcanology at TAN and controls on groundwater flow, Link, P.K., and L.L. Mink, eds., Geology, Hydrogeology and Environmental Remediation, Idaho National Engineering and Environmental Laboratory, Eastern Snake River Plain: Geological Society of America Special Paper.

* Geist, D., Sims, E., Hughes, S., and McCurry, M., Open-system evolution of a single cycle of Snake River magmatism, Link, P.K., and L.L. Mink, eds., Geology, Hydrogeology and Environmental Remediation, Idaho National Engineering and Environmental Laboratory, Eastern Snake River Plain: Geological Society of America Special Paper.

* Hames, W.E., Renne, P.R., and Ruppel, C.R. , New evidence for geologically-instantaneous emplacement of earliest Jurassic Central Atlantic magmatic province basalts on the North American margin, Geology.

* Hughes, S.S., McCurry, M., and Geist, D.J., Geochemical correlations and implications for the magmatic evolution of basalt flow groups at the Idaho National Engineering and Environmental Laboratory, Link, P.K., and L.L. Mink, eds., Geology, Hydrogeology and Environmental Remediation, Idaho National Engineering and Environmental Laboratory, Eastern Snake River Plain: Geological Society of America Special Paper.

* Johnson, K., Barnes, C.G., Browning, J.M., Karlsson, H.R., Petrology of iron-rich magmatic segregations associated with strongly peraluminous trondhjemite in the Cornucopia stock, northeastern Oregon, Contributions to Mineralogy and Petrology.

* Kamp, P.J.J., Possible Jurassic age for part of the Rakaia Terrane in Canterbury: Implications for the development of the Torlesse accretionary prism, New Zealand journal of Geology and Geophysics.

---

* Indicates OSTR use.

* Karner, D.B., Renne, P.R., McDougall, I., and Becker, T.A. , The Viability of Leucite for 40Ar/39Ar Dating and as a Quaternary Standard, Chemical Geology (Isotope Geoscience Section).

* Katoh, S., Nagaoka, S., WoldeGabriel, G., Renne, P., Asfaw, B., Beyene, Y., and Suwa, G. , Lithology, Geochemistry, and Geochronology of the Plio-Pleistocene Tephra Layers of the Konso Formation in the Southern Main Ethiopian Rift, East Africa, Quaternary International.

* Kirner, N., Webb, J., and Glowa, M., Case Study: ESCO Corp - Control and Use of NORM, Procedings of the American Foundry Society.

Loveland, W., Ninov, V., Gregorich, K.E., Souliotis, G.A., Phair, L.W., Wozniak, G.J., Aleklett, K., Zyromski, K.E., Emerald, K.G., Laue, C., Ginter, T.N., Strellis, D.A. and Wilk, P.A., Survival of Heavy 'Hot' Nuclei, Phys. Rev. C.

* Mertz, D.F., Sharp, W.D., and Haase, K.M., Mantle composition and dynamics in the Eggvin Bank-Jan Mayen region (North Atlanitic, latitude ~71oN), Journal of Geodynamics.

* Mertz, D.F., Weinrich, A., Renne, P.R., Sharp, W.D. , Alkaline intrusions in a near-trench setting, Franciscan Complex, California: Constraints from geochemistry, petrology, and 40Ar/39Ar geochronology, American Journal of Science.

* Miller, S.R., Fitzgerald, P.G. and Baldwin, S.L., Structure and kinematics of the central Transantarctic Mountains: Constraints from structural geology and geomorphology near Cape Surprise, Terra Antartica.

* Moore, T., Dumitru, T., Adams, K., Witebsky, S., and Harris, A., Origin of the Lisburne Hills-Herald Arch-Wrangel Arch Structural Belt: Stratigraphic, Structural, and Fission-Track Evidence from the Cape Lisburne Area, Northwestern Alaska, The Tectonic Evolution of the Bering Shelf-Chukchi Sea and Adjacent Landmasses, Alaska and Russia: Geological Society of America Special Paper.

* Mote, T.I., Becker, T.A., Renne, P.R., and Brimhall, G.H. , Chronology of Exotic Mineralization at El Salvador, Chile by Dating of Copper Wad and Transported Alunite, with Reconnaissance Results at Chuquicamata and El Abra, Economic Geology.

* Pappalardo, L., Civetta, L., D'Antonio, M., Deino, A., Di Vito, M., Orsi, G., Carandente, A., de Vita, S., Isaia, R., Piochi, M., Chemical and Sr-isotopic evolution of the Phlegraean magmatic system before the Campanian Ignimbrite and the Neapolitan Yellow Tuff eruptions, Earth and Planetary Science Letters.

* Roden-Tice, M. and Wintsch, R., Thermochronologic Evidence for Post-Early Cretaceous displacement of Bronson Hill Terrane and Hartford Basin, CT and MA, Journal of Geology, 6/00.

---

* Indicates OSTR use.

* Rook, L., Renne, P.R., and Benvenuti, M. , Geochronology of the Oreopithecus-bearing succession at Baccinello (Italy) and the extinction pattern of European Miocene Hominoids, Journal of Human Evolution, in press., Journal of Human Evolution.

* Tiyapun, K., and Binney, S., BNCT Neutron Beam Design in a TRIGA Reactor Beam Port, Nuclear Technology.

Zyromski, K.E., Loveland, W., Souliotis, G.A., Morrissey, D.J., Powell, C.F., Batenkov, O., Aleklett, K., Yanez, R., and Forsberg, I., Fusion Enhancement in the 32,38S + 181Ta Reaction, Phys. Rev.C.

* Indicates OSTR use.

C. Documents in Preparation

* Andresen, A. & Calvert, A., Exhumation of Precambrian basement block in S Norway based on 40Ar/39Ar data on white mica and K-feldspar.

Bachmann, O., Dungan, M. and Singer, B., Geochronology of the Fish Canyon Magmatic System.

* Baldwin, S.L., Rawling, T. and P. G. Fitzgerald, Thermochronology of the northern high P/T terrane of New Caledonia: implications for mid-Tertiary plate boundary processes in the SW Pacific.

* Basu, AR et al., Alkalic rocks associated with the Kerguelen Plume.

* Brandon, M. and Roden-Tice, M., Apatite fission-track evidence for modern denudation in Olympic Mts.

* Feeley, T.C., Cosca, M.A., Lindsay, C.R., Geochronology and Geochemistry of the Sunlight Volcano, Absaraka Volcanic Field, Wyoming.

* Fitzgerald, P.G., Apatite fission track ages associated with the altered igneous intrusive in Beacon Sandstone near the base of CRP-3, Victoria Land Basin, Antarctica, Cape Roberts final report.

* Johnson, K., Barnes, C.G., Walton, C., Wright, J.E., Kistler, R.W., and Browning, J.M., Late Jurassic to Middle Cretaceous magmatism in the Blue Mountains of northeastern Oregon: Implications for terrane amalgamation and accretion.

* Rose, T., Smith, D., Hutcheon, I., Hudson, G., Phinney, D., Secondary ion mass spectrometry measurements of tritium sorption on zeolitized tuffs (preliminary report to the U.S. Department of Energy, Nevada Operations Office, Sept 2000).

* Siddoway, C., Baldwin, S.L., Fitzgerald, P.G. and Luyendyk, B.P., Marie Byrd Land mylonites provide evidence for Mid-Cretaceous continental extension between East and West Antarctica.

* Tollo, R.P., and others, Petrology and Tectonic Significance of Late Neoproterozoic Anorogenic Granitoids, Central Blue Ridge Province, USA.

* Tollo, R.P., and others, Geologic Map of the Fletcher 7.5-minute Quadrangle, Virginia.

---
* Indicates OSTR use.

D. Theses and Student Project Reports

* Antignano, A.A., (2000), Petrology of Precambrian Basement, Fletcher 7.5-minute Quadrangle, Madison County, Virginia, BS, Earth & Environmental Sciences, George Washington University.

* Bates, D., (1999), The In-situ Chemical Fractionation of an Eastern Snake River Plain Basalt Flow: Implications for Heterogeneous Chemical Interaction with Groundwater Contaminants, MS, Geology, Idaho State University.

* Casper, J., (1999), The Volcanic Evolution of Circular Butte, MS, Geology, Idaho State University.

* Cole, J., (1998 - 2000), Uranium Volatility from Mixed Wastes, MS, Nuclear Engineering, University of california.

Geiger, S., (2000), Reactive Transport Modeling in a Discrete Fracture: Applications to the Early Hydrothermal Alteration at Butte, Montana, MS, Geosciences, OSU.

* Hamblock, J.M., (2000), Petrography and Geochemistry of the Copper Lakes Intrusive Rocks, Northern Absaroka Mountains, Park County, Wyoming, BS, Earth Sciences, Montana State University.

* Kao, M., (1999), Tectonic evolution of the Marlborough Region, New Zealand, PhD, Earth Sciences, University of Waikato.

* Lambert, M., (2000), The Neutron Capture Cross Section of Pb-208, BS, Physics, OSU.

* Lee, T., (2000), Dependence of Oxygen Vacancy Concentration in Zirconia on Processing and Under Reducing Conditions, PhD, Physics, Science.

* Stockli, D.F., (1999), Timing of Extensional Faulting in the Northern Basin and Range Province, and the Structured and Thermal Transition to the Central Sierra Nevada., PhD, Geological and Environmental Sciences, Stanford University.

* Surpless, B. E., (1999), Tectonic evolution of the northern Sierra Nevada - Basin and Range transition zone, PhD, Geological and Environmental Sciences, Stanford University.

Tostavorky, T., (2000), Kinetics of Cs, Cr, Cd, and Hg in Aquatic Invertebrates, MS, Radiation Biology, Colorado State University.

* Vaughn, J., (2000), Geology of Cretaceous Jackass Mountain Group, Southern British Columbia, BS, Geology, Idaho State University.

* Weaver, K., (2000), Composition of the Kerguelen Plume as Determined by Its Earliest Melts, MS, Earth and Environmental Sciences, University of Rochester.

---

* Indicates OSTR use.

E. Presentations

* Angelika, K., Fernando, C., and Wijbrans, J.R., Time Calibration of a P-T Path from a Variscan High-Temperature Low-Pressure Metamorphic Complex (Bayerische Wald, Germany), EUG, Strasbourg, France, March, 1999.

* Baldwin, S. L., Fitzgerald, P.G., Li, B. and S. R. Miller, Thermal evolution of the Transantarctic Mountains in the Shackleton Glacier area, 8th International Symposium on Antarctic Earth Sciences, Wellington, New Zealand, July 4-9th, 1999.

* Beintema, K. A., Roermund, H. L., M. van, White & Wijbrans, J. R., Structural-Kinematic Analysis of a Terrane Boundary Formed in the Late Archean During Arc Accretion: An Example from the West Pilbara, Western Australia., EUG, Strasbourg, France, March, 1999.

Binney, S., General Considerations for Neutron Capture Therapy at a Reactor Facility, IAEA Technical Committee Meeting on Current Issues Related to Neutron Capture Thera, Vienna, Austria, June 14, 1999.

* Casper, J.L., Hughes, S.S., Geist, D.J., Physical Volcanology and Petrologic Evolution of Circular Butte Volcano, East of Test Area North, INEEL: Geological Society of America Abstracts With Programs, v. 31, no. 4, p. A-6., Geological Society of America, Rocky Mountain Section Meeting, Pocatello, Idaho, April, 1999.

* Conrady, M., Investigative Results, Neutron Activation Analysis, State v Cannon, Polk County Circuit Court, Dallas, OR USA, January, 2000.

* De Jong, K., Kurimoto C. & , Wijbrans, J.R., Trench-Parallel Extension and Exhumation of Rocks of the Sambagawa Belt (Japan): New 40Ar/39Ar Whole-rock Ages and Structural Data, EUG, Strasbourg, France, March, 1999.

* De Jong, K., Kurimoto, C., Guise, P.G., et Wijbrans, J.R., 40Ar/39Ar whole-rock ages of the Sambagawa belt from western the Kii peninsula, (Wakayama Prefecture): constraints on the timing of accretion and reactivation along the Aridagawa tectonic line. , 105 th annual assembly of the Geological Society of Japan,, Matsumoto (Japan), , August,1999.

* De Jong, K., Kurimoto, C., Wijbrans, J.R., and Guise P.G., 40Ar/39Ar whole-rock ages and structural data from the western the Kii peninsula (western Japan): implications for extension and exhumation of the Mikabu and Sambagawa belts. In: Tectonic Evolution of East Asia (Takagi, H., Otoh, S., and Kimura, K., eds), The second Joint Meeting of Korean and Japanese Structure and Tectonic Research Groups, Samani, Hokkaido (Japan), March,1999.

* Dunai, T. J. & Wijbrans, J.R., Calibration of Time Integrated Cosmogenic Production Rates Over the Last 1.25 Million Years: Results from Lava Flows on Lanzarote, Spain, EUG, Strasbourg, France, March, 1999.

---

* Indicates OSTR use.

* Dunai, T.J. and Wijbrans, J.R., Calibration of time Integrated Cosmogenic Production Rates over the last 1.24 Ma,, EGS, The Hague, Netherlands, April, 1999.

* Feeley, T.C., Lindsay, C.R., Cosca, M.A., Timing and Compositional Evolution of Magmatism at the Sunlight Volcano, Absaroka Volcanic Province, Wyoming, Geological Society of America Annual Meeting, Denver, Colorado, USA, October, 1999.

* Fitzgerald, P.G., Tectonic evolution, vertical tectonics and landscape evolution of the Transantarctic Mountains and West Antarctic rift system, Invited keynote address. Penrose 2000 Volcanic Rifted margins, Abstract Volume p. 24; Department of Geology, Royal Holloway, Univeristy of London, March 28-29, 2000.

* Fitzgerald, P.G., Nature and evolution of the Antarctic Landscape since Gondwana breakup. Invited plenary address, 8th International Symposium on Antarctic Earth Sciences, Wellington, New Zealand, July 4-9th, 1999.

* Fitzgerald, P.G., Muñoz, J.A., and Baldwin, S.L., Asymmetric exhumation across the Pyrenean intraplate collisional orogen, extended abstract, Fission Track 2000, 9th International Conference of Fission Track Dating and Thermochronology, Lorne, Victoria, Australia, February 2000.

* Hackley, P.C., and Tollo, R.P., Field relations, petrology, and geochemistry of the Old Rag magmatic suite, Blue Ridge province, Virginia: perspectives on crustal melting and magma evolution during latter stages of the Grenville orogeny, Fourth Hutton Symposium on the Origin of Granite and Related Rocks, France, September, 1999.

* Hackley, P.C., and Tollo, R.P., Petrology of a Mesoproterozoic granite suite in the Virginia Blue Ridge: evidence for cyclic magmatism during assembly of Rodinia, Northeastern Section of Geological Society of America, Brunswick, New Jersey, March, 2000.

* Hughes, S.S., McCurry, M., Geochemical evidence for time-space transition in evolution of Snake River Plain rhyolites: Geological Society of America Abstracts With Programs, v. 31, no. 4, p. A-17, Geological Society of America, Rocky Mountain Section Meeting, Pocatello, Idaho, April, 1999.

* Hughes, S.S., Wetmore, P.H., Casper, J.L., Evolution of Quaternary Tholeiitic Basalt Eruptive Centers on the Eastern Snake River Plain, Idaho: Geological Society of America Abstracts With Programs, v. 31, no. 4, p. A-17, Geological Society of America, Rocky Mountain Section Meeting, Pocatello, Idaho, April, 1999.

* Johnson, K., Johnson, I.G., Hudson, J., Jackson, M., Browning, J.M., Barnes, C.G., and Karlsson, H.R., Petrology of the Jurassic Wallowa batholith and Fish Lake Complex: Implications for terrane amalgamation in the Blue Mountains province of northeastern Oregon, Geological Society of America National Meeting, Denver, Colorado USA, October, 1999.

---

* Indicates OSTR use.

* Kloppenburg, A., White,S., Wijbrans, J.R. and Nelson, D.R., Tectonic Evolution of a Mid-Crustal Shear Zone in the Eastern Pilbara, EUG, Strasbourg, France, March,1999.

* Lindsay, C.R., Feeley, T.C., Petrology and Geochemistry of the Electric Peak-Sepulcher Mountain Eruptive Center: Implications for the Petrogenesis of Calc-Alkaline Magmas in the Absaroka Volcanic Province, Geological Society of America Annual Meeting, Denver, Colorado, USA, October, 1999.

* Lips, A.L. W., White S., Wijbrans, J.R. and Boorder Hugo de, Miocene and Pre-Miocene Destabilizations of the Alpine Orogenic Wedge and Their Effect on Ore Deposit Formation in the Carpathian-Balkan Region., EUG, Strasbourg, France, March,1999.

Loveland, W., Superheavy Nuclei, 1999 Teachers Day at the DNP, Asilomar, CA, October, 1999.

Loveland, W., Survival of Hot Heavy Nuclei, ACS National Meeting, Washington, DC, August, 2000.

Loveland, W., Observation of Superheavy Elements in the 208Pb (86Kr,n) reaction, OSU Physics Dept., November, 1999.

Loveland, W., Quest for Superheavy Nuclei, Univ. of Michigan, Ann Arbor, MI, January, 2000.

Loveland, W., Synthesis of New Heavy Nuclei using RNBs, RIA Workshop, Raleigh-Durham, NC, July, 2000.

Loveland, W., Discovery of the new superheavy elements 116 and 118, Angstrom Laboratory Colloquium, Uppsala University, September, 1999.

Loveland, W., Ninov, V., Gregorich, K.E., Souliotis, G.A. Phair, L.W., Wozniak, G.J., Aleklett, K., Zyromski, K.E., Emerald, K.G., Ginter, T.N., Strellis, D.A., and Wilk, P.A., Survival of Hot Heavy Nuclei, 2000 DNP Meeting of the APS, Long Beach, CA, May, 2000.

Loveland, W., van Veldhuizen, E.J., Kuznetsov, A., Lyapin, V., Westerberg, L., and Aleklett, K., Fusion-Like Events in Energetic Nuclear Collisions, 1999 DNP Meeting of the APS, Asilomar, CA, October, 1999.

Loveland, W., Zyromski, K.E., Souliotis, G.A., Fekou-Youmbi, V., Morrissey, D.J. and Aleklett, K., Fusion Studies with Radioactive Beams, 1999 DNP Meeting, Asilomar, CA, October, 1999.

* Miller, S.R., Fitzgerald, P.G., and Baldwin, S.L., Faulting, uplift, and denudation across the Transantarctic Mountain Front near Cape Surprise and Shackleton Glacier, 8th International Symposium on Antarctic Earth Sciences, Wellington, New Zealand, July 4-9th, 1999.

---

* Indicates OSTR use.

* O'Connor, M., Feeley, T.C., Petrogenesis of Lava Flows in the Southwest Washburn Range, Absaroka Volcanic Province (AVP), Yellowstone National Park, WY, Geological Society of America Annual Meeting, Denver, Colorado, USA, October, 1999.

* Page, L., Beunk F., Wijbrans, J.R., and Stephens, M., 40Ar/39Ar and Ion-Microprobe U-Pb Geochronological Constraints on the Svecofennian Tectonothermal History of South-Central Sweden., EUG, Strasbourg, France, March,1999.

* Roden-Tice, M., Differential unroofing in the Adirondack Mts., Invited Colloquia, University of Vermont, Burlington, VT, September, 1999.

* Roden-Tice, M., Differential unroofing in the Adirondack Mts., Invited Colloquia, Rensselaer Poly. Inst., Troy, NY, March, 2000.

* Roden-Tice, M., Differential unroofing in the Adirondack Mts., Invited Colloquia, SUNY Binghamton, Binghamton, NY, March, 2000.

* Roden-Tice, M., Differential unroofing in the Adirondack Mts., Invited Colloquia, Lehigh University, Bethlehem, PA, April, 2000.

Souliotis, G.A., Loveland, W., Wozniak, G.J., Morrissey, D.J., and Aleklett, K., Fission Fragment Charge and Mass Distributions from Intermediate Energy Reactions of 238U Projectiles, 1999 DNP Meeting of the APS, Asilomar, CA, October, 1999.

* Tollo, R.P., Hackley, P.C., and Aleinikoff, J.N., Petrologic evolution of Grenville-age basement, central Blue Ridge, Virginia, Northeastern Section of Geological Society of America, Brunswick, New Jersey, March, 2000.

* VanGool, J., Cawood, P. and Wijbrans, J.R., An Orogenic Cycle within 10 My: Thermochronology of the Corner Brook Lake Belt in the Western Newfoundland Appalachians, EUG, Strasbourg, France, March,1999.

* VonEynatten, H., Schlunegger, F., Wijbrans, J.R. and Reinhard, G., The Exhumation of the Lepontine: Evidence from Ar/Ar Laserprobe Dating of Detrital White Micas from the Swiss Molasse Basin., EUG, Strasbourg, France, March,1999.

* Wetmore, P.H., Hughes, S.S., Rodgers, D.W., Anderson, S.R., Late Quaternary constructional development of the axial volcanic zone, eastern Snake River Plain, Idaho:Geological Society of America Abstracts With Programs, v. 31, no. 4, p. A-61, Geological Society of America, Rocky Mountain Section Meeting, Pocatello, Idaho, April, 1999.

* Wijbrans, J.R., White, S., Kloppenburg, A., Zegers, T. and Nelson, D., Timing Tectonothermal Processes in the Early Earth Crust: A Combined 40Ar/39Ar and U/Pb Study of Basement Gneisses and Associated Supracrustal Rocks from the Eastern Pilbara Craton, W. Australia, EUG, Strasbourg, France, March,1999.

---

* Indicates OSTR use.