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

July 1, 1997 - June 30, 1998

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of the
Oregon State University
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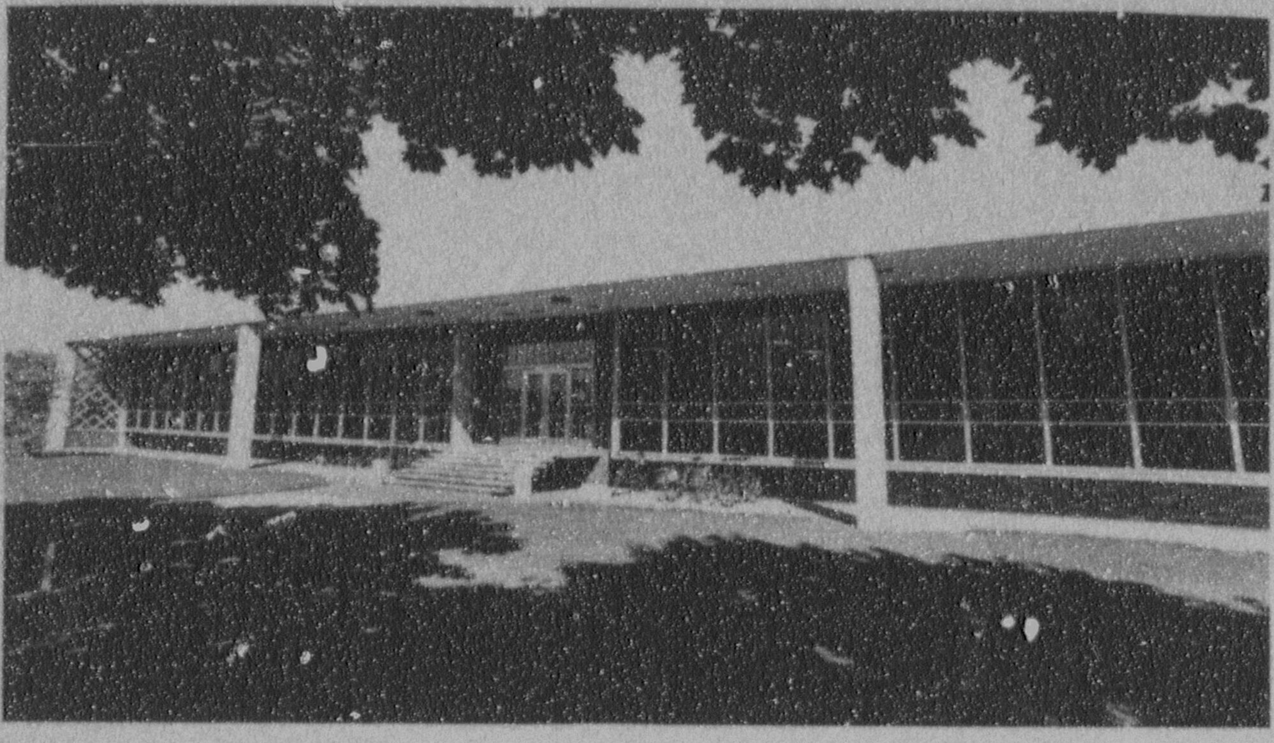

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Annual Report of the
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July 1, 1997 - June 30, 1998

To satisfy the requirements of:

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

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J. F. Higginbotham, Reactor Administrator
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October 1998

Annual Report of the
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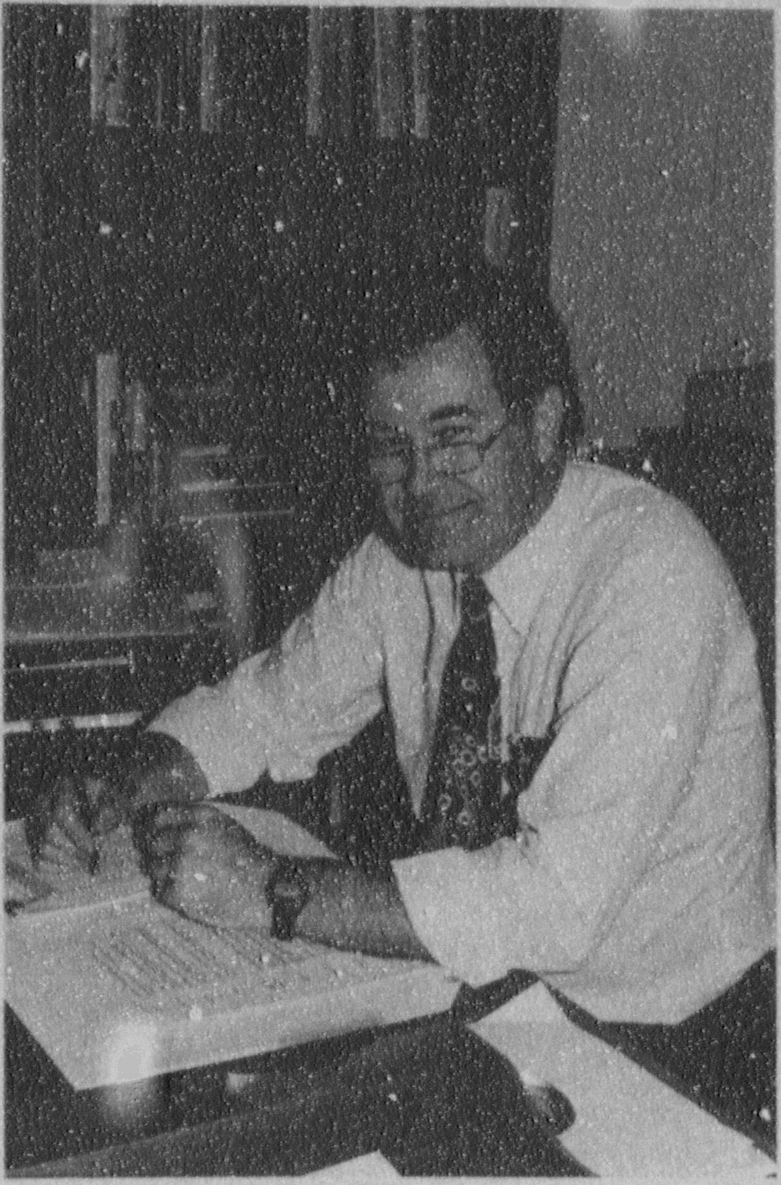
OVERVIEW



Part I

OVERVIEW

A. Acknowledgments

Many individuals and organizations help the Radiation Center succeed, and in recognition of this, the staff of the OSU Radiation Center and TRIGA Reactor 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 to provided our funding, particularly the state of Oregon and the U. S. Department of Energy (USDOE); to our regulators; to the researchers, the students, and others who used the Radiation Center; to OSU Facilities Services; to OSU Security Services and the Oregon State Police; and to the OSU Department of Printing and Mailing, who provide a consistent and quality service in this report. 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. These times of budget cuts have meant that each person has had to work harder with less help. It is to their credit that we have managed to maintain 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 has done at the data-gathering, organization and keyboarding of this annual report. Thanks, Linda!

B. Executive Summary

The data from this reporting year show that the use of the Radiation Center and OSTR has still increased, despite being "maxed" out in many areas. This increase has been achieved by greater efficiencies. A good illustration of this is in reactor use hours. The reactor was busy an average of 40 hours per week. Additional users were accommodated by increasing the number of people who were simultaneously using the different reactor facilities. This year there were two or more users on the reactor for a total of 441 hours.

The OSTR supported 29 different OSU classes this year, mostly in the Department of Nuclear Engineering. The number of hours for courses (up 29% from last year) roughly equaled the number of hours spent supporting research projects (about 1490 hours each). Eighty-five percent of the OSTR research hours were in support of off-campus research projects. The number of samples irradiated in the reactor during this reporting period was 4,707, which is over 1,000 more than the average. The percent of unfunded OSTR use hours (3%) decreased by a factor of two from last year. This is the result of an initial attempt to 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 $^{39}Ar/^{40}Ar$ geochronology laboratories around the world.

Personnel at the Radiation Center conducted 101 tours of the facility, accommodating 1,081 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 almost always go away with a good impression of the facility and of Oregon State University.

Research projects of personnel housed in the Radiation Center totaled approximately $1.2 million for this year.

The Radiation Center projects database initiated a few years ago 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 134. Reactor projects comprised about 93% of all projects. The contracts supporting these research projects totaled approximately $3,000,000. This year the Radiation Center serviced 81 research faculty and 133 students (for a total of 586 uses of Center facilities) from 63 different institutions, 65% of which were from other states and 16% 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.

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. (check it out!)

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, 1997 through June 30, 1998. 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, 1998. 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 colleges and universities 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 Institute of Nuclear Science and Engineering, and for the OSU nuclear chemistry, radiation chemistry, and geo- 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; a neutron radiography facility capable of taking still or very high speed radiographs; and a variety of instruments for radiation measurements and monitoring. Specialized facilities for radiation work include teaching and research laboratories with up-to-date instrumentation and related equipment for performing neutron activation analysis and radiotracer studies; laboratories for animal and 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 added to the Radiation Center this past year is the Advanced Thermal Hydraulics Research Laboratory, which will be 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)	≤LLD (95%) of 1.79×10^{-5} Ci
b.	Detectable radionuclides in the liquid waste	N/A
c.	Estimated average concentration of released radioactive material at the point of release	≤LLD (95%) of 4.08×10^{-6} μCi/ml
d.	Percent of applicable monthly average concentration for released liquid radioactive material at the point of release	N/A
e.	Total volume of liquid effluent released, including diluent(3)	1,158 gallons

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

a.	Volume of liquid waste packaged(4)	52 gallons
b.	Detectable radionuclides in the waste	^{32}P, ^{60}Co, ^{86}Rb
c.	Total quantity of radioactivity in the waste	4.0×10^{-2} 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 our water analysis data and not background radioactivity in the Corvallis city water.

(3) Total volume of effluent plus diluent does not take into consideraion 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	5.42 Ci
b.	Detectable radionuclides in the gaseous waste(1)	^{41}Ar ($t_{1/2}$ = 1.83 hr)
c.	Estimated average atmospheric diluted concentration of ^{41}Ar at the point of release	3.5×10^{-8} µCi/ml
d.	Percent of applicable monthly average concentration for diluted concentration of ^{41}Ar at the point of release	0.9%
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	66 ft^3
b.	Detectable radionuclides in the solid waste	^{3}H, ^{22}Na, ^{24}Na, ^{46}Sc, ^{47}Sc, ^{51}Cr, ^{58}Co, ^{59}Fe, ^{60}Co, ^{86}Rb, ^{90}Sr, ^{113}Cd, ^{122}Sb, ^{124}Sb, ^{204}Tl, ^{214}Bi, ^{226}Ra, ^{238}U, ^{241}Am
c.	Total radioactivity in the solid waste	6.6×10^{-5} Ci

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(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)[1]

a.	Facility Operating Personnel		(mrem)
(1)	Average whole body		11
(2)	Average extremities		80
(3)	Maximum whole body	35	
(4)	Maximum extremities	100	
b.	Key Facility Research Personnel		
(1)	Average whole body		<1
(2)	Average extremities		2
(3)	Maximum whole body	ND	
(4)	Maximum extremities	30	
c.	Facilities Services Maintenance Personnel		
(1)	Average whole body		<1
(2)	Maximum whole body	1	
d.	Laboratory Class Students		
(1)	Average whole body		<1
(2)	Average extremities		1
(3)	Maximum whole body	10	
(4)	Maximum extremities	80	
e.	Campus Police and Security Personnel		
(1)	Average whole body		ND
(2)	Maximum whole body	ND	
f.	Visitors		
(1)	Average whole body		<1
(2)	Maximum whole body	20	

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(1) "ND" indicates that each of the beta-gamma dosimeters during the reporting period was less than the vendor's gamma dose reporting threshold of 10 mrem or that each of the neutron dosimeters was less than the vendor's threshold of 30 mrem, as applicable.

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	148
(b)	Neutron dosimeter measurements	48

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

b. Environmental Survey Data

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

(a) Onsite monitoring

-- OSU TLD monitors	108
-- Radiation Detection Co. TLD monitors	72
-- Monthly μrem/h measurements	108

(b) Offsite monitoring

-- OSU TLD monitors	264
-- Radiation Detection Co. TLD monitors	104
-- Monthly μrem/h measurements	252

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

(a)	Soil samples	16
(b)	Water samples	14
(c)	Vegetation samples	56

F. History

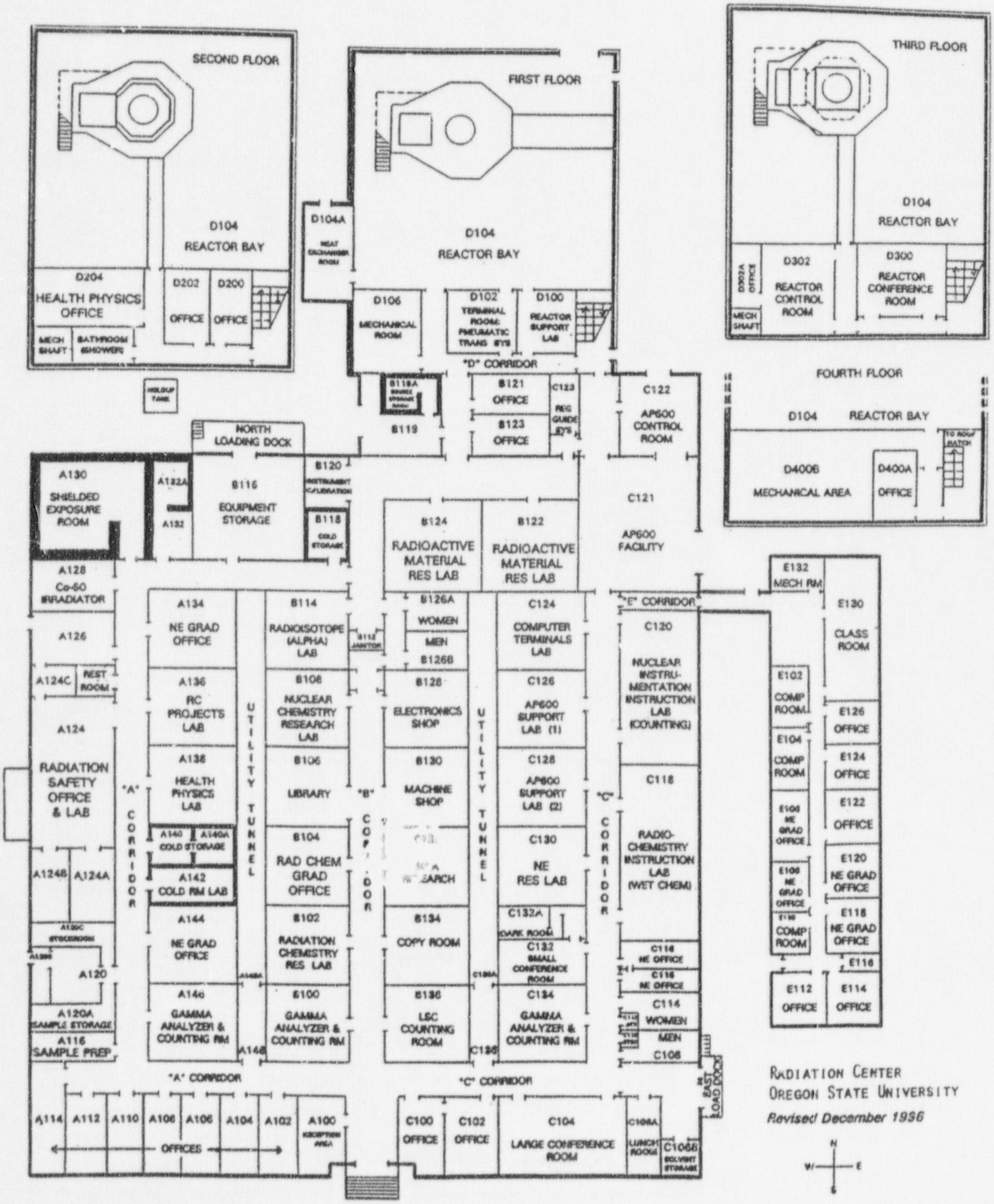
A brief chronology of the key dates and events in the history of the OSU Radiation Center and the TRIGA reactor is given below:

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 Mechanical Engineering Department 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 its current total of 45,553 square feet.
January 1980	Major upgrade of the electronics in the OSTR control console.

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.
March 1998	Start of ATHRL construction.

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 give 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.
Professor
Nuclear Engineering
Chairman, OSTR Reactor Operations Committee

*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

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* OSTR users for research and/or teaching.

Daniels, Malcolm
Professor Emeritus
Chemistry

*Dodd, Brian
Director, Radiation Center
Director, Institute of Nuclear Science and Engineering
Professor
Nuclear Engineering and Radiation Health Physics

Fekou-Youmbi, Valentin
Faculty Research Associate
Chemistry

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

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

Hart, Lucas P.
Faculty Research Associate
Chemistry

*Higginbotham, Jack F.
Reactor Administrator
Associate Professor
Nuclear Engineering and Radiation Health Physics

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

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

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* OSTR users for research and/or teaching.

*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.
Acting Department Head
Department of Nuclear Engineering
Director, Oregon Space Grant Program
Professor
Nuclear Engineering

*Krane, Kenneth S.
Chair, Physics Department
Professor
Physics

Krebs, Rolf
Faculty Research Associate
Crop and Soil Science

Lafi, Abd Y.
Faculty Research Associate
APEX Research Analyst
Nuclear Engineering

*Loveland, Walter D.
Professor
Chemistry

MacVicar, Robert
President Emeritus

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

---

* OSTR users for research and/or teaching.

Mommer, Niels K.
Faculty Research Associate
Physics

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.
APEX Principal Investigator
Professor
Nuclear Engineering

Ringle, John C.
Professor
Nuclear Engineering
Associate Dean of the Graduate School

Robinson, Alan H.
Department Head Emeritus
Nuclear Engineering

*Schmitt, Roman A.
Professor Emeritus
Chemistry

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* OSTR users for research and/or teaching.

*Schütfort, Erwin G.
Faculty Research Assistant
Radiation Center Project Manager

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

*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

Yundt, Michael S.
Faculty Research Assistant
APEX Instrument Specialist/Test Engineer
Nuclear Engineering

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* OSTR users for research and/or teaching.

B. Visiting Scientists and Special Trainees

Name	*Field (Affiliation)*	*Advisor or Research Program Director*
Foreman, Katherine	Saturday Academy Mentorship Program Crescent Valley High School Corvallis, Oregon	W. D. Loveland
Jovanovic, Ana G.	Visiting Undergraduate Student Chemical Engineering Baylor University	E. G. Schütfort
Lekas, David	Visiting Undergraduate Student Chemistry Uppsala Universitet, Sweden	W. D. Loveland
Less, Greg	Undergraduate Student Chemistry Oregon State University	W. D. Loveland
Menge, Duncan	Saturday Academy Mentorship Program Crescent Valley High School Corvallis, Oregon	W. D. Loveland
*Nakazawa, Yuko	NSF Research Experience for Undergraduates Program State University of New York at Stonybrook	K. S. Krane
Ngernvijit, Narippawaj	Visiting Faculty Thailand	J. F. Higginbotham
*Reel, Justin	NSF Research Experience for Undergraduates Program Carnegie-Mellon University	K. S. Krane
*Shivers, Robert J.	Student Research Assistant Environmental Science Oregon State University	W. D. Loveland
Wallin, Petra	Visiting Undergraduate Student Chemistry Royal Institute of Technology, Sweden	W. D. Loveland
Xiao, Zejun	Project Manager Reactor Thermalhydraulic Lab Nuclear Power Institute of China Chengdu, China	J. N. Reyes

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* OSTR users for research and/or teaching.

C. OSU Graduate Students

Name	*Degree Program*	*Field*	*Advisor*
Al-Hussan, Khalid A.	PhD	Nuclear Engineering	A. C. Klein
Alves, Mauro A.	PhD	Physics	J. A. Gardner
Asghar, Sabooh	MS	Nuclear Engineering	T. S. Palmer
Baik, Seung-Hyuk	PhD	Nuclear Engineering	J. F. Higginbotham
Boone, Darren M.	MS	Radiation Health Physics	J. F. Higginbotham
Brice, Derek J.	MS	Nuclear Engineering	T. S. Palmer
Cantaloub, Michael G.	MS	Radiation Health Physics	J. F. Higginbotham
Chinudomsub, Kittisak	MS	Radiation Health Physics	J. F. Higginbotham
Colpo, Sarah E.	MS	Nuclear Engineering	J. N. Reyes
*Crail, Scott A.	MS	Radiation Health Physics	J. F. Higginbotham
Crowley, Paul R.	MS	Radiation Health Physics	J. F. Higginbotham
Day, Travis D.	MS	Chemistry	W. D. Loveland
Dunn, John R.	MS	Chemistry	W. D. Loveland
Ellis, Christopher P.	MS	Nuclear Engineering	J. N. Reyes
Jue, Tracy M.	MS	Radiation Health Physics	S. E. Binney
Keillor, Martin E.	PhD	Nuclear Engineering	S. E. Binney
Kellar, Marvin G.	MS	Radiation Health Physics	B. Dodd
Kim, Kang Seog	PhD	Nuclear Engineering	T. S. Palmer
Kropp, Edward K.	MS	Radiation Health Physics	S. E. Binney
Lee, Hsing Hui	PhD	Nuclear Engineering	A. C. Klein
Leon, Laura M.	MS	Radiation Health Physics	J. F. Higginbotham
Marianno, Craig M.	PhD	Radiation Health Physics	K. A. Higley
Menn, Scott A.	MS	Radiation Health Physics	K. A. Higley
Miller, Robert E.	MS	Radiation Health Physics	K. A. Higley
Pagh, Richard T.	PhD	Nuclear Engineering	A. C. Klein
Potter, Nathan K.	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
Rusher, Christopher D.	MS	Nuclear Engineering	J. N. Reyes
Saiyut, Kittiphong	PhD	Nuclear Engineering	J. F. Higginbotham
*Schütfort, Erwin G.	MS	Geosciences	C. Field
Schwab, Kristen E.	MS	Radiation Health Physics	K. A. Higley
Strohecker, Mark F.	MS	Nuclear Engineering	T. S. Palmer
Tiyapun, Kanokrat	PhD	Radiation Health Physics	S. E. Binney
Uyeda Jr., Graydon S.	MS	Nuclear Engineering	J. N. Reyes
Wachs, Daniel M.	MS	Nuclear Engineering	J. N. Reyes
Walker, Matthew J.	MS	Radiation Health Physics	J. F. Higginbotham
Welter, Kent B.	PhD	Nuclear Engineering	T. S. Palmer
Zyromski, Kristiana E.	PhD	Chemistry	W. D. Loveland

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* OSTR users for research and/or teaching.

D. Business, Administrative and Clerical Staff

Director, Radiation Center	B. Dodd
Business Manager	S. C. Campbell
Office Manager	D. K. Dalton
Office Specialists	D. C. West L. M. James
Custodian	E. Cimbri
Office Coordinator (Nuclear Engineering)	R. A. Keen
Word Processing Technician (Nuclear Engineering)	L. J. Robinson
Word Processing Technician (APEX – Nuclear Engineering)	T. L. Culver

E. Reactor Operations Staff

Principal Security Officer, Senior Reactor Operator	B. Dodd
Reactor Administrator, Senior Reactor Operator	J. F. Higginbotham
Reactor Supervisor, Senior Reactor Operator	A. D. Hall
Senior Reactor Operator	S. P. Smith *(from 3/12/98)* G. M. Wachs
Reactor Operator	S. A. Crail *(from 3/12/98)* N. A. Carstens
Reactor Operator Trainee	*(from 9/30/97 through 3/11/98)* N. A. Carstens *(from 9/30/97 through 3/11/98)* G. M. Wachs

F. Radiation Protection Staff

Senior Health Physicist	D. S. Pratt
Health Physicist	K. M. Brock
Radiation Protection Technologist	D. R. Carver
Health Physics Monitors (Students)	J. Bergman J. Davidson J. Lewis M. Sellers K. Hulse

G. Scientific Support Staff

Analytical Support Manager	M. R. Conrady
Projects Manager	E. G. Schütfort
Geochemist	S. Geiger
Neutron Activation Analysis Technicians (Students)	I. Davis A. Ham M. Kelman P. Richards R. Shivers
Scientific Instrument Technician	S. P. Smith
Nuclear Instrumentation Support	S. Menn

H. OSU Radiation Safety Office Staff

Radiation Safety Officer	R. H. Farmer
Radiation Specialists	D. L. Harlan *(through 7/31/97)* E. F. Forrer *(from 9/29/97)* S. R. Reese
Office Manager	K. L. Miller
Lab Technician	L. C. Meeks
Student Technicians	S. Menn B. Kowash

I. Committees

1. Reactor Operations Committee

Name	*Affiliation*
S. E. Binney, Chair	Nuclear Engineering
D. L. Amort	*(through 12/31/97)* Electrical and Computer Engineering
B. Dodd	Radiation Center and Nuclear Engineering
A. D. Hall	Radiation Center
J. F. Higginbotham	Radiation Center and Nuclear Engineering
A. C. Klein	Nuclear Engineering
M. E. Magana	Electrical and Computer Engineering
D. S. Pratt	Radiation Center
W. J. Richards	McClellan Nuclear Radiation Center
J. C. Ringle	Nuclear Engineering and Graduate School
W. H. Warnes	Mechanical Engineering

2. Radiation Safety Committee (OSU)

Name	*Affiliation*
T. Wolpert, Chair	Botany and Plant Pathology
J. Higginbotham, Vice Chair	Radiation Center and Nuclear Engineering
R. Collier	Oceanic and Atmospheric Sciences
T. Dreher	Agricultural Chemistry
R. Farmer, Secretary and RSO	Radiation Safety Office
B. Francis	Environmental Health and Safety
M. McCambridge (ex officio)	Vice President for Finance and Administration
D. Nelson	Oceanic and Atmospheric Sciences
C. Rivin	Botany and Plant Pathology
C. Snow	Exercise and Sport Science
J. Steiner	USDA-ARS/Crop and Soil Science
I. Wong	Biochemistry/Biophysics

3. Radiation Center Safety Committee

Name	*Affiliation*
W. D. Loveland, Chair	Chemistry
S. C. Campbell	*(through 5/28/98)* Radiation Center
M. R. Conrady	Radiation Center
B. Dodd	Radiation Center and Nuclear Engineering
A. D. Hall	*(through 5/28/98)* Radiation Center
J. F. Higginbotham	Radiation Center and Nuclear Engineering
D. S. Pratt	Radiation Center
S. P. Smith	*(through 5/28/98)* Radiation Center
D. R. Carver	*(from 5/29/98)* Radiation Center
J. T. Groome	*(from 5/29/98)* Radiation Center
K. L. Miller	*(from 5/29/98)* Radiation Safety

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 sampleholding (dummy) fuel elements for special in-core irradiations, and a cadmium-lined in-core irradiation tube for experiments requiring a high energy neutron flux.

The **pneumatic transfer facility** enables samples to be inserted and removed from the core in a few 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. The 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. 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. Two of the OSTR's beam ports are permanently configured for neutron radiography while the other two may be used for a variety of experiments.

If samples which are to be irradiated require a large neutron fluence, especially from higher energy neutrons, then such samples 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.

The **cadmium-lined in-core irradiation tube** 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.

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. Since the normal reactor operations week of 45 hours included several longer, after-hours runs this year.

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 radiation 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.[illegible]) of this report.

During this reporting period the OSTR accommodated 29 different OSU academic classes. In addition, portions of classes from other Oregon universities were also supported by the OSTR. The OSU teaching programs utilized 1488 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 popular experimental technique requiring reactor use is neutron activation analysis (NAA). 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 NAA 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 NAA, but also for other experimental purposes such as geochronology using the $^{39}Ar/^{40}Ar$ ratio technique or fission track methods.

During this reporting period, the OSTR accommodated 98 funded research projects which utilized 1,448 hours of reactor time, and 16 unfunded research projects which utilized 43 hours of reactor time. 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 these tables OSTR use is indicated with an asterisk.

B. Analytical Equipment

1. Description

The Radiation Center has a great variety of radiation detection instrumentation. Much of this equipment involves the latest in counting technology as represented by the state-of-the-art gamma ray spectrometers with their associated computers and germanium detectors. Tables III.B.1 through III.B.4 provide a brief listing of typical laboratory counting devices present at the Center. Much additional equipment for use in the classroom 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 is commonly 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 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 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 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 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 appropriate state-of-the-art gamma spectrometry equipment located in Center laboratories. A number of classes also regularly use the reactor 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 a member of the nuclear engineering faculty 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, during this year a new building, the Advanced Thermal Hydraulics Research Laboratory (ATHRL), was constructed next to the Reactor Building. Two-phase flow experiments will be conducted in the ATHRL.

2. Utilization

All of the laboratories and classrooms are used extensively during the academic year. For example, a listing of 84 courses accommodated at the Radiation Center during this reporting period along with their enrollments is given in Table III.D.1. Table III.A.1 gives a separate listing of the 29 classes specifically accommodated by the reactor during the reporting period.

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 each 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. Libraries

1. Description

The Radiation Center has libraries 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, Center libraries maintain a current collection of leading research and regulatory documentation in the nuclear area. In addition, the Center has a collection over 50 sets of nuclear power reactor safety analysis 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

Radiation Center libraries are used mainly to provide reference material on an as-needed basis. They receive 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 113	Introduction to Nuclear Engineering
NE 233	Nuclear Radiation Detection and Instrumentation
RHP 233	Nuclear Radiation Detection and Instrumentation
NE 429	Nuclear Reactor Laboratory
NE 457	Nuclear Reactor Laboratory
RHP 480	Field Practices in Radiation Protection
NE 484	Applied Radiation Safety
RHP 484	Applied Radiation Safety
NE 486	Radiation Dosimetry
RHP 486	Radiation Dosimetry
RHP 488	Radioecology
NE 503	Thesis (Nuclear Engineering)
RHP 503	Thesis (Radiation Health Physics)
RHP 506	Projects
NE 559	Nuclear Reactor Laboratory
RHP 580	Advanced Field Practices in Radiation Protection
RHP 584	Advanced Applied Radiation Safety
RHP 586	Advanced Radiation Dosimetry
RHP 588	Advanced Radioecology
NE 603	Thesis (Nuclear Engineering)
CH 222	General Chemistry for Science Majors
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
Earth Week Celebration	Visiting Students

Table III.A.2

OSTR Teaching Hours

Description	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
Departmental	473	6,747
Nuclear Engineering	425	
Chemistry	40	
Adventures in Learning	4	
4H	2	
SMILE	1	
Earth Week	1	
Geosciences(1)	0	
Oceanic and Atmospheric Sciences(1)	0	
Special Classes and Projects(2)	1,015	3,652
TOTAL TEACHING HOURS(3,4,5)	1,488	10,399

---

(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 974 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 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	217	7,974
Off-Campus Research	1,274	12,404
TOTAL RESEARCH HOURS(1)	1,491	20,378

---

(1) Total research hours statistics:
- (a) 97% (1,448 hours) of the total research hours were user-funded by federal, state, or other organizations.
- (b) 3% (43 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	Adcam 8k MCA, Ortec HP Ge	26.8
B100	Adcam 8k MCA, Ortec HP Ge	38.1
B100	Adcam 8k MCA, EG&G HPGe	30.0
B100	Adcam 8k MCA, Ortec HP Ge	28.8
D102	Adcam 8k MCA, Ortec Ge(Li)	27.0
C120	Ace 1, 4k Ortec, NaI(Tl) 3x3	N/A
C123	Adcam 8K MCA, Canberra Ge(Li)	16.6
A138	H.P. Scaler, NaI(Tl) 2x2	N/A
C134	Ace, 4k Ortec, Ortec Si(Li)	N/A
C134	Adcam 8k MCA, PGT Ge(Li)	19.3
C134	Adcam 8k MCA, PGT LEP	N/A
C134	Adcam 8k MCA, Ortec LEP	N/A
C120	Ace 3, 4k Ortec, 576A Alpha Spectrometer	N/A

Table III.B.2

Radiation Center Liquid Scintillation Counting Systems

Room	System
C120	Beckman, Betamate
C120	Beckman, Betamate
C118	Beckman, Betamate
C118	Beckman, Betamate
B136	Beckman, LS 6500

Table III.B.3

Radiation Center Proportional Counting Systems

Room	**System**
C120	NMC 1, PC5
C120	NMC 2, PC5
C120	NMC 3, PC5
C120	NMC, PCC-11T and DS 2
A124	NMC AC5 84
A138	Protean MPC 9400
A138	Tennelec LB 5100 Auto Counting System w/IBM PC

Table III.B.4

Thermoluminescent Dosimeter Systems

Room	System
C120	Harshaw Model 2000
A132	Harshaw Model 2000

Table III.C.1

Gammacell 220 ^{60}Co Irradiator Use
(2809 Ci: 7/1/97)

Purpose of Irradiation	**Samples**	**Dose Range (rads)**	**Number of Irradiations**	**Use Time (hours)**
Sterilization	Blood serum, wood, soil, plastic tubes	2.50×10^6 to 4.0×10^6	34	584
Material Evaluation	Memory chips, gemstones	1.0×10^6 to 2.0×10^7	9	371
Botanical Studies	Corn, bean seeds, nectarines, other food items	4.0×10^1 to 2.5×10^6	27	22
Biological Studies	Calf serum, spleen cells, blood, peptide DNA bases	2.0×10^3 to 2.5×10^6	45	79
TOTALS			115	1,056

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 1997	Winter 1998	Spring 1998	Summer 1998
Nuclear Engineering Department Courses						
NE 111*	3	Introduction to Nuclear Engineering	35	--	--	--
NE 112	3	Introduction to Nuclear Engineering	--	30	--	--
NE 113*	3	Introduction to Nuclear Engineering	--	--	26	--
NE 231	3	Nuclear and Radiation Physics	14	--	--	--
RHP 231	3	Nuclear and Radiation Physics	9	--	--	--
NE 232	3	Nuclear and Radiation Physics	--	14	--	--
RHP 232	3	Nuclear and Radiation Physics	--	4	--	--
NE 233*	0	Nuclear Radiation Detection and Instrumentation	--	--	11	--
RHP 233*	0	Nuclear Radiation Detection and Instrumentation	--	--	7	--
NE 319	3	Societal Aspects of Nuclear Technology	47	--	--	--
NE 361	3	Nuclear Reactor Systems	--	6	--	--
NE 381	3	Principles of Radiation Safety	5	--	--	--
RHP 381	3	Principles of Radiation Safety	11	--	--	--
RHP 401	1-16	Research	--	1	1	--
RHP 405	1-16	Reading & Conference	1	--	--	--
NE 406	1-16	Projects	1	--	--	--
NE 407	1	Nuclear Engineering Seminar	13	11	10	--
RHP 410	1-12	Internship	1	--	1	--
NE 429**	3	ST: Nuclear Reactor Laboratory	6	5	5	--
NE 444	3	Nuclear Fuel Cycle	--	12	--	--
RHP 444	3	Nuclear Fuel Cycle	--	10	--	--
RHP 450	3	Principles of Nuclear Medicine	--	--	6	--
NE 454	3	Nuclear Reactor Analysis	6	--	--	--
NE 455	3	Nuclear Reactor Analysis	--	5	--	--
NE 456	3	Nuclear Reactor Analysis	--	--	5	--
NE 467	4	Nuclear Reactor Thermal Hydraulics	7	--	--	--
NE 417	3	Nuclear Power Systems Design	--	5	--	--
NE 472	3	Nuclear Power Systems Design	--	--	5	--
RHP 480**	1-3	Field Practices in Radiation Protection	3	3	--	1
NE 484**	3	Applied Radiation Safety	6	--	--	--

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

Course	Credit	Course Title	Number of Students			
			Fall 1997	Winter 1998	Spring 1998	Summer 1998
RHP 484**	3	Applied Radiation Safety	9	--	--	--
NE 486*	3	Radiation Dosimetry	--	--	4	--
RHP 486*	3	Radiation Dosimetry	--	--	7	--
RHP 487	3	Radiation Biology	--	--	9	--
RHP 488*	3	Radioecology	--	1	--	--
RHP 501	1-16	Research	--	1	1	--
NE 503*	1-16	Thesis	4	3	3	--
RHP 503*	1-16	Thesis	8	6	6	2
NE 505	1-16	Reading and Conference	--	1	--	--
RHP 505	1-16	Reading and Conference	2	--	3	1
NE 506*	1-16	Projects	--	--	1	--
RHP 506	1-16	Projects	--	1	--	1
NE 507	1	Seminar	2	1	2	--
RHP 510	1-12	Internship	--	--	1	--
NE 535	3	Nuclear Radiation Shielding	--	--	3	--
RHP 535	3	Nuclear Radiation Shielding	--	--	9	--
NE 543	3	Radioactive Waste Management	--	3	--	--
RHP 543	3	Radioactive Waste Management	--	7	--	--
NE 544	3	Nuclear Fuel Cycle	--	1	--	--
RHP 544	3	Nuclear Fuel Cycle	--	7	--	--
RHP 550	3	Principles of Nuclear Medicine	--	--	5	--
NE 554	3	Advanced Nuclear Reactor Analysis	1	--	--	--
NE 555	3	Advanced Nuclear Reactor Analysis	--	2	--	--
NE 556	3	Advanced Nuclear Reactor Analysis	--	--	2	--
NE 559**	1	ST/ Nuclear Reactor Lab	1	1	1	--
NE 567	4	Advanced Nuclear Reactor Thermal Hydraulics	3	--	--	--
NE 568	3	Nuclear Reactor Safety	--	--	5	--
NE 571	3	Nuclear Power Systems Design	--	2	--	--
NE 572	3	Nuclear Power Systems Design	--	--	1	2
RHP 580**	1-3	Field Practice Radiation Protection	2	--	--	--

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

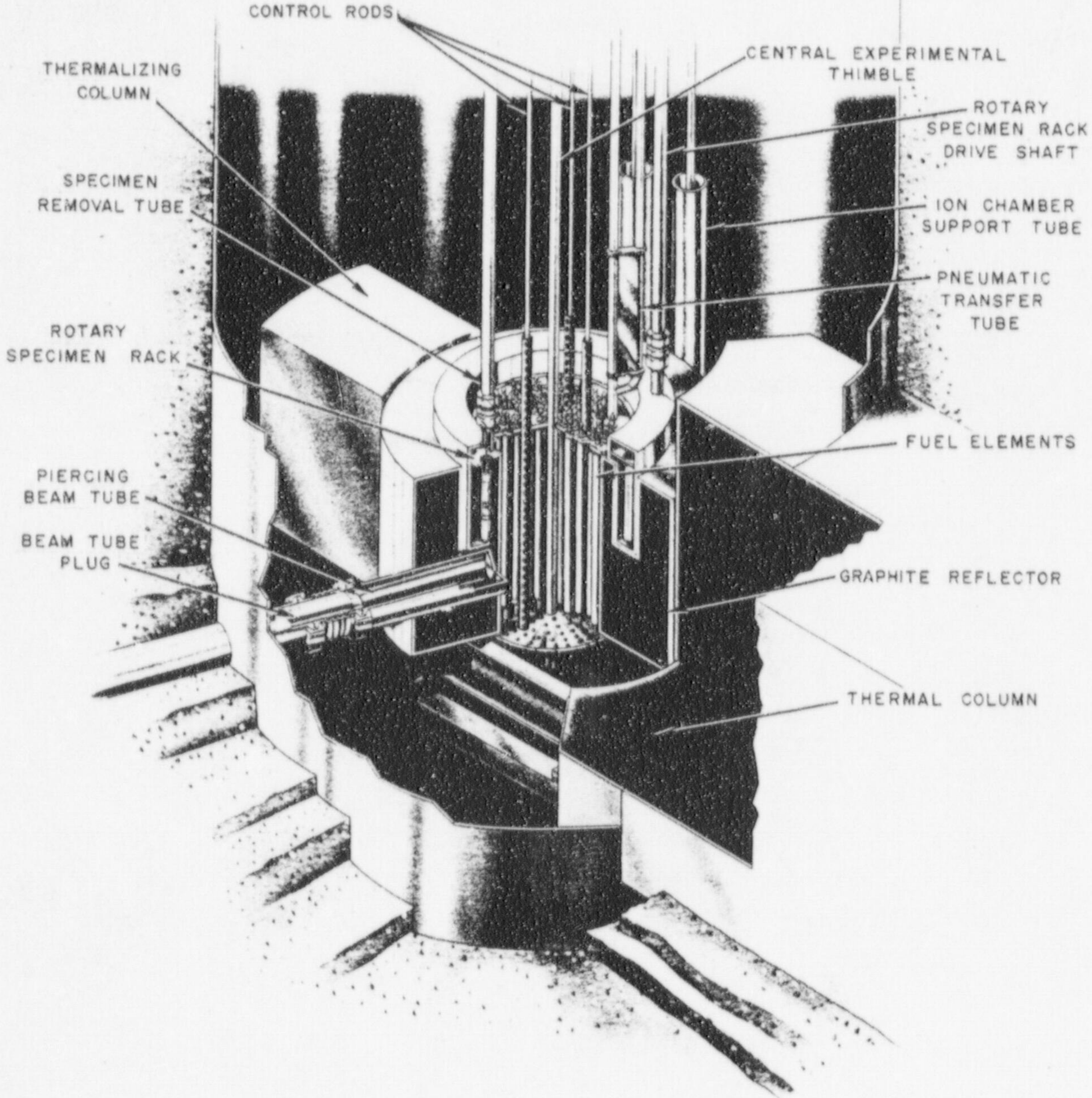
Table III.D.1 (continued)

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

Course	Credit	Course Title	Number of Students			
			Fall 1997	Winter 1998	Spring 1998	Summer 1998
RHP 584**	3	Applied Radiation Safety	4	--	--	--
RHP 585	3	Environmental Aspects of Nuclear Systems	13	--	--	--
RHP 586*	3	Advanced Radiation Dosimetry	--	--	1	--
RHP 587	3	Radiation Biology	--	--	7	--
RHP 588*	3	Radioecology	--	5	--	--
RHP 589	1	ST: Computer Modeling Lab	--	4	--	--
RHP 599	1	ST: Principles of Nuclear Medicine	--	--	1	--
RHP 599	2	ST: Principles of Nuclear Medicine	--	--	1	--
NE 603*	1-16	Thesis	--	--	--	2
RHP 603	1-16	Thesis	--	3	3	--
NE 607	1	Nuclear Engineering Seminar	2	1	1	--
RHP 607	1	Nuclear Engineering Seminar	--	--	2	--
RHP 610	1-12	Internship	--	1	--	--
NE 654	3	Neutron Transport Theory	6	--	--	--
Courses from Other Departments						
CH 222*	5	General Chemistry (Science Majors)	--	456	--	--
CH 462*	3	Experimental Chemistry II Laboratory	--	26	--	--
CH 503	1-16	Thesis (Chemistry)	2	1	1	--
CHE 101	3	Chemical Engineering Orientation	40	--	--	--
CE 356	3	Technology and Environmental Systems	--	--	45	--
Courses from Other Institutions						
CH 223	PCC	Chemistry	--	--	--	40
RH 289	LBCC	Alternate Energy Sources	12	30	--	--
GS 105	CCC	General Science	--	--	--	--
GS 105	LBCC	General Science	--	84	--	--
CH 223	LBCC	Nuclear Energy	--	--	44	--

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.



(MII-27B)

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

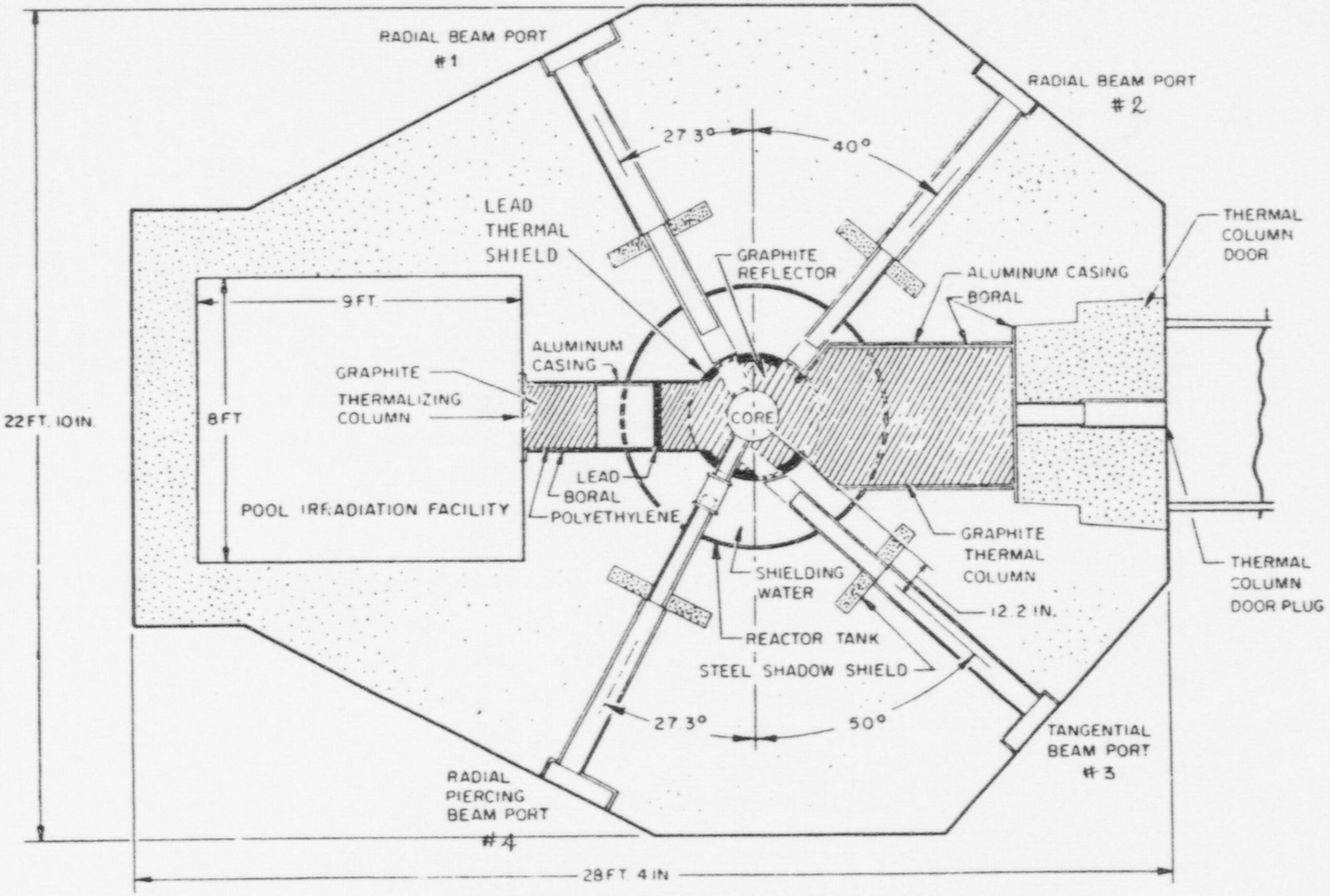


Fig. III.A.2 Horizontal Section of TRIGA Mark II Reactor

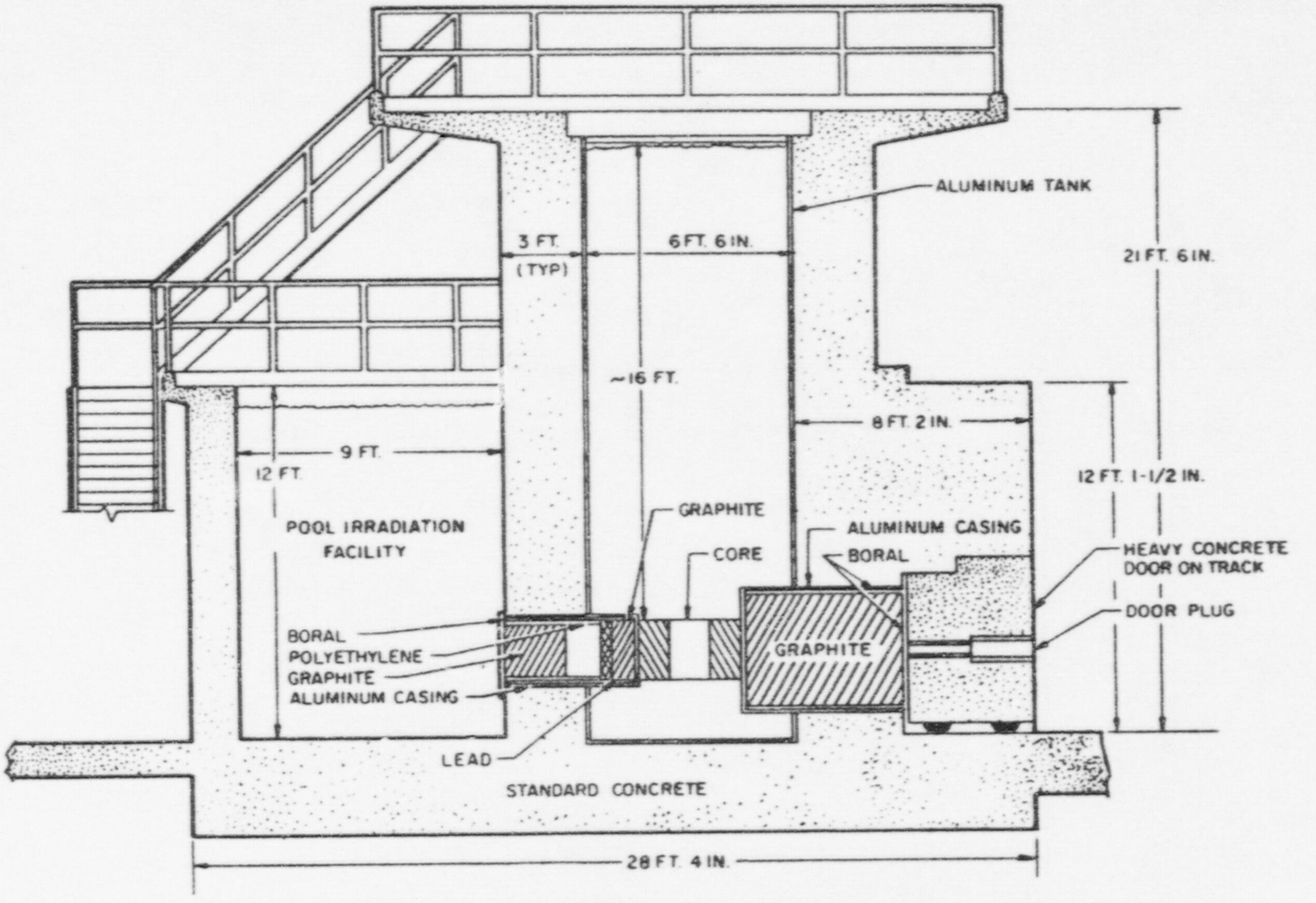


Fig. III.A.3 Vertical Section of TRIGA Mark II Reactor

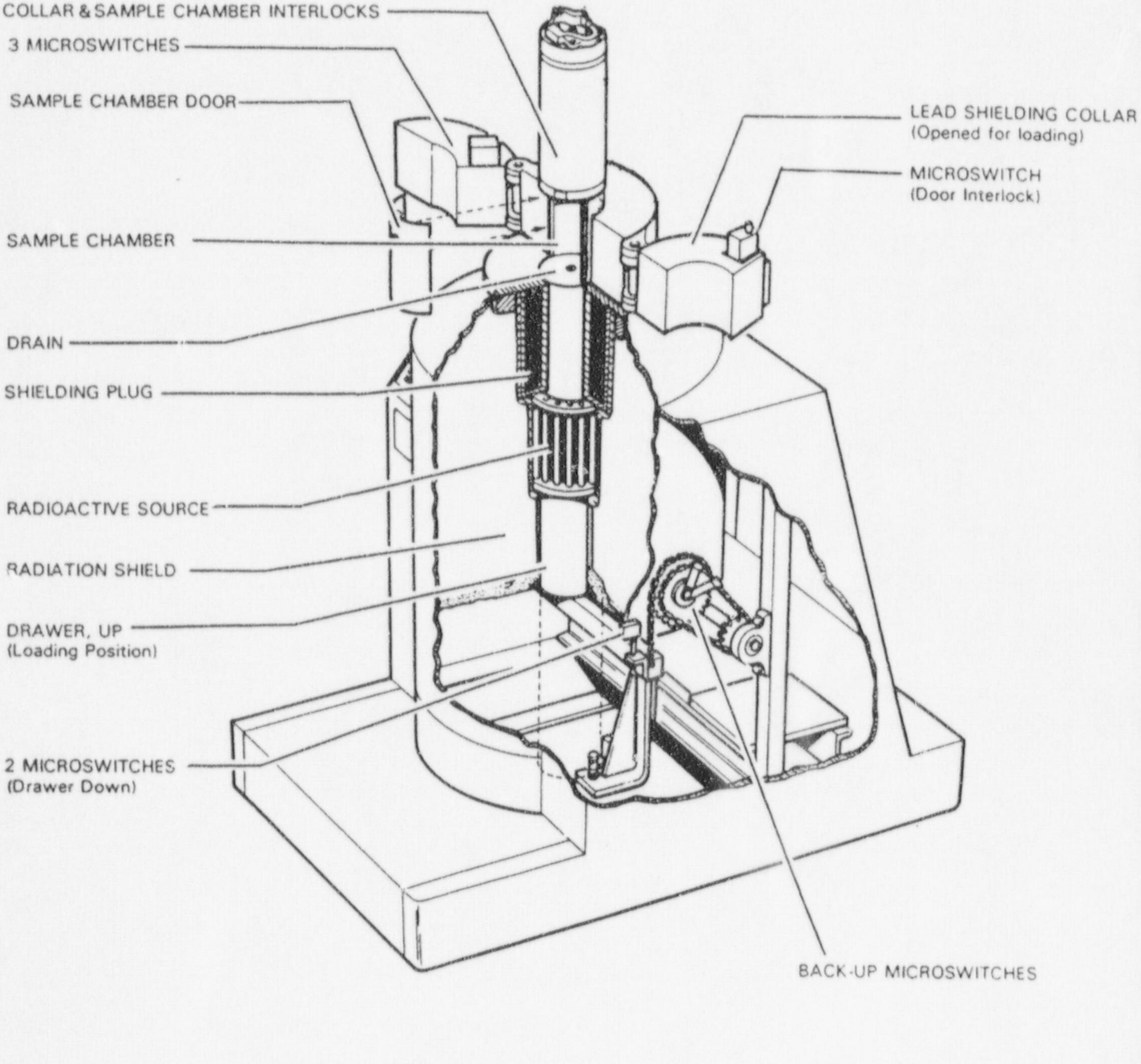


Fig. III.C.1 Gammacell 220 ^{60}Co Irradiator

Part IV

REACTOR

Part IV

REACTOR

A. Operating Statistics

For the current reporting period, some of the operating statistics for the OSTR showed a slight drop as shown in this section. 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.

The thermal energy generated in the reactor during this reporting period was 38.6 megawatt days (MWD). The cumulative thermal energy generated by the FLIP core now totals 828.4 MWD from August 1, 1976 through June 30, 1998. Reactor use time averaged approximately 89.3% 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.

No fuel elements were removed or added during the reporting period. The reactor core excess reactivity increased slightly (~5¢) 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 available for use in reactor-related programs. The following list of reactor experiments identifies the seven approved experiments. 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.

Of the approved experiments on the active list, three 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 30 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 30 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 fifteen 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 five changes to the reactor facility during the reporting period.

a. *Installation of a Separate Cleanup System for the Bulk Shielding Tank*

(1) Description

The cleanup system for the water in the bulk shielding tank (BST) was replaced to allow for complete separation between the water in the BST and that in the primary reactor tank. This separation provided the capability for the operations staff to place a chemical tracer in the water of the BST tank in order to confirm whether that tank was the source of the water leakage from the thermal column and beam port No. 2. The cleanup system also serves the function of ensuring excellent water quality to prevent corrosion of the stainless steel liner installed in January and February of 1997.

The new system is housed in the D106 Mechanical Room and has siphon breaks 1 inch below the low water level. This will prevent accidental draining of the BST.

It was proposed that the operations staff remove the existing cleanup lines and valves (DV19 and DV2) which are identified in Fig. 1.60 of the OSTR training manual. The ends of the piping were capped off at the 12 foot level. The BST cleanup system was installed after being satisfactorily tested by the Reactor Supervisor.

(2) Safety Evaluation

The proposed facility change did not increase the probability of accidentally draining water from the Bulk Shielding Tank or from the reactor tank nor did it cause any corrosion problems with the primary system, since it was constructed with PVC pipe.

b. *Replacement of the Rack and Drive Gear on the Regulating Rod*

(1) Description

Inspection of the regulatory rod drive system on September 10, 1997 revealed that the rack had experienced significant wear and was in need of replacement. Unfortunately, the manufacturer of the rod drive system was unable to provide replacement parts for the rack, drive gear, draw tube bearing, or drive bearing. These parts were available at the Radiation Center in the form of the new stepper rod drive which had been awaiting installation pending final work on the development of interfacing and installation procedures. These parts were exactly the same as those in the existing regulatory rod with the single exception that the stepper motor rack was made of brass instead of steel. Telephone conversations with General Atomic confirmed that the stepper motor purchased by OSU was the same model which had been placed in service at other facilities as direct replacement for the older rod drive designs. Since the manufacturer had successfully moved to using brass as the rack material in rod drives, the OSTR staff was confident that the brass rack would perform its intended function and that it satisfied the need for an equivalent replacement part.

Therefore it was proposed that the parts be replaced with those from the new stepper motor. The control rod drive maintenance shall be performed in accordance with OSTROP 12, "Control Rod Maintenance, Removal and Replacement Procedures."

(2) Safety Evaluation

The control rod drive mechanism was designed to maintain positive control over the insertion or removal of reactivity from the core. The parts described did not diminish the ability of the drive system to serve this function. There was no identified failure mode which could lead to an inadvertent reactivity insertion, and hence there was no new unreviewed safety concern as a result of the use of the brass rack instead of the steel rack. An increased rate of wear will occur with the brass versus the steel; however, the maintenance and inspection program already in place will be sufficient to identify when the wear reaches the point that the rack would need replacement again.

c. *AP600 Addition to the Radiation Center*

(1) Description

Dr. Jose Reyes's AP600 project entered a new phase which required that additional laboratory space (Advanced Thermal Hydraulic Research Laboratory) be constructed adjacent to the Radiation Center's Reactor Building. There were two issues which arose from the perspective of the reactor facility.

1) The installation of the electrical power for the new addition was accomplished by a tie-in to the existing sub-distribution panel "A" in the D-106 Mechanical Room.
2) Does a seismic concern exist because of the location of the new building adjacent to the reactor building?

Electrical Power Tie-in

The installation of the electrical power for the new addition was accomplished by a tie-in to the existing sub-distribution panel "A" in the D-106 Mechanical Room. The Project Manual required that conduit routing be verified with "the owner" prior to installation. It also required that all conduit inside the reactor bay be rigid or intermediate metallic conduit and that all reactor bay penetrations be sealed. The sealing was required to be one of the following methods: (1) provide mechanical fire-stop fittings with UL-listed fire rating equal to wall or (2) seal opening around conduit with UL-listed foamed silicone elastomer compound. And finally, expansion joints were required to be installed where conduit crossed building expansion or seismic joints.

Seismic Concern

The architect, gLAs Architectural Group, stated that the new addition was actually a free-standing structure, decoupled from the existing reactor building, and would in no way interact with the seismic integrity of the reactor facility. The new addition is being built to current seismic standards.

(2) Safety Evaluation

The conduit runs were sufficiently sealed and routed so that the integrity of the reactor bay was maintained. Thus the current ability of the facility to contain a potential release of radioactive material was unaffected, and there was no increased safety concern.

The seismic concern was adequately addressed by the new building complying with current building code. There was no safety concern with regards to the seismic interaction between the two buildings.

d. *Modification to the Scram Circuit System*

(1) Description

On February 17, 1998 at 0855, the reactor failed to scram when the manual scram button was depressed. The reactor had been operating for 14 minutes at a power level of 15 W. Reactor shutdown was achieved within two seconds by the operator checking the key switch and finding that it clicked from the reset into the operate position. He then retried the manual scram button, and it operated properly. Subsequent investigation discovered that the TB2-3 to TB1-9 jumper was not present. At sometime in the past, a connection had been made between TB1-9 and TB10-10 which was further connected to the B deck of the console key switch. This in turn was connected to the AC (neutral) at TB10-4. The consequence was that an alternate path was created to supply power to the control rod magnets. When the key switch was in the reset position, the scram bus was disabled, so instead of the magnet power being disrupted, the alternate power source kept the magnets energized, resulting in the failure to scram.

It was proposed that the facility be modified:

1) to remove the connection between TB1-9 and TB10-10 and

2) to reinstall the jumper between TB2-3 and TB1-9.

In addition, the Scientific Instrument Technician electronically checked the rest of the scram loop circuitry to provide assurance that the as-built condition matched the circuitry shown in the facility documentation. The semi-annual S&M 15.11, Console Checklist, was conducted prior to restart of the facility.

It was further proposed that a modification be made to the startup procedure, OSTROP 2, to add a scram test which would confirm that the control rod magnetic power was de-energized when the console key switch was in the reset position.

(2) Safety Evaluation

The proposed facility change returned the operate permissive circuitry to its original, as designed configuration and hence removed the possibility that the scram bus could be rendered inoperative by positioning the console key switch in the reset position. The procedural change provided operational verification before each startup that indeed the magnetic power was de-energized when the console key switch was in the rest position.

Additional testing of the remainder of the scram circuitry was completed and the results confirmed that there were no further deviations from the as designed circuit.

These proposed changes permitted compliance with the requirement in the Technical Specifications that scrams identified in Table I of section 3.5.3 be operable when the reactor is unsecured. These changes corrected an identified malfunction of equipment which was evaluated in the safety analysis report. They did not introduce a possibility for a different type of malfunction, and clearly the overall margin of safety was increased by ensuring that the scrams are operable during all phases of operation.

e. *Installation of a Temperature Monitor on the Primary Water Return Line*

(1) Description

As the staff of the reactor facility continued to investigate the source of the water leak from the thermal column and beam port No. 2, it became apparent that when the temperature of the reactor tank primary water dropped below 23 °C, there was an increase in water leakage from both facilities. In order to minimize leakage from these facilities, the reactor primary cooling system had been operated with the administrative goal of maintaining the primary temperature above 23 °C. In order to aid the operator in monitoring the status of the primary water temperature, it was proposed that a facility modification be performed to install a thermocouple on the outside of the primary piping downstream of PV6. This thermocouple was connected to a control unit located in the control room. The unit provided the operator with both an audible and visual alarm when the primary water temperature drops below a set point value.

Installation of the type K thermocouple used a non-invasive technique of strapping the thermocouple to the outside surface of the return leg of the primary cooling system. The location was on the 24 foot level, under the deck plating and adjacent to the current thermocouple used to monitor reactor inlet temperature. The thermocouple lead was routed to the control room using existing conduits and was connected to the alarm/monitor unit (Love Controls Temperature Control Unit) in the right side cabinet. AC power for the new unit comes from an existing 120V power strip in the right hand side cabinet. An audio and visual alarm with acknowledge capability was also designed into the circuit. The circuit was installed in the right hand side cabinet adjacent to the temperature control unit.

The advantage of the new system is that it has alarm capability to warn the operator when the temperature of the return water is below the set point. The set point is specified and changed by the Reactor Supervisor based on the leakage history and the demands of the operating schedule. It was initially set to alarm when the water temperature dropped below 23°C.

This system serves to notify the reactor operator when the primary temperature drops below the set point. The operator's actions are to either secure the primary cooling system to prevent further cooling or to notify the Reactor Supervisor, who has the authority to continue cooling based on other considerations. For example, the Reactor Supervisor will authorize cooling the primary water below the set point during power calibration operation. The consequence of continued cooling is the increased possibility of water leakage from the thermal column and beam port No. 2.

(2) Safety Evaluation

There was no unreviewed safety concern from the installation of this monitor. The thermocouple was mounted using a technique currently employed on the existing temperature channel. The mounting materials were stainless steel, and hence there was no corrosion concern. The mounting did not require drilling into the existing piping, so there was no concern regarding leakage of air or water through the thermocouple mount.

2. 10 CFR 50.59 Changes to Reactor Procedures

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

a. *Revisions to the Radiation Center and OSTR Emergency Response Plan*

(1) Description

As a result of the annual review of the Radiation Center and OSTR Emergency Response Plan, a number of changes to the plan were needed. The majority of the corrections were typographical and grammatical errors or were updates which reflected staff changes. The emergency plan was also updated to conform to the revised Appendix I of NUREG-0849. The detailed description of the evaluation and implementation of this revision to Appendix I is given in Record #97-4 of Emergency Response Plan activities. One other change was to correct the plan to reflect the change from semi-annual calibration of portable instruments to an annual schedule. The details of these changes are given below.

Cover Page

Changed the last revision date to " November 1997."

All Changed Pages

Added or changed the revision date to "11/97."

Page i, ii, iii, Table of Contents

Retyped the table into the current word processing program. On pages ii and iii, changed the current page number from 7-5 through 7-17 to 7-6 through 7-18.

Page 3-1, Oregon Office of Energy (OOE)

Corrected the reference to OOE rules from "30-005 and 30-010" to "345-030-0005 and 345-030-0010".

Page 4-4, footnote (1)

Changed the last sentence from "This value is 8.13 x 10-4 (0.0008) of the 15 mrem action level ..." to "This value is 1.63 x 10-4 (0.00016) of the 75 mrem action level ...".

Page 5-4, footnote (1)

Changed the last sentence from:

This value is 8.13 x 10^{-4} (0.0008) of the 15 mrem action level specified, ...

To:

This value is 1.63×10^{-4} (0.00016) of the 75 mrem action level specified, ...

Page 7-5, 7.1.4.Protective Actions for Personnel and Operational Events

Moved from page 7.5 to 7.6

Page 7-11, Part 7.2.4 Protective Actions for Notification of Unusual Events

Changed from:

h) A battery-operated public address device (bullhorn) is available in the emergency equipment locker in **the ESC** to communicate protective actions and other information to personnel at the assembly area.

To:

h) A battery-operated public address device (bullhorn) is available in the emergency equipment locker in **B134** to communicate protective actions and other information to personnel at the assembly area.

Page 8-2, Part 8.2.1 Portable and Fixed Radiological Monitors

(1) Changed part a) number iv) Neutron survey meters **(BF_3 detectors and rem meters)**.

To: number iv) Neutron survey meters.

(2) Changed v)Alpha survey meters **(gas flow and scintillation)**.

To: v) Alpha survey meters.

(3) Deleted - vi) Tritium survey meter (gas flow).

(4) Changed - vii) to vi)

Page 8-8, Part 8.3.5 Medical Treatment

Changed:

iv) The radiological emergency **footlocker** at the hospital, which contains all the equipment necessary for monitoring and decontamination, will have been set up near the restricted treatment area. The typical contents of this **box** are detailed in Appendix B.

To:

iv) The radiological emergency **cabinet** at the hospital, which contains all the equipment necessary for monitoring and decontamination, will have been set up near the restricted treatment area. The typical contents of this **cabinet** are detailed in Appendix B.

<u>Page 10-3, Part 10.4.1 Required Maintenance and Minimum Calibration Frequency</u>
Changed:

b) All portable survey instruments are repaired as necessary and calibrated at least **semiannually**.

To:

b) All portable survey instruments are repaired as necessary and calibrated **at least annually.**

<u>Appendix B, page B-1, part B.2 Semi-Annual Emergency and Safety Equipment Inspection checklist</u>

Changed:

a) Good Samaritan Hospital Emergency Department **footlocker**.

To:

a) Good Samaritan Hospital Emergency Department **cabinet**.

<u>Appendix B, page B-2</u>

Added:

Under A 2 - Exchange Batteries **and check for proper operation**.
Under A 4 - 100 moist towelettes. **Replace if dried out.**

<u>Appendix B, Page B-3, Item B, B134 Small Emergency Equipment Cabinet #15</u>

Changed:

Four rolls of masking tape (replace annually)
To:
Four rolls of masking tape. **Replace if discolored, dry, or brittle.**

Appendix B, Page B-4

Item A: Changed - Good Samaritan Hospital (Foot Locker).
TO: Good Samaritan Hospital (**Cabinet**).

Item A-9: Changed - 3-4 rolls of 1 1/2" masking tape. Note that the tape is usable, i.e., not dried out or shriveled up.
TO: 3-4 rolls of 1 1/2" masking tape. **Replace if discolored, dry, or brittle.**

Appendix B, page B-5

Item B # 6: Changed - 2 rolls masking tape.
TO: 2 rolls masking tape. **Replace if discolored, dry, or brittle.**

Item B, Box 2 #9: Changed - Masking tape
TO: Masking tape. **Replace if discolored, dry, or brittle.**

Item B, Box 3 #f: Changed - Masking tape
TO: Masking tape. **Replace if discolored, dry, or brittle.**

Appendix, page B-6

Box #5, Item 3a: Changed - Replace the battery in the air sampler.

TO: Note date on battery, replace the battery in the air sampler biannually

Box #5, Item 5: Deleted item a. Check and replace batteries. Changed item b to a.

Appendix B, page B-7

Box #5, Item 10: Changed - 2 flashlights.
TO: 2 flashlights. Replace batteries and check for proper operation.

Item C, #2: Changed - 2 flashlights.
TO: 2 flashlights. Replace batteries and check for proper operation.

Appendix B, page B-10, item A

Changed item 1 title from "A100 Cabinet" to "B134 Large Cabinet"
Changed item b. from "...large decon kit..." to "...large decon kit #1..."
Added item "c. Check large decon kit #2 (see item C. on next page)."
Deleted entire item 2, "B126B Cabinet," including items a and b.
Renumbered remaining items 3 and 4 to be items 2 and 3

Appendix B, page B-10, item B

Number 1: Changed - Verify the quantity and quality of the following small kit items: (Refill or replace as necessary to meet the minimum quantity indicated for each item).

TO: Verify the quantity and quality of the following small kit items: (Refill or replace as necessary to meet the minimum quantity indicated for each item **or if items are unusable**).

Deleted the column for "C122" from the table.

Appendix B, page B-11

Item C, #1: Changed - Verify the quantity and quality of the following large decon items: (Refill or replace as necessary to meet the minimum quantity indicated for each item).

TO: Verify the quantity and quality of the following small kit items: (Refill or replace as necessary to meet the minimum quantity indicated for each item **or if items are unusable**).

Changed table for Large Decon Kit Item rooms from A100 to B134#1, and B126B to B134#2.

Attachment B: **Revisions to the OSU Radiation Center and TRIGA Reactor Emergency Response Plan Implementing Procedures (ERIPs)**

Page E-2-1 footnote (1)

Changed the last sentence from "This value is 8.13 x 10^{-4} (0.0008) of the 15 mrem action level specified, ... to "This value is 1.63 x 10^{-4} (0.00016) of the 75 mrem action level specified, ...

Page E-5-6 Appendix B

Made consistent with initials D. R. Carver, added J. T. Groome under APEX Facility Operator and M. Yundt under APEX I & C Technician.

Page E-5-16, Checklist for the Initial Emergency Response Action of the Radiation Protection Technologist

Changed S. P. Smith to D. R. Carver.

Page E-5-17, Checklist for the Initial Emergency Response Action of the Radiation Center Receptionist

Changed C. L. Hall to D. C. West.

NEW Page E-5-18

Inserted new Page E-5-18 with the following text.
Renumbered previous page E-5-18 to become E-5-19.

CHECKLIST FOR THE INITIAL EMERGENCY RESPONSE ACTION OF THE BUILDING CHECKERS

NAME	CORRIDOR
E. G. Torne	A
K. M. Brock	B
M. R. Conrady	C
A. D. Hall	D
S. E. Binney	E

ERIP 7, page E-7-4

Inserted new version of Radiation Center Directory.

Page E-7-6

For *Radiological Assessment Team*, deleted "E. F. Forrer" and "S. R. Smith," and added "D. R. Carver" in alphabetical order by last name.

For *Historian, 1st Choice*, changed "C. L. Hall" to "D. C. West".
For *Historian, 2nd Choice*, changed "J. R. Smith" to "L. M. James".

(2) Safety Evaluation

The only change in the plan which changed from the original intent was the definition of action level for the duration of a fire which would require the declaration of an Unusual Event. In the previous plan it was defined as 10 minutes and in Appendix I as 15 minutes. Since there was no documented or institutional memory for the basis of selecting the 10 minute period, the ROC Emergency Plan Review Subcommittee felt it was not a decrease in the effectiveness of the plan if the NRC definition of 15 minutes was used instead. The annual calibration criterion for the portable survey instruments is actually the industry standard of practice and does not increase the chance that a given instrument would be incapable of performing its intended function. All of the other changes corrected typographical and grammatical errors or updated personnel lists. Since these changes made the plan easier to read, the plan's effectiveness actually improved.

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

September 3, 1997	Completed the installation of a new deionized water make up and clean up system for the bulk shielding tank.
September 15, 1997	Refurbished the regulating rod drive assembly. Replaced the rack and pinion gears, the pinion shaft and bearing, and the draw tube sleeve bearings.
September 17, 1997	Replaced the reactor building water heater.
December 4, 1997	Inspected and performed maintenance on the chemical injection pump in the reactor secondary cooling system.
December 5, 1997	Replaced the bearings on the regulating rod motor.
December 15, 1997	Changed out the dual element mechanical shaft seal on the reactor demineralizer pump and replaced the pump's motor bearings.
December 16, 1997	Received new Flip IFE and FFCR.
December 22, 1997	Replaced the stack monitor pump. Rebuilt old pump for spare.
January 5, 1998	Replaced capacitors in the stack gas recorder amplifier to correct a 60 cycle oscillation on the pen.
January 27, 1998	Replaced all transistors on the test signal card (XA-6) for the log and linear channels.
January 29, 1998	Cleaned and inspected the Corkin compressed air pressure regulator that supplies the transient control rod.
January 29, 1998	Replaced the % demand potentiometer on the console.
February 9, 1998	Replaced the local meter on area radiation monitor #8.
February 18, 1998	Performed scram failure investigation of console wiring.

February 20, 1998	Performed scram circuit modification that assures control rod magnet power is de-energized when console key switch is in the reset position.
February 23, 1998	Completed electronic tests verifying the console power pathway, the magnet power circuit, and all scram circuit wiring.
April 28, 1998	Completed point-to-point checks of all reactor console interwiring verifying that as-built conditions match the circuitry shown in facility documentation.
April 29, 1998	Replaced all the transistors in the servo module's pre-amplifier and power amplifier.
April 29, 1998	Replaced the K-14 relay that switches regulating rod motor power to servo control for auto/square wave modes.
May 5, 1998	Installed a reactor primary inlet temperature alarm system.
May 5, 1998	Replaced the chopper in the reactor control servo system.
May 12, 1998	Installed 2" rigid conduit in reactor bay for electrical tie-in to the new Advanced Thermal Hydraulics Research Laboratory constructed adjacent to the reactor building.

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 were two reportable occurrences during the reporting period. The first involved a failure to submit a Material Balance Report, required by 10 CFR 74.12 (a)(1), within 30 days following the end of the reporting period. The occurrence was self-identified and was addressed in detail in a report to the NRC dated September 5, 1997.

The second event involved a failure of the OSTR to shut down when the console manual scram button was pushed. The event was promptly reported, thoroughly investigated, the root causes were identified and effectively corrected in a timely manner. This occurrence was self-identified and was addressed in detail in a report to the NRC dated March 2, 1998.

Table IV.A.1

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	August 1, 1976 Through June 30, 1977(1)	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)	-2(3)	0	-1,+1(4)	-1(5)	0(6)
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		
Megawatt Hours	1026	1122	1117	1105	985	927		
Megawatt Days	42.7	46.7	46.6	46.0	41.0	38.6		
Grams ^{235}U Used	53.6	58.6	58.4	57.8	51.5	48.5		
Hours at Full Power (1 MW)	1000	1109	1110	1101	980	921		
Numbers of Fuel Elements Added or Removed (-)	0	0	0	-1(5)	-1, +1(7)	0		
Number of Irradiation Requests	329	303	324	268	282	249		

(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 (1)	Jul 1, 68 Through Jun 30, 69	Jul 1, 69 Through Mar 31, 70 (2)	Apr 1, 70 Through Mar 31, 71 (3)	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 (4)	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; 250 kW). Note: This period length is 1.33 years as initial criticality occurred in March of 1967.

(2) Reactor shut down August 22, 1969 for one month for upgrading to 1 MW (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 shut down June 1, 1971 for one month for cooling system upgrading.

(4) Reactor shut down 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	927	19,881
MWD of energy produced	38.6	828.4
Grams ^{235}U used	48.5	1039.6
Number of fuel elements added to (+) or removed from (-) the core	0	81 + 3 FFCR(1)
Number of pulses	11	1,290
Hours reactor critical	1,029	24,603
Hours at full power (1 MW)	921	19,489
Number of startup and shutdown checks	255	5,554
Number of irradiation requests processed(0)	249	7,639
Number of samples irradiated	4,707	93,487

---

(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 1 to 120 samples. The number of samples per irradiation request averaged 18.9 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)	1,488	10,398
OSU research(2)	217	7,974
Off-campus research(2)	1,274	12,404
Forensic services	0	216(3)
Reactor preclude time	1,104	16,752
Facility time(4)	57	6,939
Visitor demonstration(5)	9	312
TOTAL REACTOR USE TIME	4,149(6)	54,995

---

(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	280	3,256
Three	115	1,080
Four	38	402
Five	8	111
Six	0	45.5
Seven	0	11
TOTAL MULTIPLE USE TIME	441(2)	4,905.5(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 43% of the total hours the reactor was critical during this reporting period.

(3) This represents 20% 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)

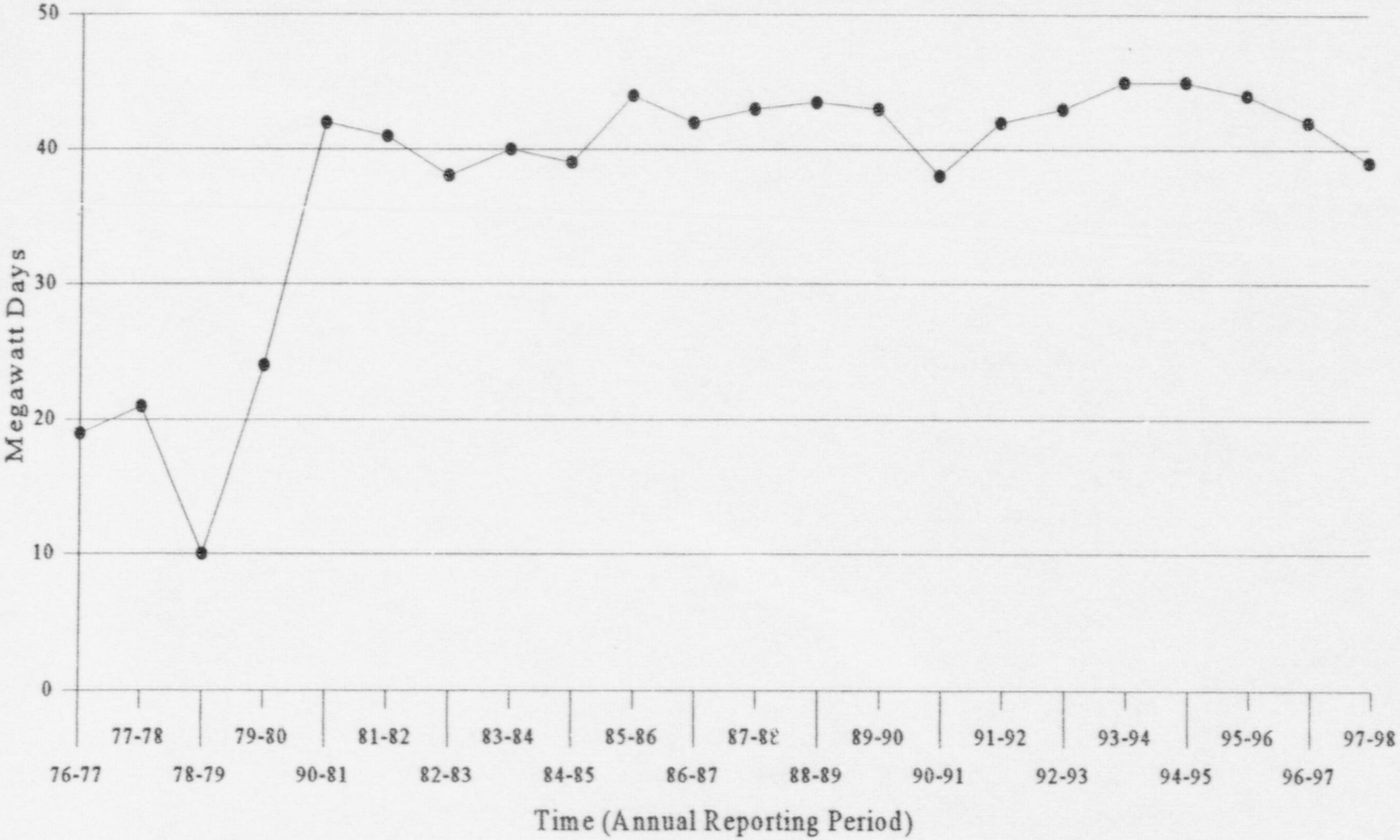


Table IV.B.1

Use of OSTR Reactor Experiments[1]

Reactor Experiment Number[2]	Research	Teaching	Forensic	Facility Time[3]	TOTAL
A-1	0	38	0	14	52
B-3	175	21	0	N/A	196
B-23	0	1	0	N/A	1
TOTAL	175	60	0	14	249

---

(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-23	Studies Using TRIGA Thermal Column

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

Table IV.C.1

Unplanned Reactor Shutdowns and Scrams

Type of Event	Number of Occurrences	Cause of Event
Period Scram	1	Operator withdrew the regulating rod too far while taking the reactor to power.
Safety Channel Power Scram	2	An apparent oscillation in safety channel response, while at full power, resulted in the scram set point on the safety channel being reached. (These did not involve actual over power situations.)
Manual Scram	1	Operator observed the regulating rod behaving sluggishly. The reactor was scrammed and the rod drive assembly was inspected. Areas of wear were found on the rack and pinion. Worn parts on the drive assembly were replaced.
Manual Scram	1	Commercial power failure. Commercial power was restored in about fiftenn minutes and reactor operation was resumed.
Manual Scram	2	Operator observed the linear power level to be tracking improperly in auto mode. Warn motor bearings on the regulating rod were diagnosed to be the problem. Bearings were replaced.
Safety Channel Power Scram	3	The scram set point on the safety channel (106%) was reached while balancing rods at 1MW with a cadmium experimental facility located in-core. The flux perturbation caused bu the in-core experiment resulted in lower readings on the linear and percent power channels relative tot he reading on the safety channel.
Safety Channel Power Scram	1	Square wave overshoot. Operator positioned the regulating rod too low in the core for square waving to 1MW. The shielding effect on the fission chamber caused a slight delay in the power level signal to the servo system to drive in rod. The licensed power level was not exceeded.
Manual Scram	1	Transient rod air pressure level was found to be ~10 psig higher than normal. Maintenance on the pressure regulator corrected the condition.

Table IV.C.1 (continued)

Manual Scram	1	Failure of reactor to manually scram on initial operator demand. NRC was immediately notified. Wiring flaw was subsequently found and corrected.
Manual Scram	1	Operator noticed the linear power trace in auto mode to be several % broader than usual and that little, if any, servo control of the regulating rod seemed to be going on. Problem was corrected by replacing the chopper in the servo module.
Period Scram	1	Electronic noise caused spike in the period channel while the reactor was starting up in the 0.2 watt power range.

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 AND 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 1/4" LEFT					
7 GREEN LIGHT BULB REPLACEMENT	75 WATT					
8 CHANGE LAZY SUSAN FILTER	FILTER CHANGED					
9 LUBRICATE THE TRIGA TUBE LOADING TOOL (REEL)	USE GUN OIL	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 date completed last month plus six weeks.

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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					
	NAME		a) TIME	b) OPERATING EXERCISE			
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 ______________________

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 ≤8 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.

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 ______				

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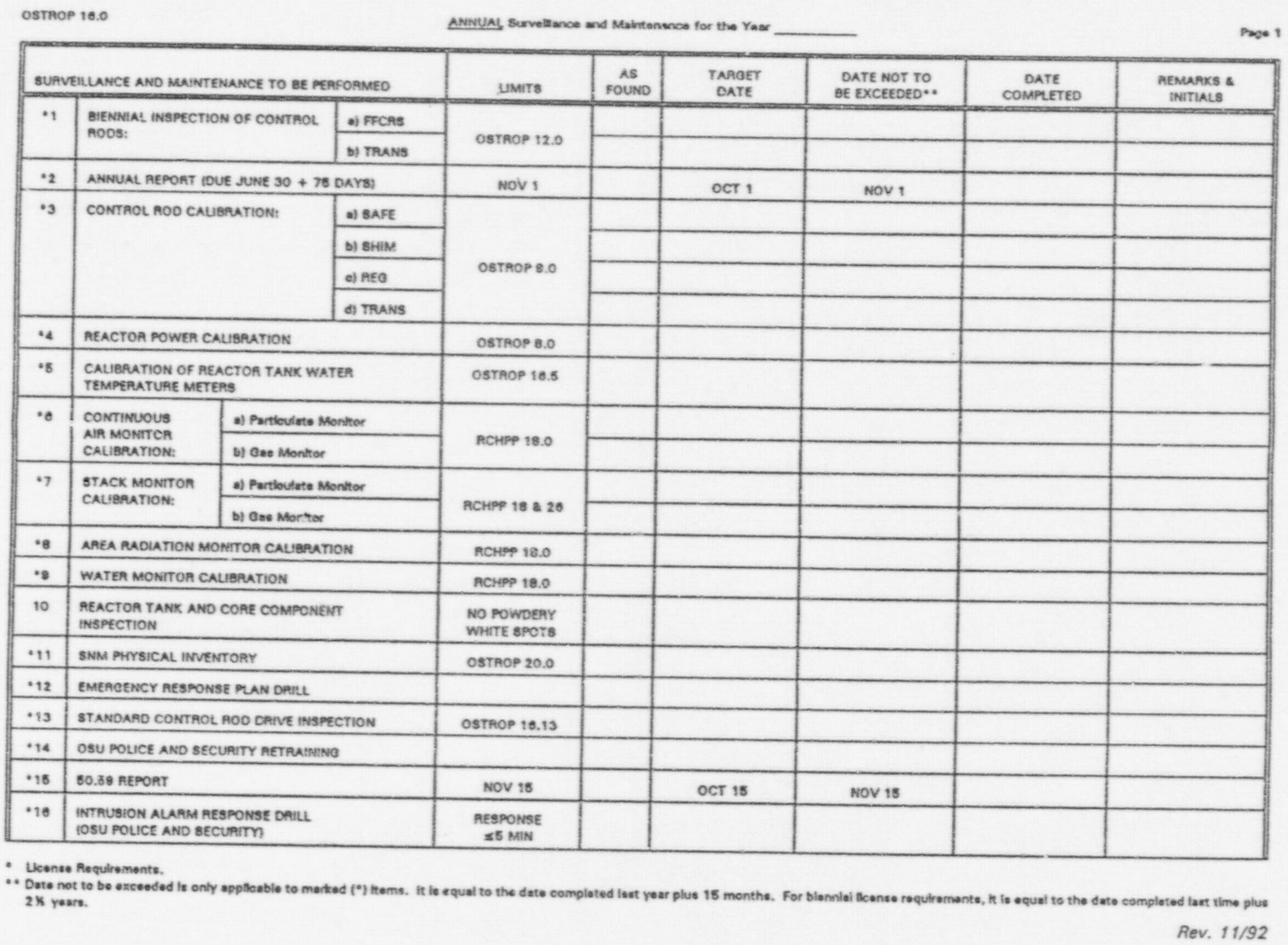
* License Requirements.

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

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 + 76 DAYS)		NOV 1		OCT 1	NOV 1		
*3	CONTROL ROD CALIBRATION:	a) SAFE	OSTROP 8.0					
		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 2 ½ years.

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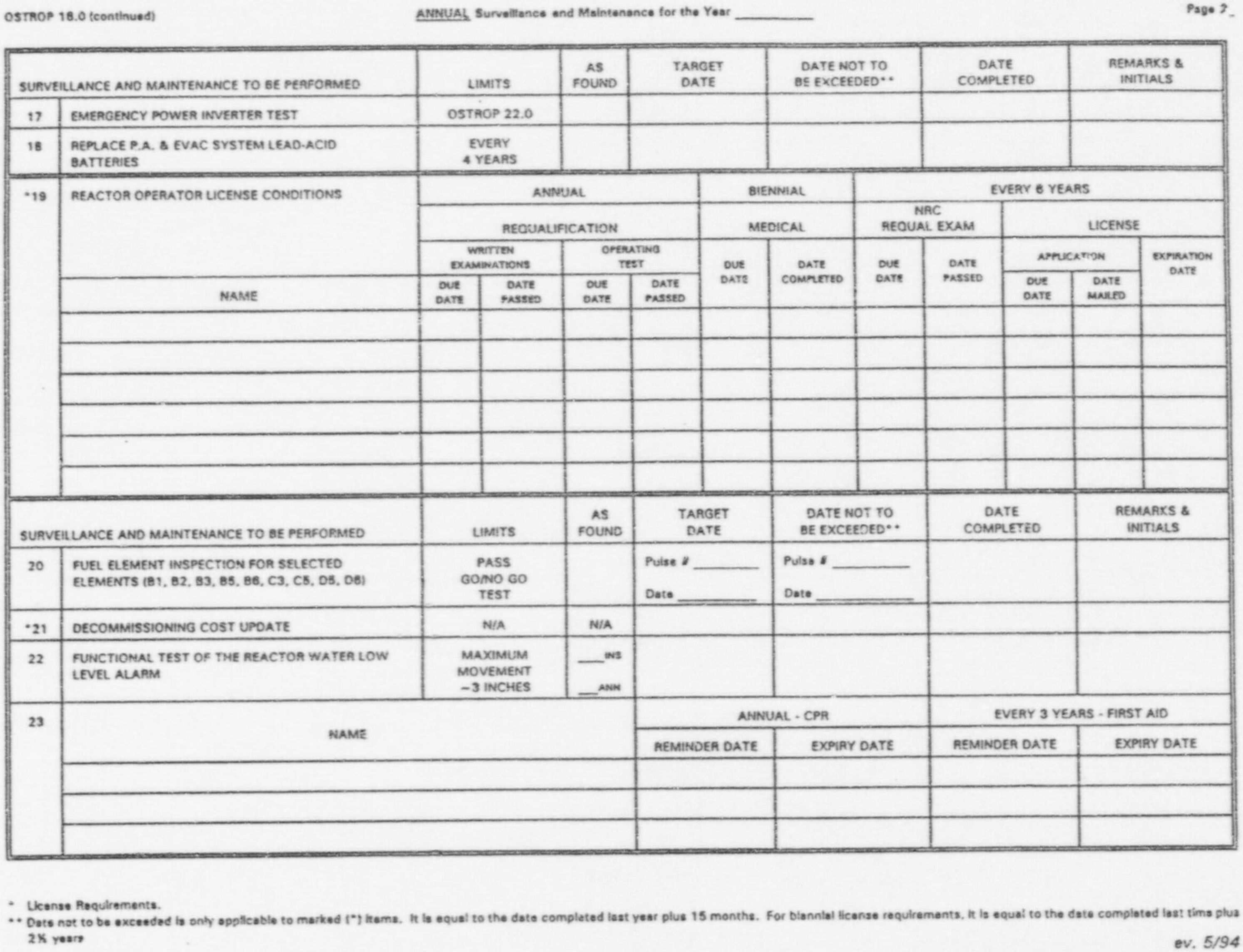
Figure IV.E.4 (continued)

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		DUE DATE	DATE COMPLETED	DUE DATE	DATE PASSED	APPLICATION		EXPIRATION DATE
	NAME	DUE DATE	DATE PASSED	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, a Radiation Protection Technologist, 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 one liquid effluent release 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 1×10^{-9} µCi/ml to 3×10^{-11} 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 monthly or quarterly X-ray, beta, and gamma [Xβ(G)] 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 Xβ(G) 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 Xβ(G) TLD badge and other dosimeters as appropriate for the work being performed.

Students attending laboratory classes are issued quarterly Xβ(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 Xβ(G) 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.

Each fence environmental station also utilized a $CaSO_4$ TLD monitoring packet supplied and processed by Radiation Detection Company (R.D. Co.), Sunnyvale, California. Each R.D. Co. packet contained two $CaSO_4$ TLDs and was exchanged quarterly for a total of 72 samples during the reporting period (9 stations x 2 TLDs per station per quarter x 4 quarters per year). A summary of Radiation Detection Company's 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 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 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 (MRCTE-11 has six) 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 Lab. and National Forage Seed Lab., respectively). These monitors are exchanged and processed quarterly, and the total number of TLD samples during the current one-year reporting period was 264 (20 stations x 3 chips per station per quarter x 4 quarters per year plus 1 station x 6 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 R. D. Co. TLD samples for the reporting period was 104 (13 stations x 2 TLDs per station per quarter x 4 quarters per year). A summary of Radiation Detection Company's 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) are made at each of the twenty-one 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 252 μrem/h 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 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.
Weekly	Perform gamma spectroscopy of the (OSTR) continuous air monitor particulate filter.
Monthly	Perform routine response checks of radiation monitoring instruments. Monitor radiation levels (µrem/hr) 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 and X-ray machine. 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 x 10^{-7} μCi/cm³ (μCi/ml)	Total Quantity of Each Detectable Radionuclide Released in the Waste (Curies)	Average Concentration of Released Radioactive Material at the Point of Release (μCi/ml)	Percent of Applicable Monthly Average Concentration for Released Radioactive Material (%)[3]	Total Volume of Liquid Effluent Released Including Diluent[4] (gal)
December 97 **(No OSTR Contribution)**	≤LLD (95%) of 1.79 x 10^{-5}	None	Not Applicable	Not Applicable	≤LLD (95%)[5] of 4.08 x 10^{-6}	Not Applicable	1158
Annual Total for Radiation Center	≤LLD (95%) of 1.79 x 10^{-5}	None	Not Applicable	Not Applicable	≤LLD (95%)[5] 4.08 X 10^{-6}	Not Applicable	1158
OSTR Contribution to Above	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable	Not Applicable

(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	None	Not Applicable	Not Applicable	Not Applicable	Not Applicable
Radiation Center Laboratories	52	^{60}Co, ^{32}P, ^{86}Rb	4×10^{-2}	9/26/97 5/9/98	Not Applicable(2)
TOTAL	52	^{60}Co, ^{32}P, ^{86}Rb	4×10^{-2}	---	---

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(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) (μCi/ml)	Percent of the Applicable MPC for Diluted Concentration of Argon-41 at Point of Release (Reactor Stack) (%)
July 97	0.58	0.58	4.4×10^{-8}	1.1%
August 97	0.47	0.47	3.5×10^{-8}	0.9%
September 97	0.33	0.33	2.6×10^{-8}	0.7%
October 97	0.40	0.40	3.0×10^{-8}	0.8%
November 97	0.39	0.39	3.0×10^{-8}	0.8%
December 97	0.50	0.50	3.9×10^{-8}	1.0%
January 98	0.28	0.28	2.2×10^{-8}	0.5%
February 98	0.30	0.30	2.5×10^{-8}	0.6%
March 98	0.55	0.55	4.2×10^{-8}	1.0%
April 98	0.38	0.38	3.0×10^{-8}	0.7%
May 98	0.42	0.42	3.2×10^{-8}	0.8%
June 98	0.82	0.82	6.5×10^{-8}	1.6%
ANNUAL VALUE	5.42	5.42	3.5×10^{-8}	0.9%

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(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	22[3]	^{46}Sc, ^{47}Sc, ^{51}Cr, ^{58}Co, ^{54}Mn, ^{59}Fe, ^{60}Co, ^{124}Sb, ^{152}Eu	3.0×10^{-5}	7/2/97 9/26/97 1/21/98 3/11/98	11/20/97 2/5/98 5/18/98
Radiation Center Laboratories	34	^{3}H, ^{22}Na, ^{24}Na, ^{46}Sc, ^{47}Sc, ^{59}Fe, ^{60}Co, ^{86}Rb, ^{90}Sr, ^{113}Cd, ^{122}Sb, ^{124}Sb, ^{204}Tl, ^{214}B, ^{226}Ra, ^{238}U, ^{241}Am	3.6×10^{-5}	9/26/97 1/21/98 3/11/98	11/20/97 2/5/98 5/18/98
TOTAL	66	See Above	6.6×10^{-5}	---	---

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(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	14	80	35	100	190	1110
Key Facility Research Personnel	ND	<1	ND	30	ND	30
Facilities Services Maintenance Personnel	<1	N/A	3	N/A	4	N/A
Laboratory Class Students	ND	<1	ND	30	ND	50
Campus Police and Security Personnel	ND	N/A	ND	N/A	ND	N/A
Visitors	<1	N/A	20	N/A	161	N/A

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(1) "ND" indicates that each of the beta-gamma dosimeters during the reporting period was less than the vendor's gamma dose reporting threshold of 10 mrem or that each of the neutron dosimeters was less than the vendor's threshold of 30 mrem, as applicable. "N/A" indicates that there was no extremity monitoring conducted or required for the group.

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)]**	
		xβ(G) (mrem)	**Neutron (mrem)**
MRCTNE	D104: North Badge East Wall	15	ND
MRCTSE	D104: South Badge East Wall	0	ND
MRCTSW	D104: South Badge West Wall	105	ND
MRCTNW	D104: North Badge West Wall	ND	ND
MRCTWN	D104: West Badge North Wall	70	ND
MRCTEN	D104: East Badge North Wall	580	ND
MRCTES	D104: East Badge South Wall	1300	ND
MRCTWS	D104: West Badge South Wall	305	30
MRCTTOP	D104: Reactor Top Badge	295	30
MRCTHXS	D104A: South Badge HX Room	420	ND
MRCTHXW	D104A: West Badge HX Room	20	30
MRCD-302	D302: Reactor Control Room	140	ND
MRCD-302A	D302A: Reactor Supervisor's Office	20(3)	N/A

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(1) The total recorded dose equivalent values do not include natural background contribution and, except as noted, reflect the summation of the results of 12 monthly 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 50 to 100 mrem, as applicable. "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.

(3) The total recorded dose equivalent reflects the summation of four quarterly beta-gamma dosimeters.

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]**	
			xβ(G) (mrem)	**Neutron (mrem)**
MRCA100	A100:	Receptionist's Office	ND(2)	N/A
MRCBRF	A102H:	Front Personnel Dosimetry Storage Rack	ND(2)	N/A
MRCA120	A120:	Stock Room	ND(2)	N/A
MRCA120A	A120A:	NAA Temporary Storage	175	N/A
MRCA126	A126:	Campus RSO's Isotope Receiving Lab	275(2)	N/A
MRCCO-60	A128:	^{60}Co Irradiator Room	525(2)	N/A
MRCA130	A130:	Shielded Exposure Room	ND(2)	N/A
MRCA132	A132:	TLD Equipment Room	ND(2)	N/A
MRCA134-2	A134:	Graduate Student Office	190(2)	N/A
MRCA138	A138:	Health Physics Laboratory	ND(2)	N/A
MRCA146	A146:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCB100	B100:	Gamma Analyzer Room (Storage Cave)	390	N/A
MRCB114	B114:	α Lab (^{226}Ra Storage Facility)	1595	ND
MRCB119-1	B119:	Source Storage Room	210(2)	N/A
MRCB119-2	B119:	Source Storage Room	445(2)	N/A
MRCB119A	B119A:	Sealed Source Storage Room	4080	3100
MRCB120	B120:	Instrument Calibration Facility	20(2)	N/A
MRCB122-2	B122:	Radioisotope Storage Hood	25(2)	N/A
MRCB122-3	B122:	Radioisotope Research Laboratory	ND(2)	N/A
MRCB124-1	B124:	Radioisotope Research Lab (Hood)	10(2)	N/A
MRCB124-2	B124:	Radioisotope Research Laboratory	ND(2)	N/A
MRCB124-6	B124:	Radioisotope Research Laboratory	ND(2)	N/A
MRCB128	B128:	Instrument Repair Shop	ND(2)	N/A
MRCC100	C100:	Radiation Center Director's Office	ND(2)	N/A
MRCC106A	C106A:	Staff Lunch Room	ND(2)	N/A
MRCC106B	C106:	Solvent Storage Room	90(2)	N/A
MRCC106-H	C106H:	East Loading Dock	ND(2)	N/A
MRCC118	C118:	Radiochemistry Laboratory	ND(2)	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)**	
			xβ(G) (mrem)	**Neutron (mrem)**
MRCC120	C120:	Student Counting Laboratory	ND(2)	N/A
MRCC121	C121:	APEX Facility	ND(2)	N/A
MRCC122	C122:	APEX Control Room	ND	N/A
MRCC123N	C123:	Gamma Analyzer Room (Storage Cave)	85(2)	N/A
MRCC123S	C123:	Gamma Analyzer Room	ND	N/A
MRCC124	C124:	Student Computer Laboratory	10(2)	N/A
MRCC130-1	C130:	Radioisotope Laboratory (Hood)	ND(2)	N/A
MRCC134	C134:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCD100	D100:	Reactor Support Laboratory	125	N/A
MRCD102	D102:	Pneumatic Transfer Terminal Lab	20	ND
MRCD102-H	D102H:	1st Floor Corridor at D102	ND	ND
MRCD106-H	D106H:	1st Floor Corridor at D106	95(2)	N/A
MRCD200	D200:	Reactor Administrators's Office	ND	N/A
MRCD202	D202:	Senior Health Physicist's Office	20	N/A
MRCBRR	D200H:	Rear Personnel Dosimetry Storage Rack	ND(2)	N/A
MRCD204	D204	Health Physicist Office	30(3)	ND
MRCD300	D300:	3rd Floor Conference Room	ND	ND

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(1) The total recorded dose equivalent values do not include natural background contribution and, except as noted, reflect the summation of the results of 12 monthly 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 50 to 100 mrem, as applicable. "N/A" indicates that there was no neutron monitor at that location.

(2) The total recorded dose equivalent reflects the summation of four quarterly beta-gamma dosimeters.

(3) The total recorded dose equivalent reflects one quarterly beta and gamma dosimeter and nine monthly beta-gamma dosimeters.

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/hr)		Contamination Levels(1) (dpm/cm^2)	
	Average	Maximum	Average	Maximum
TRIGA Reactor Facility:				
Reactor Top (D104)	<1	100	<500(2)	3,169(2)
Reactor 2nd Deck Area (D104)	5	35	<500	<500
Reactor Bay SW (D104)	<1	5	<500	<500
Reactor Bay NW (D104)	<1	15	<500	<500
Reactor Bay NE (D104)	<1	15	<50	<500
Reactor Bay SE (D104)	<1	19	<500(2)	1,480(2)
Class Experiments (D104, D302)	<1	70	<500	<500
Demineralizer Tank--Outside Shielding (D104A)	<1	50	<500(2)	1,296(2)
Particulate Filter--Outside Shielding (D104A)	<1	2	<500(2)	1,667(2)
Radiation Center:				
NAA Counting Rooms (A146,B100,C134)	<1	5	<500	<500
Health Physics Laboratory (A138)	<1	<1	<500	<500
^{60}Co Irradiator Room (A128)	<1	9	<500	<500
Radiation Research Labs (B114, B122, B124, B132, C130, C132A)	<1	11	<500	<500
Radioactive Source Storage (B119A)	<1	35	<500	<500
Student Chemistry Laboratory (C118)	<1	5	<500	<500
Student Counting Laboratory (C120)	<1	9	<500	<500
Operations Counting Room (C123)	<1	6	<500	<500
Pneumatic Transfer Laboratory (D102)	<1	22	<500	<500
TRIGA Tube Wash Room (D100)	<1	2	<500	<500

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

(2) The contamination shown for this location assumes 100% smearing efficiency and was immediately removed. As a result, the average contamination level at this location during the reporting period was, for all practical purposes, <500 dpm per 100 cm^2.

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 R. D. Co. 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 µrem/h Dose Rate(3) (mrem)**
MRCFE-1	100	59 ± 4	66 ± 12
MRCFE-2	97	49 ± 4	63 ± 10
MRCFE-3	98	52 ± 4	74 ± 12
MRCFE-4	105	61 ± 4	75 ± 19
MRCFE-5	94	49 ± 4	64 ± 11
MRCFE-6	101	51 ± 4	66 ± 10
MRCFE-7	96	51 ± 4	65 ± 8
MRCFE-8	93	49 ± 4	59 ± 9
MRCFE-9	94	50 ± 5	58 ± 10

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(1) Radiation Detection Company (R.D. Co.) TLD totals include their annual natural background contribution of 80 mrem for the reporting period. Average Corvallis area natural background using Radiation Detection Company TLDs totals 86 mrem for the same period.

(2) OSU fence totals include a measured natural background contribution of 45 ± 8 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 R. D. Co. 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	---	37 ± 4	46 ± 7
MRCTE-3	102	43 ± 4	69 ± 11
MRCTE-4	94	72 ± 12	66 ± 9
MRCTE-5L	---	43 ± 4	61 ± 8
MRCTE-6	100	76 ± 16	67 ± 7
MRCTE-7L	---	38 ± 5	63 ± 13
MRCTE-8	106	56 ± 5	69 ± 14
MRCTE-9	102	39 ± 4	61 ± 10
MRCTE-10	92	40 ± 3	54 ± 9
MRCTE-11	92	40 ± 2	50 ± 9
MRCTE-12	102	55 ± 7	66 ± 8
MRCTE-13L	---	50 ± 4	61 ± 7
MRCTE-14L	---	42 ± 3	53 ± 10
MRCTE-15	91	49 ± 5	55 ± 8
MRCTE-16L	---	63 ± 5	66 ± 12
MRCTE-17	92	54 ± 5	52 ± 11
MRCTE-18L	---	62 ± 6	67 ± 15
MRCTE-19	106	59 ± 6	68 ± 10
MRCTE-20L	---	68 ± 13	64 ± 13
MRCTE-21	80	50 ± 5	39 ± 7
MRCTE-22	84	41 ± 4	39 ± 9

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(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 R.D. Co. TLD monitoring pack.

(2) Radiation Detection Company TLD totals include their annual natural background contribution of 80 mrem for the reporting period. Average Corvallis area natural background using Radiation Detection Company TLDs totals 86 mrem for the same period.

(3) OSU off-site totals include a measured natural background contribution of 45 ± 8 mrem.

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

Table V.E.3

Annual Average Concentration of the Total Net Beta Radioactivity (Minus ^{3}H)
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 ^{3}H) Radioactivity(1)	Reporting Units
1-W	Water	4.17E-08 ± 3.22E-08(2)	μCi/cm^3
4-W	Water	3.48E-08 ± 5.83E-09(2)	μCi/cm^3
11-W	Water	3.36E-08 ± 2.9E-09(2)	μCi/cm^3
19-RW	Water	4.20E-08 ± 3.43E-08(2)	μCi/cm^3
3-S	Soil	1.45E-04 ± 1.30E-04	μCi/g of dry soil
5-S	Soil	1.21E-04 ± 1.92E-04	μCi/g of dry soil
20-S	Soil	1.22E-04 ± 9.64E-05	μCi/g of dry soil
21-S	Soil	1.53E-04 ± 1.54E-04	μCi/g of dry soil
2-G	Grass	2.88E-04 ± 4.06E-04	μCi/g of dry ash
6-G	Grass	3.12E-04 ± 4.97E-04	μCi/g of dry ash
7-G	Grass	3.25E-04 ± 5.01E-04	μCi/g of dry ash
8-G	Grass	2.45E-04 ± 3.48E-04	μCi/g of dry ash
9-G	Grass	2.80E-04 ± 3.92E-04	μCi/g of dry ash
10-G	Grass	2.67E-04 ± 4.21E-04	μCi/g of dry ash
12-G	Grass	3.51E-04 ± 4.78E-04	μCi/g of dry ash
13-G	Grass	2.62E-04 ± 3.62E-04	μCi/g of dry ash
14-G	Grass	2.32E-04 ± 2.57E-04	μCi/g of dry ash
15-G	Grass	2.86E-04 ± 3.78E-04	μCi/g of dry ash
16-G	Grass	2.89E-04 ± 4.26E-04	μCi/g of dry ash
17-G	Grass	3.42E-04 ± 5.44E-04	μCi/g of dry ash
18-G	Grass	2.59E-04 ± 3.60E-04	μCi/g of dry ash
22-G	Grass	3.57E-04 ± 5.64E-04	μCi/g of dry ash

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(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	2.49E-05	1.81E-07 *to* 3.46E-05	μCi/gram of dry soil
Water	3.80E-08	3.18E-08 *to* 6.82E-08	μCi/cm^3
Vegetation	2.38E-05	7.37E-06 *to* 4.11E-05	μCi/gram 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	**White I**	**Yellow II**	**Total**
OSU Oceanography Corvallis, OR	1.70×10^{-5}	1	0	4	5
General Atomics San Diego, CA	Empty Package	1	0	0	1
OSU Electrical and Computer Engineering Corvallis, OR	6.27×10^{-7}	1	0	0	1
Berkeley Geochronology Center Berkeley, CA	9.74×10^{-6}	12	0	1	13
University of California Berkeley, CA	3.12×10^{-5}	1	0	2	3
Lawrence Berkeley National Laboratory Berkeley, CA	1.19×10^{-6}	1	0	0	1
Stanford University Stanford, CA	1.98×10^{-6}	6	0	1	7
Idaho State University Pocatello, ID	3.78×10^{-4}	1	3	24	28
University of Washington Seattle, WA	4.95×10^{-7}	2	0	0	2
University of California Santa Barbara, CA	9.02×10^{-7}	2	0	0	2
University of Wyoming Laramie, WY	8.61×10^{-7}	4	0	0	4
Brigham Young Provo, UT	1.17×10^{-6}	2	0	0	2
SUNY-Plattsburgh Plattsburgh, NY	1.37×10^{-6}	3	0	0	3
Columbia University Pallisades, NY	5.29×10^{-5}	1	0	1	2
Union College Schenectady, NY	2.7×10^{-7}	1	0	0	1
TOTALS	4.98×10^{-4}	39	3	33	75

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	**Yellow II**	**Total**

There were no radioactive material shipments originating from the Radiation Center's State of Oregon License ORE 90005 during this reporting period.

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**	**Total**
Vrije Universiteit Amsterdam, The Netherlands	4.11×10^{-7}	0	1	1
Scottish Universities Research and Reactor Centre Scotland, UK	1.69×10^{-6}	0	1	1
University of Geneva Geneva, Switzerland	4.03×10^{-5}	0	2	2
University of Waikato Hamilton, New Zealand	1.86×10^{-6}	1	0	1
University of Queensland Brisbane, Australia	3.98×10^{-5}	0	3	3
FAPIG Research and Reactor Centre Yokosuka, Japan	9.16×10^{-7}	2	0	2
Universite Paris-Sud Paris, France	2.61×10^{-7}	0	1	1
TOTALS	8.52×10^{-5}	3	8	11

Figure V. D. 1

TRIGA Facility and Radiation Center Area Dosimeter Locations

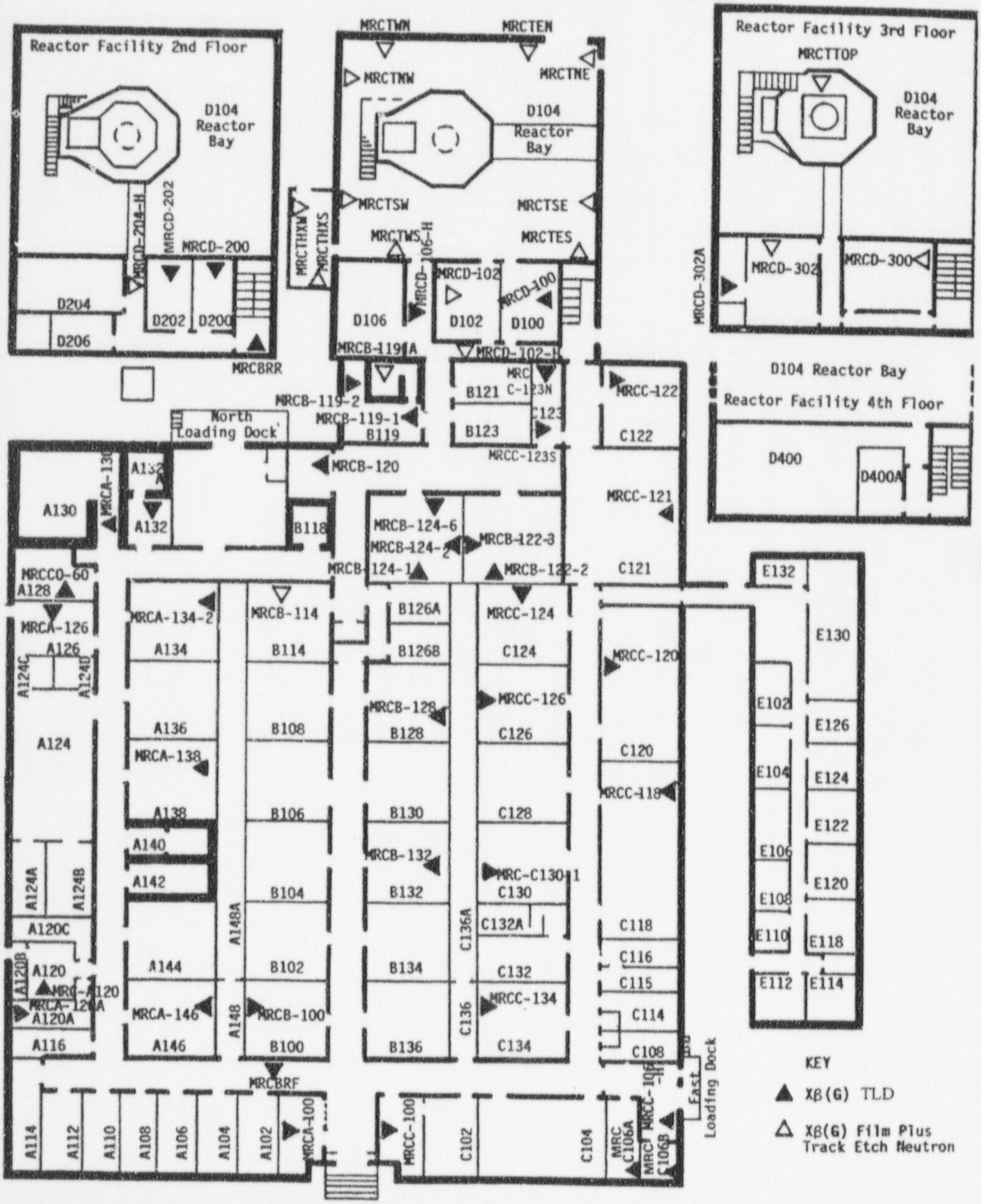


Figure V. E. 1

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

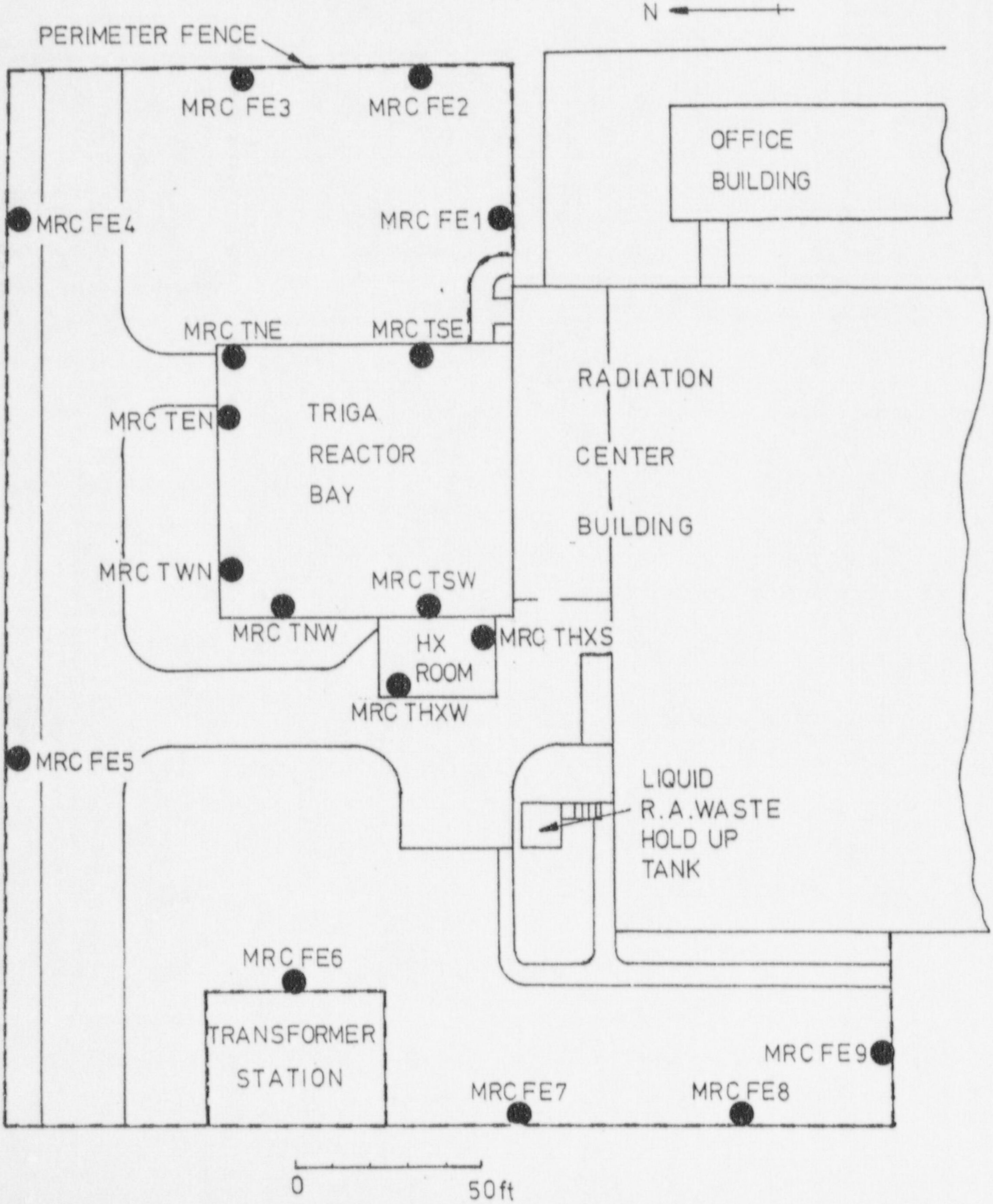
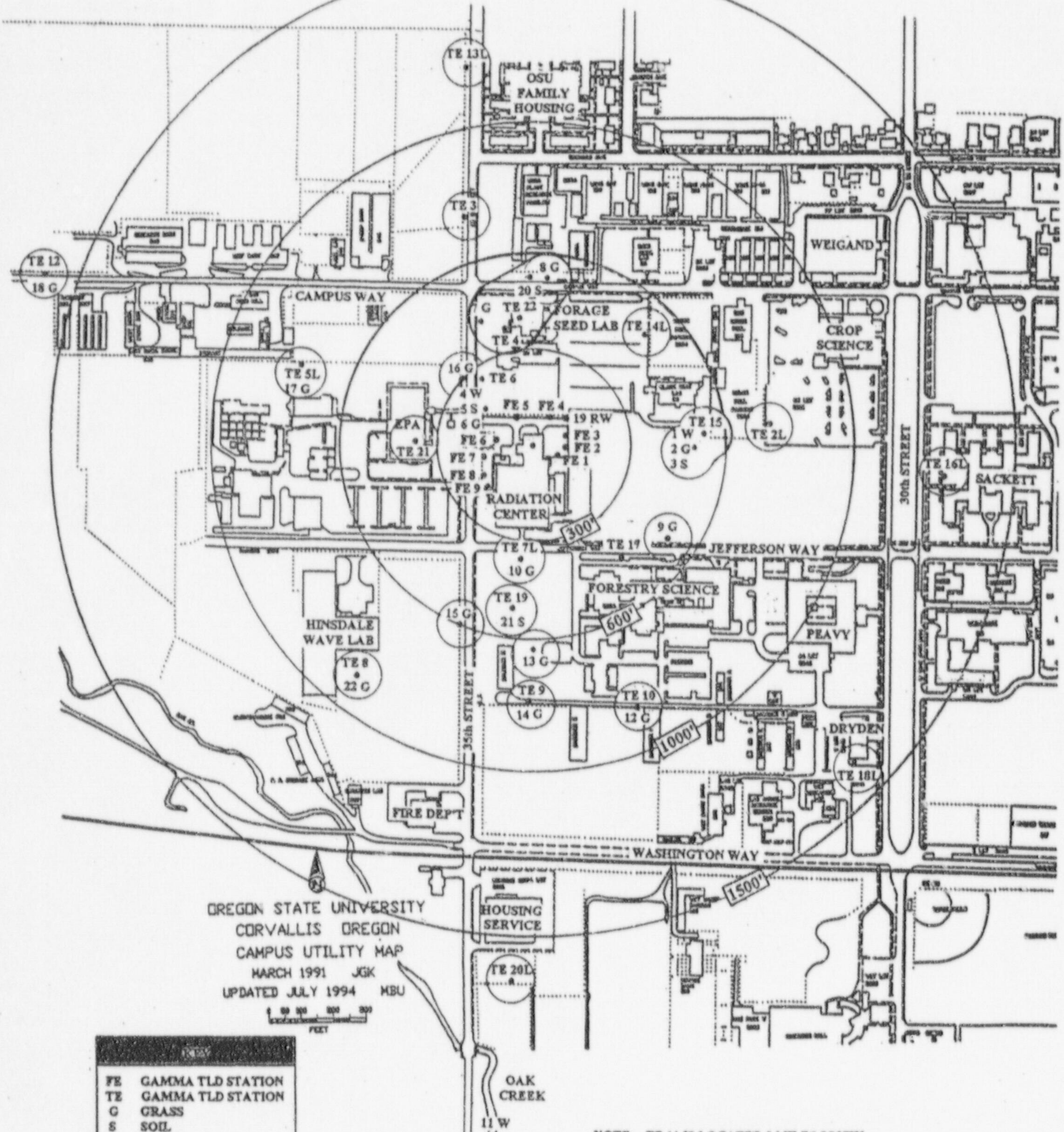


Figure V. E. 2

Monitoring Stations for the OSU TRIGA Reactor



NOTE: TE 11 IS LOCATED 5 MILES SOUTH OF THE RADIATION CENTER AT THE CORVALLIS AIRPORT

Part VI

WORK

Part VI

WORK

A. Summary

The Radiation Center offers a large 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 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 69 OSU academic classes involving a number of different academic departments. In addition, portions of classes from other Oregon universities were also supported by the Radiation Center. The OSU teaching programs (not including research) utilized 1,156 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 system. When a request for facility use is received, a number is assigned to the project, 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, a description of the project, Radiation Center resources needed, the Radiation Center project manager, estimated costs 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. Data reduction of gamma ray spectra by means of a computer then yields the concentrations of 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 activatable 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 for the major, minor, and trace element content in many 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.

In conjunction with the OSU Department of Nuclear Engineering, Radiation Center staff provide ongoing support to the state of Oregon's emergency response plan for the Trojan Nuclear Power Plant. Although the reactor itself is now shut down, Trojan still must have an emergency plan for the fuel kept in the spent fuel storage ponds. About seven persons residing in the Radiation Center hold either primary, second shift or alternate positions in the Trojan Emergency Plan and would work in the Emergency Operations Center in Salem or in the Emergency Operations Facility at Trojan in the event of an incident.

During the past year, Radiation Center personnel attended training sessions, participated in drills and exercises, and provided advice relating to emergency response to a Trojan incident, but no one was required to respond to a real Trojan 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 (IAEA) 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, the HAZMAT Response Teams Radiological Course was taught this year from May 4-7, 1998 at HAMMER, Richland, Washington.

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 spectroscopy 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 and cross-calibrations.

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 detection 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 able to provide consultation services in any of the areas discussed in this annual report, but in particular: 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 consulting functions with various agencies, in addition to sitting on numerous committees in advisory capacities.

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*Oregon State University(1) Corvallis, Oregon	44	12	18	271(2)
U.S. Environmental Protection Agency Corvallis, Oregon	1	NA	NA	1
U. S. Forest Service Corvallis, Oregon	1	NA	NA	1
*Center for the Study of First Americans Corvallis, Oregon	1	NA	NA	1
Good Samaritan Hospital Corvallis, Oregon	1	NA	NA	8
Corvallis Fire Department Corvallis, Oregon	1	NA	NA	8
Oregon Office of Energy Salem, Oregon	1	NA	NA	44
*University of Oregon Eugene, Oregon	3	4	9	3
*Oregon Episcopal School Portland, Oregon	1	1	1	1
*Geovic Ltd. Beaverton, Oregon	1	NA	NA	2
Rogue Community College Grants Pass, Oregon	1	1	1	1
Central Oregon Community College Bend, Oregon	1	1	1	1
Pacific Northwest National Laboratories Richland, Washington	1	1	1	2

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(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, projects conducted by Dr. W. D. Loveland, which involve daily use of Radiation Center facilities.

* Project which involves the OSTR.

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*University of Washington Seattle, Washington	2	3	3	3
*Idaho State University Pocatello, Idaho	6	3	13	13
*Berkeley Geochronology Center Berkeley, California	1	NA	NA	28
*California State University Chico, California	1	1	1	1
*San Jose State University San Jose, California	1	1	2	1
*California State University Northridge, California	1	1	1	1
*Pomona College Claremont, California	1	1	1	1
*Stanford University Stanford, California	4	3	3	8
*University of California Energy Institute Berkeley, California	1	1	1	2
*University of California at Santa Barbara Santa Barbara, California	1	1	5	5
*University of California at Los Angeles Los Angeles, California	1	1	1	1
M.K. Gems and Minerals Stanton, California	1	NA	NA	3
*Montana State University Bozeman, Montana	1	1	2	1
*University of Utah Salt Lake City, Utah	1	1	1	1
*Brigham Young University Provo, Utah	3	2	2	3

* Project which involves the OSTR.

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*University of Wyoming Laramie, Wyoming	2	2	2	5
*Colorado College Colorado Springs, Colorado	3	3	2	3
*University of Colorado Boulder, Colorado	6	1	1	4
*State University of Nebraska Lincoln, Nebraska	1	1	1	1
*University of Arizona Tucson, Arizona	1	1	1	1
*Eastern New Mexico University Portales, New Mexico	1	1	1	1
*New Mexico Tech Socorro, New Mexico	1	1	1	2
*Texas Tech University Lubbock, Texas	3	2	3	3
*Trinity University San Antonio, Texas	1	1	1	1
*University of New Orleans New Orleans, Louisiana	1	1	1	1
*Southern Indiana University Evansville, Indiana	1	1	1	1
*Carlton College Northfield, Minnesota	2	2	4	2
*University of Dayton Dayton, Ohio	1	1	1	1
*Franklin and Marshall College Lancaster, Pennsylvania	1	1	2	1
*State University of New York at Plattsburgh Plattsburgh, New York	1	2	4	2

* Project which involves the OSTR.

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*City College of New York New York, New York	1	1	2	1
*State University of New York at Stonybrook Stonybrook, New York	1	1	1	1
*Columbia University Pallisades, New York	1	1	1	6
*Williams College Williamstown, Massachusetts	1	1	1	1
*Smith College Northampton, Massachusetts	1	1	1	2
*George Washington University Washington, D.C.	1	1	2	1
*North Carolina State University Raleigh, North Carolina	1	1	1	1
*Clemson University Clemson, South Carolina	1	1	1	2
*University of Florida Gainesville, Florida	3	2	2	2
*Union College Schenectady, New York	1	3	4	1
*FAPIG Radiation Research Nagasaka, Yokosuka, Japan	1	NA	NA	2
*Scottish Universities Research and Reactor Centre Glasgow, Scotland, United Kingdom	1	1	15	3
Borealis Technical Limited London, England, United Kingdom	1	NA	NA	5
*Universite Paris-Sud Paris, France	1	NA	NA	1
*University de Pierre et Marie Curie Paris, France	1	1	1	1

* Project which involves the OSTR.

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*Vrije Universiteit Amsterdam Amsterdam, The Netherlands	1	1	1	6
*GEOMAR Geneva, Switzerland	1	NA	NA	1
*University of Geneva Geneva, Switzerland	3	2	5	5
*University of Queensland Brisbane, Queensland, Australia	1	1	1	4
*University of Waikato Hamilton, New Zealand	1	1	1	3
TOTALS	134	81	133	586

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* Project which involves the OSTR.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Brigham Young University				
E Lee Bray	MS	Geology	Nelson	Petrogenesis of the Absaroka Volcanic Supergroup, WY.
Kevin Hae Hae	MS	Geology	Kowallis	Subsidence and Uplift History of the Uinta Basin from Apatite Fission Track Analysis.
Cal. State University, Northridge				
Barbara Chinn	MS	Geological Sciences	Weigand	Detailed Isotopic Modelling of the Origin of Miocene Lavas from the Northern Channel Islands.
City College of New York				
Scott Chesman	PhD	Earth and Env. Sciences	Steiner	Delineation of the Trondjemite-Tonalite-Granite Terrain of Southern New York and Connecticut.
Romana Novack	MS	Earth and Env. Sciences	Steiner	Delineation of the Trondjemite-Tonalite-Granite Terrain of Southern New York and Connecticut.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Columbia University				
Diane McDaniel	PhD	Earth Sciences	Hemming	Assessment of Correlation between Climatic Changes and Differences in Provenance in the Amazon Drainage Basin.
Eastern New Mexico University				
Douglas Anderson	MA	Anthropology	Constantopoulos	X-ray Fluorescence Spectrometry of Narbona Pass Chert: A Chemical Characterization Study.
Idaho State University				
Jason Casper	MS	Geology	Hughes	Geology of Circular Butte Volcano.
Jason Casper	MS	Geology	Hughes	Petrography and Geochemistry of Volcanic Centers near the Test Area North on the INEL.
Dave Clovis	Not Known		Hughes	Student in Geology 615.
John Glover	Not Known		Hughes	Student in Geology 615.
Jay Matarese	Not Known		Hughes	Student in Geology 615.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Kevin McKnight	Not Known		Hughes	Student in Geology 615.
Jennifer Parker	MS	Geology	Hughes	Geochemistry and Stratigraphy of the Tuff of Wooden Shoe Butte.
Scott Serrano	Not Known		Hughes	Student in Geology 615.
Ian Warren	Not Known		Hughes	Student in Geology 615.
Anni Watkins	MS	Geology	Hughes	Not Determined.
Paul Wetmore	MS	Geology	Hughes	Accumulation Rates and Stratigraphy of INEEL Basalts.
Karen Wright	MS	Geology	Hughes	Not Determined.
Montana State University				
Charles Lindsay	MS	Earth Sciences	Feeley	Geochemistry of High-K Lavas and Co-genetic Instrusions from Sepulchur Mountain and Electric Peak, Yellowstone National Park.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
North Carolina State University				
Sonja Ingram	MS	Marine, Earth & At. Sciences	Fodor	Trace Element Distinctions among Plagioclases in Hawaiian Tholeiitic and Alkalic Magmas.
Oregon State University				
Sabooh Asghar	MS	Nuclear Engineering	Reyes	Core Makeup Tank Recirculation, Drainage and Condensation Behavior.
Martin Attfield	Post-Doc.	Chemistry	Sleight	Delta Phase UO3.
Darren Boone	MS	Nuclear Engineering	Higginbotham	Evaluation of Hormetic Effect of Gamma Radiation on Pinto Bean Seeds.
Tom Brannan	MS	Nuclear Engineering	Higginbotham	Evaluation of Radionuclides in Various Sewer Sludge Samples.
Mike Cantaloub	MS	Nuclear/Civil Engineering	Higginbotham	Determination of Non-aqueous Phase Liquid (NAPL) Contamination in Saturated and Unsaturated Aquifer Material using Radon as an Indicator.
Jin Young Choi	PhD	Agricultural Chemistry	Kerkvliet	Undecided.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Sarah Colpo	MS	Nuclear Engineering	Reyes	Counter Current Flow Limitation in the APEX Facility's Pressurizer Surge Line.
Scott Crail	MS	Nuclear Engineering	Higginbotham	Detection of Potentially Contaminated Garbage Entering a City Garbage Disposal Site.
Erica Dearstyne	PhD	Agricultural Chemistry	Kerkvliet	Fate of T Cells in TCDD-Treated Mice: Anergy of Apoptsis?
Bruce Eversmeyer	PhD	Oceanography	Prahl	Suspended Solid Description of Columbia River Particulates.
Phil Gaffkin	PhD	Chemistry Dept	Chen	Use of Gamma Irradiation to Evaluate its Potential for Crosslinking Peptides and Nucleotides.
Sebastian Geiger	PhD	Geosciences	Haggerty	Diffusion in Geologic Materials.
Sebastian Geiger	PhD	Geosciences	Geiger	Fluid Flow in Fractures, Reactive Flow and Coupled Flow Phenomena.
Marish Giri	PhD	Chemical Engineering	Rochefort	Impurities in Plastics.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Sung Mo Kang	MS	Forest Products	Morrell	Fungi Colonization of Douglas Fir Sapwood and their Role in Biological Discoloration.
Janine Katanic	MS	Nuclear Engineering	Higley	RHP 587 Class project: Evaluation of the Hormetic Effect of Radiation on Pinto Bean Seeds.
Young Kim	MS	Civil Engineering	Semprini	Bioremediation of Chloroform Contamination.
Fugen Li	PhD	Food Science	Barnes	Molecular Biology of Cystatin C, a Cystein Protease Inhibitor.
Mark Mankowski	MS	Forest Products	Morrell	Biology of Carpenter Ants in the Pacific Northwest and its Relationship with Fungal Decay in Buildings.
Robert Nartley	PhD	Geosciences	Buckovic	Unknown.
Oleg Povetko	MS	Nuclear Engineering	Higley	Long-Lived Radionuclide Migration through Soils.
Rodney Prell	PhD	Agricultural Chemistry	Kerkvliet	Role of B7 Co-stimulation in TCDD Immunotoxicity.
Mari Rios	MS	Physics	Krane	Neutron Cross Section Measurements of Radioactive Ge-68 and Gd-148.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Carl Ruby	PhD	Agricultural Chemistry	Kerkvliet	Involvement of NFKB in TCDD Immunotoxicity.
Christopher Rusher	MS	Nuclear Engineering	Reyes	Level Swell in a Boiling Pool.
David Shepherd	PhD	Agricultural Chemistry	Kerkvliet	A T-Cell Receptor-Transgenic Model for Immunoticity Testing.
Christopher Sinton	PhD	Oceanography	Duncan	Age and Compostion of Two Large Igneous Provinces: The North Atlantic Volcanic Rifted Margin and the Caribbean Plateau.
Mark Strohecker	MS	Nuclear Engineering	Reyes	Flow Modeling of the APEX Facility's IRWST.
Daniel Strom	MS	Botany/Plant Pathology	Rivin	Clonal Analysis of Maise Meristem.
Beth Vorderstrasse	PhD	Agricultural Chemistry	Kerkvliet	Dendritic Cells: Role in TCDD-Induced Suppression of CTL Activity.
Dan Wachs	MS	Nuclear Engineering	Reyes	Prediction and Modeling of Thermal Stratification in the Cold Legs of the OSU APEX Facility.
Oliver Woodhouse	PhD	Oceanography	Falkner	Osmium Behavior in the Aqueous Marine Environment.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Rockie Yarwood	PhD	Microbiology	Bottomley	2, 4-D Degradation by Soil Micro-organisms.
Li Yoon	MS	Botany/Plant Pathology	Rivin	Clonal Analysis of Maise Meristem.
Lissa Zyromski	PhD	Chemistry	Loveland	Measurement of Fusion Enhancements with neutron-rich Stable and Radioactive Projectiles.
San Jose State University				
Laura Parent	MS	Geology	DeBari	Petrologic and Structural Evolution of the Cardinal Peak Pluton.
Scottish Univ. Res. & Rx Centre				
T. Barry	PhD	Leicester University	Pringle	Mongolian Basalts/Tectonics
J. Blecher	PhD	Oxford University	Pringle	Aden Volcanic Differentiation.
S. Carn	PhD	Cambridge University	Pringle	Indonesian Volcanics.
L. Chambers	PhD	Edinburgh University	Pringle	North Atlantic Tertiary Province.
H. Dixon	PhD	Bristol University	Pringle	Subglacial Volcanics.

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Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
C. Harford	PhD	Bristol University	Pringle	Montserrat Volcanic Hazards.
E. Heath	PhD	Lancaster University	Pringle	St. Vincent Volcano Hazards.
G. May	PhD	Aberdeen University	Pringle	Chilean Basins.
S. McElderry	PhD	Liverpool University	Pringle	Chilean Tertiary Faulting.
Y. Najman	PhD	Edinburgh University	Pringle	Himalayan Foredeep.
M. Purvis	PhD	Edinburgh University	Pringle	Turkish Basin Tectonics.
R. Shelton	PhD	Queens University	Pringle	North Channel Basin Evolution.
A. Sowerbutts	PhD	Edinburgh University	Pringle	Sardinia Evolution.
G. Steele	PhD	Aberdeen University	Pringle	Cerro Rico Silver.
R. White	PhD	Leicester University	Pringle	Caribean Crustal Growth.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Stanford University				
Daniel Stockli	PhD	Geological & Env. Sciences	Dumitru	Timing of Extensional Faulting in the Northern Basin and Range Province, and the Structured and Thermal Transition to the Central Sierra Nevada.
Benjamin Surpless	PhD	Geological & Env. Sciences	Miller	Geological Evolution of the Sierra Nevada - Basin and Range Transition Zone.
Da Zhou	PhD	Geological & Env. Sciences	Dumitru	Amalgamation and Uplift History of the Tian Shan, Western China.
SUNY at Stony Brook				
Troy Rasbury	PhD	Earth and Space Sciences	Hanson	Use of Fission Track Dating of Various Authigenic Calcite and Phosphate Minerals to Determine the Time of Sedimentation with a View to Calibrating the Geologic Record.
Texas Tech University				
Melissa Batum	MS	Geosciences	Barnes	Comparison of Granites Across a Proterozoic-Archean Boundary.

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Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Mi-ae Jeon	MS	Geosciences	Barnes	Elemental and Isotopic Exchange in Granite During Metamorphism.
Sang-yun Lee	PhD	Geosciences	Barnes	Granite Petrogenesis and Core Complex Formation, Ruby Mtns. NV.
The University of Waikato				
Ming Hung Ho	Ph.D.	Earth Sciences	Kamp	Thermo-tectonic History of Marlborough, New Zealand.
U.C. Berkeley				
Chad Cole	MS	Nuclear Engineering	Olander	Evaluation of Processess to Determine the Amount of Uranium in Mixed Waste.
UCLA				
Amy Young	PhD	Earth and Space Sciences	Davidson	Petrogeneis, Stratigraphy and Origin of Damavand Volcano, Iran.
Union College				
Mike Bullen	BSc	Geology	Garver	Provenance of the Ukelayet Flysch, Kamchatka, Russia.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
Jorge Mora	PhD	Env. Sciences, SUNY, Albany	Garver	Uplift and Evolution of the Venezeulan Andes.
Univ. of California, Santa Barbara				
Andy Calvert	PhD	Geological Sciences	Gans	Tectonic Studies in Eastern-Most Russia.
Jon Nauert	MS	Geological Sciences	Gans	Volcanism in the Eldorado Mountains, Southern Nevada.
Jaime Toro	Not Known	Geological Sciences	Gans	Cretaceous and Tertiary History of Alaska's Brooks Range and Russia's Chukotka Peninsula.
University of Colorado-Boulder				
Philip Verplank	PhD	CIRES	Farmer	Geochemistry of the Organ Needle Pluton in South-central New Mexico.
University of Florida				
Ann Heatherington	Post-Doc.	Geology	Mueller	Crustal Evolution Along the Western Boundary of the Wyoming Crater.
Stephanie Jenkins	MS	Geology	Mueller	Age and Origin of the Albermarle Group, Carolina State Belt.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
University of Geneva				
Mercedes Hernandez	PhD	Mineralogy	Singer	Petrology and Geochronology of the Catalan Coastal Ranges Batholith, NE Spain.
Robert Marschick	PhD	Mineralogy	Singer	Cretaceous Cu (-Fe) Mineralization in the Punta del Cobre Belt, Northern Chile.
Osman Parlak	PhD	Mineralogy	Singer	Geochemistry and Geochronology of the Merson Ophiolite within the Eastern Mediterranean Tectonic Frame.
Thao Ton-That	MS	Mineralogy	Singer	Ar-40/Ar-39 Dating of Basaltic Lava Flows and the Geology of the Lago Buenos Aires Region, Santa Cruz Province, Argentina.
Yann Vincze	MS	Mineralogy	Singer	Ar-40/Ar-39 Incremental Heating Studies of Latest Pleistocene and Holocene Lava and Tephra: Implications for the Last Glaciation in the Southern Andes.
University of New Orleans				
Judy Wilson	MS	Geology & Geophysics	Johnson	Volcanic Hazards in the Cascade Range.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
University of Oregon				
Jacqui Coll	Post Doc.	Pharmacy	Ayres	Trace Metals in Drug Suspension.
Christopher Descantes	PhD	Anthropology	Ayres	Archeological Study of Yap, Micronesia.
Scott Fitzpatrick	PhD	Anthropology	Ayres	Stone Tool Materials and Sources on Easter Island.
Roland Goodgame	Not Known		Reed	Characterization of Alteration and Mineralization in Komatiite.
Katie Rorrer	MA	Anthropology	Ayres	Pacific Archeology.
Epi Suafo'a	MA	Anthropology	Ayres	Pacific Archeology.
Stephen Twyerould	PhD	Geological Sciences	Reed	The Geology and Genesis of the Ernest Henry Fe-oxide, Cu-Au deposit, Queensland Australia.
Helen Vallianatos	PhD	Anthropology	Goles	Paleodietary Reconstruction and Effects of Diagenesis.
Joan Wozniak	PhD	Anthropology	Ayres	Easter Island Archeological Settlement and Early Agriculture.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Thesis Topic
University of Washington				
Scott Barboza	PhD	Geological Sciences	Bergantz	The Dynamics of Dehydration Melting.
Kyle Bland	MS	Geological Sciences	Bergantz	The Generation of Hybridized Magmas.
Rebecca Chrisfield	MS	Geological Sciences	Stewart	History of Faulting and Uplift of the Coast Ranges of Oregon and Washington.
University of Wyoming				
Bradford Burton	PhD	Geology/Geophysics	Murphy	Structural and Thermal History of Harrison Pass Pluton, NV.
Thomas Kalakay	PhD	Geology/Geophysics	Murphy	Structural and Themal History of Pioneer Batholith, MT.

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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.	Geophysics, U 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.	Oceanography, OSU
480	Higginbotham	Oregon State University	Technical Support to the State of Oregon	Technical support to Oregon DOE and the Department of Human Resources to assist in emergency preparedness for the PGE-Trojan facility.	Radiation Center, OSU
481	Winans	Oregon Health Sciences Univ.	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.	Radiation Center, OSU

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REE = Rare Earth Elements

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
519	Livingstone	U.S. EPA	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	EPA - Newport	Survey Instrument Calibration	Calibration of GM and other portable survey meters as per standard OSU protocol.	USEPA, Cincinnati, OH
554	Niles	Oregon Office of Energy	Instrument Calibration	Instrument calibration of survey meters for PUC truck inspectors.	Oregon Department of Transportation
632	Thompson	Oregon State Police Crime Lab.	Radiological Instrument Calibration	Calibration of radiological instruments used at the OSP Crime Laboratory	Oregon State Crime Laboratory
664	Higginbotham	Oregon State University	Instrument Calibration	Calibration of radiation survey instruments.	Radiation Center, OSU
665	Higginbotham	Oregon State University	Instrument Calibration	Calibration of radiation survey instruments.	Radiation Center, OSU

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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
711	Mattson	Oregon State University	Diagnostic Biology	Sterilization of bovine blood serum in the Co-60 irradiator.	Vet. Med. Diagnostic Laboratory, OSU
745	Wiggs	Oregon Health Sciences Univ.	Gamma Sterilization of Various Materials	Irradiation of various medicinals using the Co-60 irradiator to OHSU-specified doses for purposes of sterilization.	Oregon Health Sciences University
752	Barnes	Oregon State University	Schistoma Cell Culture	Feeder layer irradiations to 2.5 krad. Gamma irradiation of hamsters and other laboratory animals.	OSU Biochemistry & Biophysics
815	Morrell	Oregon State University	Sterilization of Wood Samples	Sterilization of wood samples to 2.5 Mrads in Co-60 irradiator for fungal evaluations.	Forest Products, OSU
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.	Geophysics, Stanford University

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
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.	Agriculture Chemistry, OSU
932	Dumitru	Stanford University	Fission Track Dating	Thermal column irradiation of geological samples for fission track age-dating.	Geology, Stanford University
995	Bottomley	Oregon State University	Herbicide Mineralization in Agricultural Soils	Soil sterilization in the Co-60 irradiator.	Crop & Soil Science, OSU
1002	Singer	University of Geneva	Ar-40/Ar-39 Dating of Young Geological Materials	CLICIT irradiation of geological materials such as volcanic rocks from sea floor, etc. for Ar-40/Ar-39 dating.	University of Geneva
1018	Gashwiler	Occupational Health Lab	Calibration of Nuclear Instruments	Calibrate radiation survey meters.	Occupational Health Laboratory
1020	Gans	Univ. of California, 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
1025	Semprini	Oregon State University	Sterilization of Subsurface Soil	Soil sterilization in order to investigate the bioremediation of chloroform contamination.	Civil Engineering, OSU

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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 Univ. Res. & Rx Centre	Argon 40/39 Dating of Rock Minerals	Age dating of various materials using the Ar-40/Ar-39 ratio method.	Scottish Univ. Research & Reactor Centre
1074	Wijbrans	Faculty of Earth Sciences	40Ar-39 Ar Dating of Rocks and Minerals	40Ar-39Ar dating of rocks and minerals.	Vrije Universiteit, Amsterdam
1075	Lederer	Univ. of California Energy Institute	Activation Analysis Experiment for NE Class	Irradiation of small, stainless steel discs for use in a nuclear engineering radiation measurements laboratory.	UC Berkeley
1097	Loveland	Oregon State University	Speciation of Pu in the Aquatic Environment	Measurement of the chemical speciation of Pu in fresh water.	Chemisty, OSU
1098	Loveland	Oregon State University	Fusion Enhancement with n-rich Projectiles	Measurement of fusion enhancements with n-rich stable and radioactive projectiles.	Chemisty, OSU
1109	Prahl	Oregon State University	Suspended Solid Description of Columbia River Particulates	Evaluation of the form, sources and fates of suspended Columbia River particulate materials.	Geosciences, OSU

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
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 using C-14 and liquid scintilation counting.	Forest Resources, OSU
1120	Rivin	Oregon State University	Clonal Analysis of Maise Meristem	Testing to determine if an isolated mutated gene is required for past embryonic meristem formation or function.	Botany, OSU
1125	Streck	University of Geneva	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 Res. Lab.	Kyoto Fission Track Age Dating	Irradiation of samples in the thermal column for fission track age dating.	FAPIG Radiation Research Lab., Japan
1129	Hughes	Idaho State University	Chemical Characterization of Vitrification Products	Evaluation of high level radioactive waste melter performance by determination of the degree of homogenization, the diffusion rates and the number and types of phases remaining after vitrification.	INEL University Consortium (MIT)

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1138	Hughes	Idaho State University	Thesis and Faculty Research Using INAA of Geologic Materials	Use of INAA to support a large variety of research projects involving the geochemistry of rocks in Idaho and surrounding regions. This includes support for two graduate classes Geology 615 and 625.	USDOE (Reactor Use Sharing)
1161	Reed	University of Oregon	Characterization of Alteration and Mineralization in Komatiite	Characterization of komatiites from Australia for rare earth element and platinum group element abundances to evaluate their economic mineral resource potential.	USDOE (Reactor Use Sharing)
1177	Garver	Union College	Fission Track Analysis of Rock Ages	Use of thermal column irradiations to perform fission track analysis with a view to the determination or rock ages.	Union College, NY
1178	Hughes	Idaho State University	Ar/Ar Radiometric Dating of Geological Samples	Investigation of the evolution of the Snake River Plain volcanic system.	National Science Foundation (EPSCoR)
1185	Elting	University of Oregon	Instrument Calibration	Radiological instrument calibration for the Environmental Health and Safety Office	University of Oregon

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1186	Fitzgerald	University of Arizona	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 on semiconductors, and gallium arsenide in particular. The project starts with gamma irradiation and progresses to alpha, beta and neutrons later.	Radiation Center, OSU
1188	Salinas	Rogue Community College	Photoplankton Growth in Southern Oregon Lakes	Liquid scintillation counting of C-14 radiotracer samples produced in a photoplankton study of four southern Oregon lakes: Miller Lake, Lake of the Woods, Diamond Lake, and Waldo Lake.	Rogue Community College
1190	Higginbotham	Oregon State University	Use of Radon as a Tracer for NAPL Determination	Determination of non-aqueous phase liquid (NAPL) contamination in saturated and unsaturated aquifer material using radon as an indicator.	Radiation Center, OSU
1191	Vasconcelos	Department of Earth Sciences	Ar-39/Ar-40 Age Dating	Production of Ar-39 from K-39 to determine ages in various anthropologic and geologic materials.	Earth Sci., University of Queensland, Australia

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1192	Higginbotham	Oregon State University	Evaluation of Radionuclides in Sewer Sludge	Analysis of several samples of sewer sludge to determine the types and quantities of any radionuclides present.	Radiation Center, OSU
1193	Smith	Oregon State University	Irradiation of Viruses	Inactivation of viruses by gamma ray irradiation.	Food Sci. & Technology, OSU
1196	Higley	Oregon State University	Dose Response Effects on Bean Seeds	Evaluation of the possible hormetic effects in irradiated pinto bean seeds. Class project associated with RHP 587.	Radiation Center, OSU
1200	Moody	Bechtel Hanford Incorporated	Stabilization of 90Sr and 100 Area Cr(6+) Using Phosphatic Material	Geochemical study of desorption of strontium and chromium from Hanford soils, adsorption of Sr and Cr on various phosphates, and the determination of the solubility product of strontium hydroxyapatites.	CH2M Hill
1201	Hanson	SUNY at Stony Brook	High Precision Dating of Sedimentary Material	Use of fission track dating of various authigenic calcite and phosphate minerals to determine the time of sedimentation with a view to calibrating the geologic record.	USDOE

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1203	Aulich	Energy & Env. Research Center	Plastics Pyrolysis	Determination of Cs, Sb, Sn, V, Cu, Ti, Sr, Ce and Zr at the ppb level in process matrices of oil, resin and char to evaluate the ability of the process to remove these elements.	Radiation Center, OSU
1205	Kelley	The Open University	Argon-39/Argon-40 Age Dating of Minerals	Determination of the ages of various minerals by use of the argon-39/argon-40 ratio technique.	The Open University, UK
1206	Hughes	Idaho State University	Chemical Correlation of Volcanic Units on INEEL	NAA of basaltic rocks obtained from drill core and surface locations to evaluate the local and regional stratigraphy beneath various facilities on the INEEL to determine the geometry of the aquifer system.	Idaho Water Resources Research Inst.
1209	Scholle	London Coin Galleries	Authenticity of Medieval Silver Coins	Use of NAA to evaluate 5-6 Romanian medieval silver coins in an attempt to compare authentic coins to some with questioned authenticity.	London Coin Galleries
1215	Brinkly	Emerald Diagnostics Laboratory	Sterilization of Latex Solutions	Irradiation of latex solutions in order to sterilize the material for biological research products.	Emerald Diagnostics Laboratory

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1225	Roden-Tice	SUNY College at Plattsburgh	Fission Track Analysis of Apatite and Zircon	Analysis of the thermal history of Triassic basins in Connecticut using fission track age dating methods.	Radiation Center, OSU
1229	Binney	Oregon State University	Production of Copper-67	Investigation of the feasibility of the production of the medical isotope Cu67 from enriched Zn67 by using the n-p reaction and a medium power research reactor.	Nuclear Engineering Dept., OSU
1230	Lamperti	City of Corvallis	Analysis of Industrial Effluent	Sampling and counting of effluent from local industries in order to determine the presence and magnitude of any radionuclides.	Radiation Center, OSU
1231	Adams	University of Utah	Rare Earth Elements in the Coso Geothermal System	Evaluation of REEs in water as a method of differentiating the various reservoirs in the Coso system geothermal field.	USDOE (Reactor Use Sharing)
1232	Bergantz	University of Washington	Chemical evolution of the lower crust	Evaluation of the mechanics involved with the growth of the continental crust and the origin of chemical diversity in volcanic rocks.	USDOE (Reactor Use Sharing)

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1236	Farmer	University of Colorado-Boulder	Geochemistry of the Organ Needle Pluton, New Mexico	Identification of the processes responsible for the generation of silicic magma using samples from the Organ Needle pluton in south-central New Mexico.	USDOE (Reactor Use Sharing)
1237	Mueller	University of Florida	Early Crustal Evolution	Evaluation of ancient crustal components with unusual Nd isotopic compositions to better constrain the origin of these segments.	USDOE (Reactor Use Sharing)
1238	Roden-Tice	SUNY College at Plattsburgh	Fission Track Analysis of Apatite and Zircon	Use of fission track dating to analyze thermal histories of various mountains, including: Olympic Moutains, WA; Adirondack Mountains, NY; Ouachita Mountains, Himalayas; Klamath Mountains, OR.	USDOE (Reactor Use Sharing)
1239	Garver	Union College	Timing of Uplift and Provenance of Sediments from Orogenic Highlands	Use of fission track analysis to determine the timing of uplift and the provenance of sediments shed from orogenic highlands.	USDOE (Reactor Use Sharing)

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1240	Hirt	College of the Siskiyous	Vertical Zonation of the Paradise Pluton, Sierra Nevada, CA	Development of a compositional profile for the upper part of the SE Sierra batholith in the region between Golden Trout Creek and Forester Pass.	USDOE (Reactor Use Sharing)
1241	Steiner	City College of New York	Delineation of TTG Terrain of Southern New York & Connecticut	Delineation of trondhjemite-tonalite-granite terrain to resolve the problem of source rock and the timing of major prograde metamorphic events.	USDOE (Reactor Use Sharing)
1243	McBirney	University of Oregon	Differentiation of the Skaergaard Intrusion	Completion of the most thorough investigation of magmatic differentiation ever completed.	USDOE (Reactor Use Sharing)
1244	Reed	University of Oregon	Geology and Genesis of the Ernest Henry Deposit, Queensland, Australia	Determination of the gains and losses of trace elements due to ore formation in the Ernest Henry Fe-Cu-Au deposit.	USDOE (Reactor Use Sharing)
1247	Johnson	Texas Tech. University	Genesis of Pre-Accretion Plutons in the Blue Mtns, OR	Determination of the process responsible for magma generation in order to provide important tectonic constraints on the development of the Blue Mountains province of the North American Cordillera.	USDOE (Reactor Use Sharing)

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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
1253	Feeley	Montana State University	Petrogenesis of Back-Arc Basaltic Lavas from St. Paul Is., AK	Examination and modeling of variations in rare earth element concentrations of Quarternary alkali olivine basaltic lavas erupted on St. Paul Island, Alaska to understand their significance with respect to the arc front volcanic rocks.	USDOE (Reactor Use Sharing)
1255	Hughes	Idaho State University	Neutron Activation Analysis of Geologic Materials	INAA for geologic materials for various projects and for two ISU classes - Geology 615: Neutron Activation Analysis and Geology 625: Quantitative Geochemical Laboratory.	USDOE (Reactor Use Sharing)
1256	McGrew	University of Dayton	Granitoid Petrogenesis in an Extensional Tectonic Regime	Use of INAA to compare the elemental compositions of two suites of monzogranites from the East Humboldt Range and the Ruby Mountains, Nevada in order to evaluate the Precambrian basement rocks in the region.	USDOE (Reactor Use Sharing)
1262	Goles	University of Oregon	Diagenetic and Dietary Reconstruction of Skeletal Material	Determination of the degree of diagenetic alteration in skeletal material from North India to assess its dietary signature.	USDOE (Reactor Use Sharing)

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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
1263	Murphy	University of Wyoming	Apatite Thermochronology	Fission track age dating of various geologic samples to determine their thermal and volcanic history.	USDOE (Reactor Use Sharing)
1264	Ayres	University of Oregon	Easter Island Stone Quarry Project	Examination of flake debris from tool manufacture on Easter Island to help define the level of variability in stone used for tools around the island. This will help interpret prehistoric stone resource use by competing social groups.	USDOE (Reactor Use Sharing)
1265	Constantopoulos	Eastern New Mexico University	Chemical Characterization Study of Narbona Pass Chert	Analysis of chert from Narbona Pass, northwest NM to characterize artifacts from the prehistoric Anasazi culture to assess the accuracy of previous artifact source area frequency distributions.	USDOE (Reactor Use Sharing)
1266	DeBari	San Jose State University	Cardinal Peak Pluton	Determination of the petrologic and structural events that created the Cardinal Peak pluton, by evaluating the geochemical differences between the pluton and other rock bodies.	USDOE (Reactor Use Sharing)

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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	Three sub-projects: (i) Sanidine phenocrysts from the Snake river plain to evaluate volcanic stratigraphy. (ii) Sandine and biotite phenocrysts from a late Miocene ash, Mallorca to more accurately constrain the stratigraphic horizon (iii) Hornblends and feldspar from the Amazon to assess climatic changes and differences in Amazon drainage basin provenance.	Columbia University
1268	Olsen	Johns Hopkins University	Metasedimentary Inclusions in Lauterbrunnen Migmatites	Modeling of the intrusion-assimilation process of the grantie matrix in Lauterbrunnen migmatites.	USDOE (Reactor Use Sharing)
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.	Radiation Center, OSU
1274	Torres	Oregon State University	Analysis of Baryte from a Hydrothermal Vent Offshore Peru	Determination of the trace element content with emphasis on thorium, uranium, and the REEs in baryte that was precipitated from a hydrothermal fluid.	Radiation Center, OSU

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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
1275	Zhang	Oregon State University	Investigation of Stable Isotopes in Butte, Montana	Chemical investigation of altered Butte quartz-monazite to determine changes caused by rock/fluid interactions.	Radiation Center, OSU
1280	Higginbotham	Oregon State University	Radiation Hormesis Study	Irradiation of a large number of pinto beans to determine if there is a hormetic effect of gamma radiation, and to evaluate its magnitude.	Radiation Center, OSU
1282	Farmer	University of Colorado-Boulder	INAA of Basalt from the southern Sierra Nevada, California	Determination of minor and trace elements in basalts from the Golden Trout Volcanic Field and the Kern Plateau Volcanic Field in order to study the petrogenesis and origin of the magma.	University of Colorado
1283	Jovanovich	Oregon State University	Geochemical Study on the Sorption of Sr-90 on Resin Spherules	Determination of the distribution of Sr-90 between ground water and polymeric resins in injection and extraction well remediation methods.	Radiation Center, OSU
1284	Baham	Oregon State University	Determination of Trace Elements in Mn Concretions	Analysis of Mn concretions from Willamette Valley soils to determine the abundance of transition metals and rare earth elements in order to constrain the geochemical behavior of these elements.	Radiation Center, OSU

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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
1286	Lamperti	City of Corvallis	Corvallis Disposal Leachate Evaluation	Analysis of leachate from the Corvallis Disposal Company Coffin Butte Landfill to evaluate the presence of uranium.	Radiation Center, OSU
1287	Barnes	Texas Tech University	Evaluation of Plutonic Processes	Determination of the petrogenesis of tertiary and cretaceous granites from Ruby Mountains, NV.	NSF Collaborative Research Project
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
1289	Braman	Horst Company Yakima, Inc.	Determination of Radioactivity of Hops Extract	Environmental level counting to determine the abundance of naturally occurring radionuclides in hops extract from Eastern Washington for regulatory purposes.	Horst Co., Yakima Inc.
1290	Kahn	M. K. Gems and Minerals	Mineral Irradiations	Irradiations of various minerals to evaluate colorization effects.	M. K. Gems & Minerals
1292	Falkner	Oregon State University	Production of Os-191 for Use as a Tracer	Production of Os-191 for use as a tracer to complete methods developments for examining Os behavior in the aqueous marine environment.	Oceanography Dept., OSU

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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
1295	Ayres	University of Oregon	Trace Metals in Drug Suspension	Determination of the trace metal concentration of transition metals in milligram amounts of aqueous samples. INAA is preferred because of its ultrasensitive detection limits and the low concentrations expected.	College of Pharmacy, Oregon State University
1297	Bonnichsen	Center - Study of First Americans	Study of Human Origins in North America	Determination of trace elements in modern and ancient hair samples to determine the age , paleodietary information, and diagenetic alteration of archeological hair samples using INAA, DNA sequencing and radiocarbon dating techniques. The project is a joint venture between the Department of Anthropology, Microbiology, Soil Sciences, Center for the Study of First Americans, and the Radiation Center.	Radiation Center, OSU
1298	Binney	Oregon State University	Production of Cu-67	Exploratory study to evaluate an (n,p) reaction as an alternate means of production of Cu-67. This is an important radionuclide used in the medical field as a radiotracer. Currently the production is limited to accelerator techniques.	Radiation Center, OSU

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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
1299	Sleight	Oregon State University	Synthesis of Delta Phase UO3	Use of Radiation Center facilities in order to produce delta phase UO3.	Radiation Center, OSU
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.
1301	Norman	New Mexico Tech	Trace Element Analysis of Gold	Characterization of the trace element composition of native gold specimens	New Mexico Tech./Radiation Center, OSU
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
1303	Krane	Oregon State University	Impurities in Titanium	Determination of impurities in Ti-44 to correct for positron annihilation contributions to the 511 keV peak.	Physics Dept., OSU
1304	Kaminski	Private Citizen	Instrument Repair and Calibration	Repair and calibration of an old civil defense instrument which is apparently giving anomalous readings.	Radiation Center, OSU

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1305	Binney	Oregon State University	Ar-41 Production for APEX	Dynamic determination of the translocation of non-condensable gases throughout the APEX facility during a variety of operational tests	US Nuclear Regulatory Commission
1306	Duncan	Oregon State University	Determination of Trace and Rare Earth Elements in Limestone	Accurate determination of the rare earth and trace element abundance in limestone in order to compare the results to regular ICP-MS analysis.	Radiation Center, OSU
1307	Krane	Oregon State University	Analysis of Lunar Soil	Determination of the chemical composition of lunar soil by INAA as part of an educational experience in the SMILE program.	Radiation Center, OSU
1308	Bennion	Idaho State University	Transfer of AGN-201 Fueled Control Rods	Evaluation of methodology for and actual transfer of four AGN-201 control rods. Three of these are fueled rods.	Idaho State University
1309	Higley	Oregon State University	Radiation Effects Study	Irradiation of bean seeds to various doses in order to study radiation effects as part of the Science and Math Investigative Learning Experience (SMILE) Program at OSU.	SMILE Program, OSU

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1310	Schutfort	Oregon State University	Investigations of Materials	INAA of various materials which may be used in sample encapsulations to evaluate their suitability with respect to neutron activation.	Radiation Center, OSU
1312	Nagle	US Forest Service	Soil Horizon Studies	Analysis of excess Pb-210 in soils to determine whether some deeply buried soil horizons near Pendleton were actually on the surface as recently as 100-150 years ago and were covered by eroded material after cultivation of the surrounding hillsides began in the late 19th century.	U.S. Forest Service
1313	Brady	Smith College	Archean Metamorphic Rocks of the Tobacco Root Mtns.	Investigation to unravel the complex tectonic, magmatic, and metamorphic history of the Tobacco Root Mountains on the western edge of the Wyoming Province.	Keck Geology Consortium
1314	Mertzman	Franklin & Marshall College	Petrochemistry of Miocene to Holocene Volcanic Rocks	Characterization of Miocene to Holocene volcanic rocks from less prominent volcanic centers in the southern Cascade range near Keno, OR to aid in the understanding of the evolution of the Cascade arc system.	Keck Geology Consortium

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1315	Noblett	Colorado College	Magma Mingling in a Proterozoic Meta-Volcanic Sequence	Analysis of carefully selected portions of rocks from the Howard region of Colorado to determine how much chemical re-distribution of elements occuured during magma mingling; as well as which elements behaved linearly during this process.	Keck Geology Consortium
1316	Haileab	Carleton College	Miocene to Holocene Volcanism in the Southern Cascades	Analysis of field, petrographic, whole rock geochemical and K-Ar age data to answer large scale questions of how the Cascade volcanic arc in southern Oregon evolved petrologically as a function of geological time.	Keck Geology Consortium
1317	Hazlett	Pomona College	Precambrian Metamorphosed Mafic Dikes	Investigation of the origin and petrogenesis of a suite of moderately metamorphosed basaltic dikes which intrude the Spuhler Peak and related formations in the Tobacco Root Mountains of SW Montana.	Keck Geology Consortium
1318	Wobus	Williams College	Geochemistry of Early Proterozoic Bimodal Metavolcanic Rocks	Definition of a thick, previously undescribed section of Early Proterozoic metavolcanic rocks from the Arkansas River Canyon in an attempt to determine the tectonic setting of the volcanic sources.	Keck Geology Consortium

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1319	Boardman	Carleton College	Early Proterozoic Terranes in Central Colorado	Determination of the eastern limit of the well-preserved, metamorphosed, bimodal volcanic terrane in the Gunnison-Salida area of central Colorado.	Keck Geology Consortium
1320	Siddoway	Colorado College	Petrology of Proterozoic Rocks Near Texas Creek, CO	Determination of the geochemistry of volcanic units and sediments from the Arkansas River Canyon near Texas Creek, CO to identify the most likely tectonic setting.	Keck Geology Consortium
1321	Forsberg	Oregon State University	A Molecular Approach to Enhance Muscle Protein Accretion	Study of the process of apoptosis (cell death) and the proteases involved in the repair of skeletal muscle proteins.	Animal Science, OSU
1322	Warner	Clemson University	Geochemistry of Two Ultramafic Bodies in the S. Appalachians	Determination of the compositional rare earth and other trace elements in the Buck Creek and Webster-Addie ultramafic bodies in the Southern Appalachians to supplement detailed petrographic studies and help constrain theories for the origin of these bodies.	USDOE (Reactor Use Sharing)

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1323	Roden-Tice	SUNY College at Plattsburgh	Fission Track Reseach in Several Geological Areas	Determination of the thermal exhumation histories of: the Triassic basins of CT and MA,; the Adirondack Mtns., NY and estimation of regional strain of Northern Walker Lane, NV using fission track analysis.	USDOE (Reactor Use Sharing)
1324	Mueller	University of Florida	Proterozoic Crustal Evolution	Examination of the distribution of Proterozoic crust in the Rocky Mountains of Montana and in the Appalachians by geochemical and geochronologic studies of young granitoids and silicic volcanic rocks.	USDOE (Reactor Use Sharing)
1325	Weigand	Cal. State University, Northridge	Origin of Miocene Volcanic Rocks from the CA Channel Islands	Determination of the isotopic composition of lavas from several of the California Channel Islands in order to better characterize the composition of the mantle source and of the crustal contaminant.	USDOE (Reactor Use Sharing)
1326	Tollo	George Washington University	Petrology of Grenville-Age Charnockites, Blue Ridge Provice, VA	Formulation of a rigorous geological model of magmatic activity and metamorphism associated with Grenville orogenesis in the Blue Ridge province of the central Appalachians.	USDOE (Reactor Use Sharing)

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1327	Barnes	Texas Tech University	Granite Petrogenesis in the Ruby Mtn. Area, Nevada	Development of an understanding of the relationship between tectonism and granitic magmatism in a metamorphic core complex. In particular, to show that the Late Cretaceous granites in the Lamoille Canyon area were derived from deep-seated crustal source rocks whereas middle Tertiary granites were derived from sources at shallower levels.	National Science Foundation
1328	Hughes	Idaho State University	Neutron Activation Analysis of Geologic Materials	INAA of a variety of geologic materials for use in graduate courses in activation analysis and quantitative geochemistry.	USDOE (Reactor Use Sharing)
1329	Davidson	UCLA	Trace Element Distribution Coefficients in Rocks from Irano, Iran	Determination of trace element concentrations in mineral phases from rocks collected from Damavand Volcano in Iran to model magma differentiation processes.	USDOE (Reactor Use Sharing)
1330	Garver	Union College	Fission Track Studies of Detrital Apatite and Zircon	Determination of the cooling age of single crystals of detrital apatite and zircon applied to sediment provenance in order to evaluate the evolution of source regions with time.	USDOE (Reactor Use Sharing)

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1331	Feeley	Montana State University	Geochemistry of Intrusions from Yellowstone National Park	Examination of model variations in chemical compositions of lavas and related co-genetic intrusions on Sepulchur Mountain and Electric Peak in Yellowstone National Park to provide insight into magma chamber dynamic processes.	USDOE (Reactor Use Sharing)
1332	McBirney	University of Oregon	Skaergaard Intrusion	Comparison of the Greenland rocks with those of a large eruption in eastern Iceland to determine if the Skaergaard Intrusion was related to the opening of the North Atlantic 55 million years ago.	USDOE (Reactor Use Sharing)
1333	Miller	Stanford University	Study of the Sierra Nevada - Basin and Range Transition Zone	Analysis of trace element geochemical data for the genesis and evolution of both plutonic complexes and associated extrusives in the Basin and Range transition zone near the latitude of Lake Tahoe to better understand the origins and compositional changes in igneous complexes through time.	USDOE (Reactor Use Sharing)

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Project	**User(s) Name**	**Organization Name**	**Project Title**	**Description**	**Funding**
1334	Fodor	North Carolina State University	Plagioclase Compositions in the Hawaiian Magmatic System	Evaluation of the trace element abundances in plagioclase in cumulate gabbro that crystallized from one of three different kinds of Hawaiian magmas to establish a means of identifying which magma types are represented.	USDOE (Reactor Use Sharing)
1335	DeBari	San Jose State University	Cardinal Peak Pluton	Determination of the petrologic and structural events that created the Cardinal Peak pluton, by evaluating the geochemical differences between the pluton and other rock bodies.	USDOE (Reactor Use Sharing)
1336	Johnson	Texas Tech. University	Petrology and Geochemistry of the Wallowa Batholith	Detailed investigation of the Wallowa batholith in the Blue Mountains of northeastern Oregon to provide information about the timing of accretion and the change in nature of magma source regions with time.	USDOE (Reactor Use Sharing)
1337	Smith	Trinity University	Petrology and Geochemistry of the Aquacate Volcanics, Costa Rica	Analysis of Aquacate Volcanic rocks to constrain processes important in the genesis and evolution of magmas in order to gain a better overall understanding of the evolution of the Central volcanic arc in Costa Rica.	USDOE (Reactor Use Sharing)

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1338	Reynolds	Central Oregon Community College	Tephra and Rock Samples from Paulina Lake, OR	Trace element characterization of tephra and rock samples from Paulina Lake, Newberry volcano to correlate them with surrounding summit tephra and lavas that are not submerged. This will enable a detailed reconstruction of the past several thousand years of geologic history at the summit of the active Newberry volcano.	USDOE (Reactor Use Sharing)
1339	Nelson	Brigham Young University	Unita Mountains Fibrous Calcite	INAA of calcite vein material in an area of a reported emerald discovery to compare with similar calcite veins in known emerald deposits.	USDOE (Reactor Use Sharing)
1340	Johnson	University of New Orleans	Evolution of Magmatic System beneath the South Sister, OR	Preliminary evaluation of the magma chamber beneath the South Sister Volcano in the Oregon Cascades to develop a volcanic hazard assessment.	USDOE (Reactor Use Sharing)
1347	Dodd	Oregon State University	Food Irradiation Study	Irradiation of fruit to various doses to demonstrate the preservation effects of gamma irradiation.	Radiation Center, OSU

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1348	Barnes	Texas Tech University	Granite Petrogenesis in the Ruby Mtn. Area, Nevada	Development of an understanding of the relationship between tectonism and granitic magmatism in a metamorphic core complex. In particular, to show that the Late Cretaceous granites in the Lamoille Canyon area were derived from deep-seated crustal source rocks whereas middle Tertiary granites were derived from sources at shallower levels.	USDOE (Reactor Use Sharing)
1349	Hemphill	Oregon Episcopal School	Effect of Gamma Radiation on Progeny of Brassicas	Irradiation of fast-growing brassicas and determination of the effect on the progeny resulting from cross-pollination of those seeds that reach maturity.	USDOE (Reactor Use Sharing)
1350	Vergin	Oregon State University	Sterilization of Micropipets and Labware	Irradiation of micropipets and other laboratory equipment used in the study of DNA.	Microbiology Dept., OSU
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.	Oceanography Dept., OSU

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1352	Streck	University of Geneva	Petrology of the San Luis Caldera Complex, SW Colorado	Use of trace elements to chemically track the magmatic history during three consecutively erupted large ignimbrite eruptions from the San Luis Caldera complex.	University of Geneva
1353	Kamp	The University of Waikato	Fission Track Thermochronology of New Zealand	Determination of the history and timing of denudation of basement terranes in New Zealand as well as the 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
1355	Senor	Pacific Northwest National Laboratory	Trace Element Analysis of Silicium Carbide	Determination of trace element concentration in SiC blocks. Analysis for Fe, Ni, Co, Cr, Th, U, Zn, Sc, Ti, Ag, Ba, Cs, and Na.	Pacific Northwest National Laboratory
1356	Cox	Borealis Technical Ltd.	Evaluation of Analytical Methods for Determination of Pt/Au	Analysis of various ore samples to develop a reliable INAA methodology for the determination of Pt and Au in various matrices.	Borealis Technical Limited

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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 and gadolinium in order to determine the thermal capture cross sections of Ge-68 and Gd-148.	Radiation Center, OSU
1358	Olander	U.C. Berkeley	Uranium in Mixed Waste	Irradiation of aluminum foils on which small quantities of uranium vapor may be deposited in order to evaluate process effectiveness.	Lawrence Livermore National Laboratory
1359	Niles	Oregon Office of Energy	State Laboratory Support	Maintenance of state radiological monitoring support capability. This involves quality assurance, counting standards and calibrations of gamma spectrometer systems suitable for measuring low levels of radioactivity in various environmental and foodstuffs samples.	Oregon Office of Energy
1360	Geiger	Oregon State University	Geochemistry of Eclogites	Determination of the trace element distribution in different minerals in Eclogites from the Swiss Alps in order to resolve the issue as to where these elements reside in the material.	Radiation Center, OSU

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1361	Chen	Oregon State University	Crosslinking of Peptides and Nucleotides	Use of gamma irradiation to evaluate its potential for crosslinking peptides and nucleotides.	Radiation Center, OSU
1362	Mueller	University of Florida	Proterozoic Crustal Evolution	Examination of the distribution of Proterozoic crust in the Rocky Mountains of Montana and in the Appalachians by geochemical and geochronologic studies of young granitoids and silicic volcanic rocks.	University of Florida
1363	Stewart	University of Washington	History of Faulting and Uplift of the Coast Ranges of OR and WA	Use of fission track geochronology to determine the offset history of major post-Miocene faults in the Coast Ranges of Oregon and Washington, and to relate this history to the uplift and erosion record of the Cascadia Subducton Zone.	American Association of Petroleum Geologists
1364	Higginbotham	Oregon State University	Radiation Attenuation of Compacted Garbage	Use of a radium source and microrem/h meter to determine the attenuation factors associated with a garbage truck full of compacted garbage.	Radiation Center, OSU

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Project	User(s) Name	Organization Name	Project Title	Description	Funding
1365	Dodd	Oregon State University	Quality Assurance Program	Irradiation of various samples for quality assurance purposes. This involves irradiations of solutions of Au and Mn both with and without cadmium covers to determine neutron flux ratios.	Radiation Center, OSU
1366	Scaillet	Universite Paris-Sud	Ar-Ar Geochronology	Determination of geological samples via Ar-Ar radiometric dating.	Universite Paris-Sud
1367	Siddoway	Colorado College	Geochemical Discrimination of "A-type" and "I-type" granites	INAA of two granitic samples from a dredge haul collected in a glacier trough offshore Marie Byrd Land, Antartica, in order to verify or disprove a correlation of these materials with the on-land granite exposures.	Colorado College
1368	Buckovic	Oregon State University	Determination of Cobalt Leach Rates in Sulfurous Acid	Determination of cobalt leach rates as a function of time, temperature, and grain size of ore minerals using sulfur dioxide through an aqueous laterite ore slurry.	Geovic Ltd.

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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
1369	Rochefort	Oregon State University	Determination of Ti and Si in Polymer Residue	Evaluation of the silicon (by ICP-AES) and titanium (by INAA) present in polymer residue for the purposes of assisting in a legal situation.	Gerald Aknouny
1370	Tollo	George Washington University	Petrology of Grenville-Age Charnockites, Blue Ridge Provice, VA	Formulation of a rigorous geological model of magmatic activity and metamorphism associated with Grenville orogenesis in the Blue Ridge province of the central Appalachians.	George Washington University
1371	Griffith	Agricultural Research Service	Liquid Scintillation Ccounting of C-14 Smears	Analysis of smears for decommissioning of a radioactive materials laboratory at the National Forage Seed Research Center.	Agricultural Research Service
1372	Slavens	DOE/Albany Research Center	Liquid Scintillation Counting for Thorium Content	Identification of thorium content in TIMET filter waste system by using the liquid scintillation counter.	DOE/Albany Research Center
1373	Haggerty	Oregon State University	Diffusion in Geologic Materials	Use of the Radiation Center facilities to research the diffusion of water through geologic materials. Tritium will be used to evaluate the diffusion along with the liquid scintillation counter.	Radiation Center, OSU

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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
Radiation Center Instruments	
Alpha Detectors	4
Civil Defense Detectors	8
GM Detectors	42
Ion Chambers	10
Micro-R Meters	4
Personal Dosimeters	58
Support Agency Instruments	
Corvallis Fire Department	8
Good Samaritan Hospital (Corvallis, OR)	8
TOTAL	142

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	9
Animal Science	3
Biochemistry/Biophysics	9
Botany and Plant Pathology	7
Chemistry	3
Civil Engineering	2
Crop Science	3
Electrical and Computer Engineering	1
Entomology	1
Fisheries and Wildlife	2
Food Science and Technology	4
Forest Science	3
Horticulture	3
Linus Pauling Institute	2
Microbiology	9
Nutrition and Food Management	1
Oceanic and Atmospheric Sciences	3
Pharmacy	4
Physics	6
Radiation Safety Office	15
Veterinary Medicine	5
Zoology	4
OSU Departments Total	99
Non-OSU Agencies	
Army Corps of Engineers	3
Corvallis Fire Department	5
Good Samaritan Hospital	6
Oregon Office of Energy	41
Oregon Department of Transportation	6
Oregon Health Sciences University	29
Oregon Public Utilities Commission	5
Oregon State Health Division	51
USDA Agricultural Research Service	4
U.S. Environmental Protection Agency	7
Non-OSU Agencies Total	157

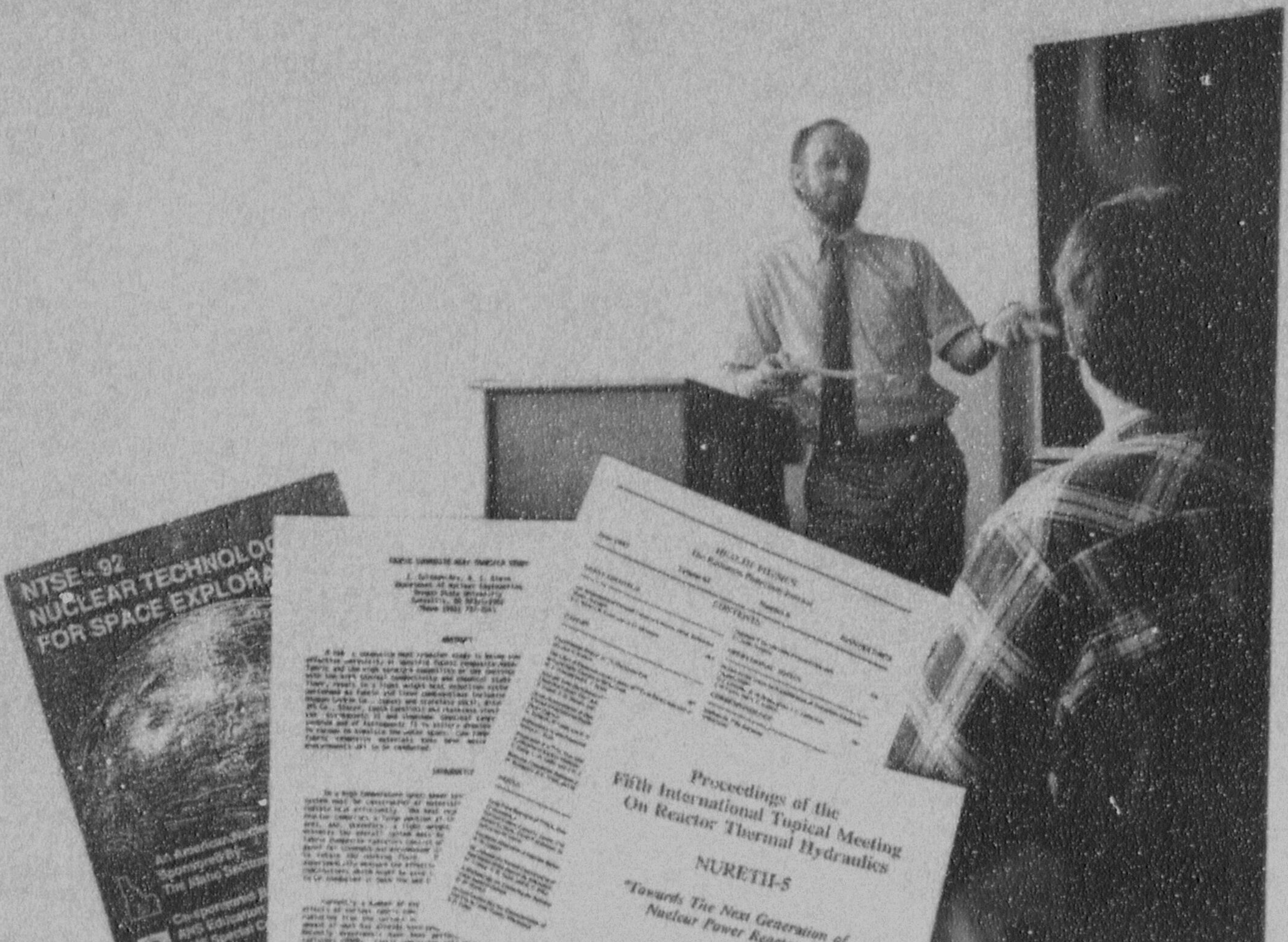
Table VI.C.6

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

Date	Organization	Instrument	Calibrated?	Nature of Repair
7/11/97	Physics, OSU	Eberline E-120	Yes	Replaced GM Tube.
7/18/97	Kaminski/Brookings	CDV-710B	Yes	Eliminated sensitivity to sunlight.
9/4/97	Food Science, OSU	Ludlum 3	Yes	Replaced GM Tube.
9/18/97	Crop Science, OSU	Mini Monitor Series 900	Yes	Replaced GM Tube.
10/16/97	Crop Science, OSU	Wm. B. Johnson GSM-110	Yes	Repaired broken connection in probe.
10/29/97	Radiation Safety Office, OSU	Technical Associates	Yes	Replaced GM Tube.
11/3/97	Botany, OSU	Mini Monitor Series 900	Yes	Replaced GM Tube.
11/14/97	Oregon Health Sciences University	Ludlum 3	No	Replaced meter movement.
2/5/98	Radiation Protection Services, Oregon State Health Division	Ludlum 12	Yes	Replaced meter movement.
2/5/98	Linus Pauling Institute, OSU	Technical Associates PUG-1E	Yes	Replaced probe and connector.
3/10/98	Botany, OSU	Mini Monitor Series 900	Yes	Replaced GM Tube.
4/1/98	Chemistry, OSU	Ludlum 3S/N73117	Yes	Cleaned up battery compartment, replaced battery contacts.
4/23/98	Radiation Protection Services, Oregon State Health Division	Victoreen 470A #5085	Yes	Completely refurbished.
Total Number of Repairs			**13**	

Part VII

WORDS



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* Indicates OSTR use.

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* Indicates OSTR use.

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F. 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 100 scheduled tours including 1,081 people were given during this reporting period. See Table VII.F.1 for statistics on scheduled visitors.

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* Indicates OSTR use.

Table VII.F.1

Summary of Visitors to the Radiation Center

DATE	No. of Visitors	NAME OF GROUP
July 2, 1997	6	Tina, Rachel and Mitch Palmer, Wendell Gebhart
July 7, 1997	1	Dr. Qiao Wu
July 8, 1997	9	Hawthorne Manor - Barbara Dandeneau
July 10, 1997	44	Adventures in Learning
July 15, 1997	1	Dr. Kun Jai Lee, Nuclear Engr Dept KAIST, Taejon Korea
July 15 - 17, 1997	55	Adventures in Learning
July 17, 1997	3	Jim Shivers, Dirk Richcreek, Jeff Carr
July 21, 1997	5	Dr Eric Norman, Dr. Iuda Goldman of LBNL, +3
July 21, 1997	2	Tom Burger, Rebecca Jergans
July 23, 1997	20	Chemistry 223 Portland Community College
July 24, 1997	1	Pati Craven
July 31, 1997	1	Samid Chakrabarti, student
August 4, 1997	1	Greg Davidson
August 11, 1997	7	SMILE program High School
August 13, 1997	14	Dr. Roy Rathja and 13 HS Native American Students
August 21, 1997	2	Mark Doran and Jim Evans of OSU
August 21, 1997	4	President Horii + 3 from DAIDO Institute of Technology Japan
September 10, 1997	2	Captain Daniel, Lt Paul Crowley
September 15, 1997	1	Mike Cappiello, Los Alamos National Laboratory
September 18, 1997	1	Scott Harper

Table VII.F.1 (Continued)

Summary of Visitors to the Radiation Center

DATE	No. of Visitors	NAME OF GROUP
September 19, 1997	2	Paul Harmon and Naoto Kawamura - Hewlett Packard
September 22, 1997	2	Faye Stewart, John Irving
October 8, 1997	25	NE111 class
October 10, 1997	2	Jose Suarta, INEA, Bogota, Columbia
October 20, 1997	3	Commissioner Nils J. Diaz
October 21 and 22, 1997	4	Larry Nielsen, Dan Jordheim, Dick Collingham, Dan Whitlow - Siemens Power Corporation
October 23, 1997	7	Dr. Terry Lash, U.S. Dept. of Energy
October 24, 1997	40	TRTR '97 Annual meeting participants
October 28, 1997	1	Mr. Kousuke Sakano, President, Nuclear Systems Division Kawasaki Heavy Industries, Ltd.
October 30, 1997	1	Sheldon Kaufman
October 30, 1997	20	SEBS (Hot Topics in Science) K-12 Teachers
October 31, 1997	25	NE111 class
November 3, 1997	5	3 French visitors and 2 NRC escorts
November 7, 1997	4	Dan Richardson, Ian Davis, Neal Ham, Mauro Alves
November 8, 1997	4	Beaver Open House
November 10, 1997	1	Gordon Reistad
November 10, 1997	1	Kenneth Hall
November 12, 1997	12	Alternate Energy Class from LBCC
November 13, 1997	1	Cynthia Hirtzel
November 14, 1997	8	Bob Shivers

Table VII.F.1 (Continued)

Summary of Visitors to the Radiation Center

DATE	No. of Visitors	NAME OF GROUP
November 25, 1997	3	Marshall, prospective student and parents, Jackie and Charles Tolunaga
November 25, 1998	1	James Long - Oregonian
December 10, 1997	3	William Martin, Michael Martin, John Kiel-Civil Engineering Students
December 11, 1997	8	Facility Services
December 18, 1997	3	Congresswoman Hooley
December 31, 1997	1	Rodney Cox and Boreal Mining Ltd.
January 8, 1998	13	CH 462 Class
January 8, 1998	2	Sgt. Miller, Oregon State Police
January 13, 1998	5	CH 462 Class
January 14, 1998	24	LBCC GS105 General Science
January 14, 1998	24	LBCC GS105 General Science
January 14, 1998	24	LBCC GS105 General Science
January 15, 1998	24	LBCC GS105 General Science
January 15, 1998	4	CH 462 Class
January 22, 1998	12	LBCC GS105 and 106 General Science
January 23, 1998	3	Congresswoman Hooley
January 26, 1998	15	Chemeketa Community College
January 27, 1998	15	Chemeketa Community College
January 29, 1998	4	CH 462 Class
January 30, 1998	25	Naval Engineering Class
January 30, 1998	15	SMILE High School Teachers
February 6, 1998	3	Christine Snow, son and friend

Table VII.F.1 (Continued)

Summary of Visitors to the Radiation Center

DATE	No. of Visitors	NAME OF GROUP
February 7, 1998	130	Dad's Weekend Open House
February 11, 1998	4	NRC/ACRS
February 12, 1998	1	Ben Youngblood
February 16 and 17, 1998	40	Chemistry Class - Portland Community College
February 17, 1998	1	Jerry Curry, Biosafety Officer
February 20, 1998	1	John Hanley, Portland Graduate Student
February 24, 1998	2	Don Bradley, Mike Foley
February 24, 1998	24	CH222/225H Section 12
March 6, 1998	1	Christine Siddoway, Colorado College
March 10, 1998	1	Tracy Ikenberry, PNNL
March 18, 1998	4	Mr. and Mrs. Schütfort, Mr. and Mrs. Anthony
April 7, 1998	3	Oregon Office of Energy
April 15, 1998	3	Roger Hart, Asst Prof., COAS and guests
April 17, 1998	4	Roy Haggerty, Geosciences and family
April 20, 1998	2	Knolls Atomic Power Laboratory
April 21, 1998	20	Earth Week Celebration
April 29, 1998	2	Dr. Ron Adams, Tektronix
May 2, 1998	79	Mom's Weekend
May 6, 1998	2	Dr. Marty Eisenberg, Univ. of Florida
May 8, 1998	2	Linda Carstens and Andreas Garraux
May 14, 1998	6	NHK TV, Japan
May 14, 1998	20	Alsea High School 9th grade Physical Science class
May 14, 1998	2	M. Skalberg and H. Johansson, Chalmers U., Sweden

Table VII.F.1 (Continued)

Summary of Visitors to the Radiation Center

DATE	No. of Visitors	NAME OF GROUP
May 15, 1998	10	Santiam Christian High School Physics Class
May 15, 1998	2	Juhani Vihavainen, Finland and Tadashi Iguchi, Japan
June 1, 1998	1	Bill Gibson, Talbott Associates Inc.
June 2, 1998	40	LBCC CH223 Class
June 2, 1998	2	Dr. Casey Kim and Joan Kim, Los Alamos
June 3, 1998	24	LBCC Nuclear Energy Class
June 4, 1998	1	Dr. Niels Mommer, Physics
June 5, 1998	12	Highland View Middle School
June 5, 1998	3	Dr Skip Rochefort and guests
June 8, 1998	4	Richard Buckovic, Geovic, Ltd.
June 9, 1998	4	Joel Roshau and 3 students of WOU
June 10, 1998	3	David Konsella and family
June 16, 1998	1	Aaron Bergman
June 24, 1998	20	4H at OSU
June 25, 1998	20	4H at OSU
June 30, 1998	1	Dr. Manfred Zellweger
TOTAL	**1081**	