RADIATION CENTER

October 26, 2001

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

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

In accordance with section 6.7.e of the OSTR Technical Specifications, we are hereby submitting the Oregon State University Radiation Center and TRIGA Reactor Annual Report for the period July 1, 2000 through June 30, 2001.

The 2000-2001 Annual Report continues the pattern established over the past few years by including information about the entire Radiation Center rather than concentrating primarily on the reactor. Because the report addresses a number of different interests, it is rather lengthy, but we have incorporated a short executive summary which highlights the Center's activities and accomplishments over the past year.

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

Sincerely,

Stephen E. Binney
Director

Enclosure

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STATE
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A020

cc w/enclosure:

Mr. Al Adams, Jr., Senior Project Manager, USNRC, MS O11 B20, Washington, DC 20555-0001
Mr. Craig Bassett, USNRC, 61 Forsyth St. SW, Ste. 23T85, Atlanta, GA 30303
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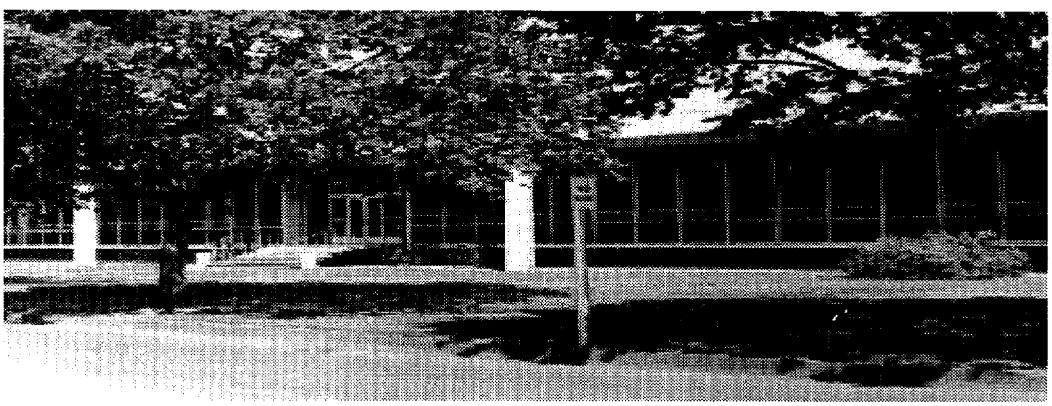
Gene Imbro, USNRC, One White Flint North, MS 9 D3, Rockville, MD 20852

cc w/out enclosure:

D. Stewart-Smith, Oregon Office of Energy
J. F. Higginbotham, Chairman, OSTR Reactor Operations Committee
G. M. Wachs, OSTR Reactor Supervisor, OSU
S. R. Reese, OSTR Reactor Administrator, OSU
K. M. Brock, Senior Health Physicist, OSU

Oregon State University Radiation Center and TRIGA Reactor



Annual Report

July 1, 2000 - June 30, 2001

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

July 1, 2000 - June 30, 2001

To satisfy the requirements of:

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

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

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

Edited by:

S. E. Binney, Director

With contributions from:

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

Submitted by:

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Director, Radiation Center

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October 2001

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

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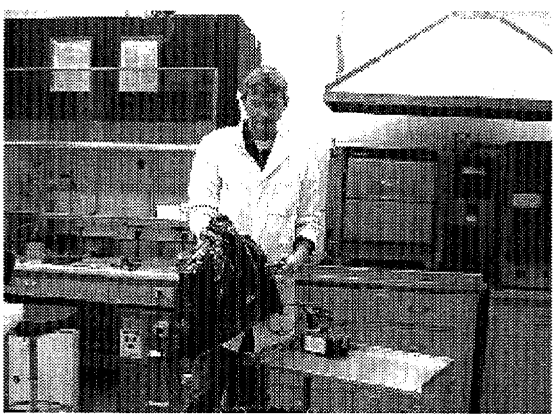
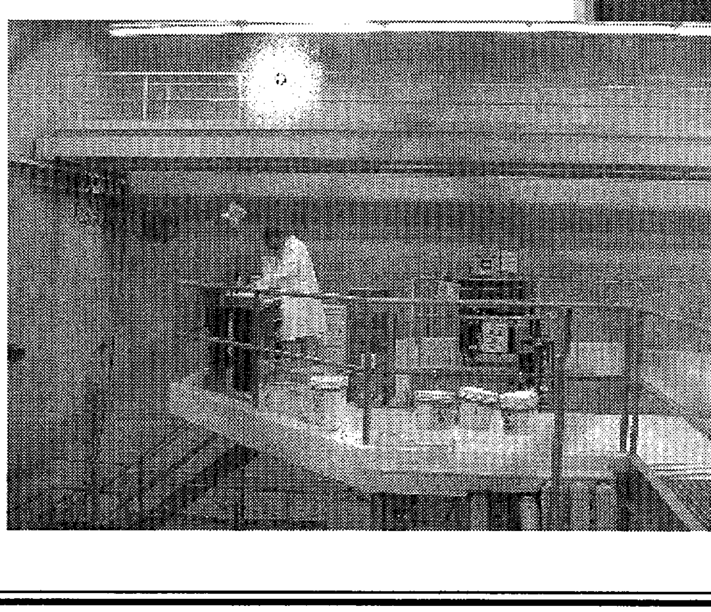
Part I

Overview





Part I

OVERVIEW

A. Acknowledgments

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

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

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

This Annual Report is dedicated to Art Hall, Reactor Supervisor at the OSU Radiation Center since 1994 and employee at the Radiation Center since 1985. Art was extremely conscientious and meticulous in his work. For years he has provided an historical perspective about details concerning the Oregon State TRIGA Reactor and its operation. Thank you, Art, for your sixteen years of service with us.

B. Executive Summary

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

The Radiation Center supported 119 different courses this year, mostly in the Department of Nuclear Engineering. About one-quarter of these courses involved the OSTR. The number of

OSTR hours used for academic courses and training was 479, while 1387 hours were used for research projects. Ninety-two percent of the OSTR research hours were in support of off-campus research projects, which reflects the increasing wider use of the OSTR nationally and internationally. Radiation Center users published 103 articles this year, with 17 more submitted for publication. There were also 14 theses completed and 36 presentations made by Radiation Center users. The number of samples irradiated in the reactor during this reporting period was 3705. Funded OSTR use hours comprised 99.2% of the research use. This is consistent with the move to a more full cost recovery basis for services provided by the Center. The OSTR continues to be the facility of choice for many of the $^{39}Ar/^{40}Ar$ and fission track geochronology laboratories around the world.

Personnel at the Radiation Center conducted 128 tours of the facility, accommodating 1,499 visitors. The visitors included elementary, middle school, high school, and college students; relatives and friends; faculty; current and prospective clients; national laboratory and industrial scientists and engineers; and state, federal and international officials. The Radiation Center is a significant positive attraction on campus because visitors leave with a good impression of the facility and of Oregon State University.

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

The Radiation Center projects database continues to provide a useful way of tracking the many different aspects of work at the facility. The number of projects supported this year was 142. Reactor projects comprised 80% of all projects. The total research supported by the Radiation Center, based on 40 user responses, was $1,931,220. The actual total is likely considerably higher. This year the Radiation Center provided service to 96 research faculty and 97 students (for a total of 474 uses of Center facilities) from 79 different institutions, 35% of which were from other states and 15% of which were from outside the U. S. and Canada. So while the Center's primary mission is local, it is also a facility with a national and international clientele.

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

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

C. Introduction

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

cover the period from July 1, 2000 through June 30, 2001. 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, 2001. For a summary of data on the reactor's original 20% enriched core, the reader is referred to Table IV.A.2 in Part IV of this report or to the 1976-77 Annual Report if a more comprehensive review is needed.

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

D. Overview of the Radiation Center

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

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

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

the full scale plant. This world-class facility meets exacting quality assurance criteria to provide assurance of safety as well as validity of the test results.

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

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)	6.3×10^{-5} Ci
b.	Detectable radionuclides in the liquid waste	^{3}H
c.	Estimated average concentration of released radioactive material at the point of release	1.19×10^{-5} $\mu Ci\ ml^{-1}$
d.	Percent of applicable monthly average concentration for released liquid radioactive material at the point of release	0.12%
e.	Total volume of liquid effluent released, including diluent(3)	3,627 gallons

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

a.	Volume of liquid waste packaged(4)	0.13 gallons

b.	Detectable radionuclides in the waste	^{3}H, ^{14}C, ^{131}I
c.	Total quantity of radioactivity in the waste	2.1×10^{-6} Ci

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

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

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

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

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

a.	Total estimated quantity of radioactivity released	3.74 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	2.5×10^{-8} μCi ml^{-1}
d.	Percent of applicable monthly average concentration for diluted concentration of ^{41}Ar at the point of release	0.62%
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	34.5 ft^{3}

b.	Detectable radionuclides in the solid waste	^{3}H, ^{14}C, ^{46}Sc, ^{47}Sc, ^{153}Sm, ^{58}Co, ^{60}Co, ^{124}Sb
c.	Total radioactivity in the solid waste	7.4×10^{-4} 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)

		(mrem)
a.	Facility Operating Personnel	
(1)	Average whole body	33
(2)	Average extremities	14
(3)	Maximum whole body	215
(4)	Maximum extremities	863
b.	Key Facility Research Personnel	
(1)	Average whole body	3
(2)	Average extremities	1
(3)	Maximum whole body	21
(4)	Maximum extremities	41
c.	Facilities Services Maintenance Personnel	
(1)	Average whole body	<1
(2)	Maximum whole body	19
d.	Class Students	
(1)	Average whole body	<1
(2)	Average extremities	<1
(3)	Maximum whole body	28
(4)	Maximum extremities	39

e. Campus Police and Security Personnel

(1)	Average whole body	2
(2)	Maximum whole body	20

f. Visitors

(1)	Average whole body	<1
(2)	Maximum whole body	27

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

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

a. Facility Survey Data

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

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

(2) Radiation and Contamination Survey ~5000 measurements (See Table V.D.3)

b. Environmental Survey Data

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

(a) Onsite monitoring

-- OSU TLD monitors	108
-- ICN TLD monitors	108
-- Monthly μrem h^{-1} measurements	108

(b) Offsite monitoring

-- OSU TLD monitors	240
-- ICN TLD monitors	144
-- Monthly μrem h^{-1} measurements	240

(2) Soil, Water and Vegetation Surveys

(See Table V.E.3)

(a)	Soil samples	16
(b)	Water samples	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:

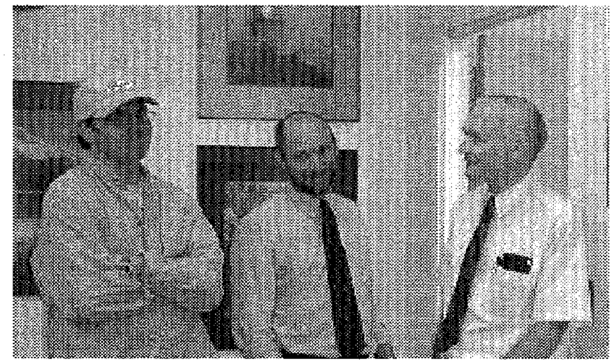
June 1964	Completion of the first phase of the Radiation Center, consisting of 32,397 square feet of office and laboratory space, under the direction of founding Director, C. H. Wang.
July 1964	Transfer of the 0.1 W AGN 201 reactor to the Radiation Center. This reactor was initially housed in the Department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

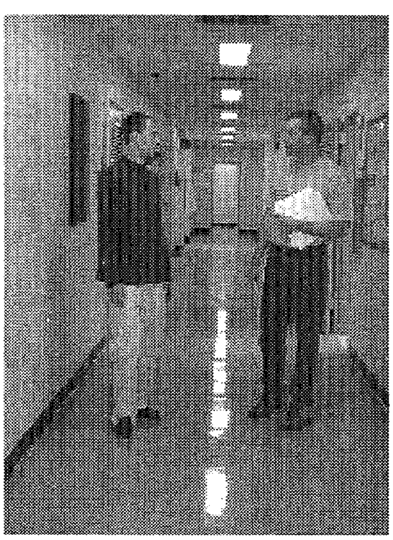
December 1974	AGN-201 reactor permanently shut down.
March 1976	Completion of 1600 square feet of additional space to accommodate the rapidly expanding nuclear engineering program.
July 1976	OSTR refueled with 70% enriched FLIP fuel.
July 1977	Completion of a second 1600 square feet of space to bring the Radiation Center complex to a total of 45,553 square feet.
January 1980	Major upgrade of the electronics in the OSTR control console.
July 1980	AGN-201 reactor decommissioned and space released for unrestricted use.
June 1982	Shipment of the original 20% enriched OSTR fuel to Westinghouse Hanford Company.
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-Milwaukee. A. G. Johnson became new Director.
December 1988	AGN-201 components transferred to Idaho State University for use in their AGN-201 reactor program.
December 1989	OSTR licensed power increased to 1.1 MW.
June 1990	Installation of a 7000 Ci ^{60}Co Gammacell irradiator.
March 1992	25th anniversary of the OSTR initial criticality.
November 1992	Start of APEX plant construction.
June 1994	Retirement of Director A. G. Johnson. B. Dodd became new Director.
August 1994	APEX inauguration ceremony.
August 1995	Major external refurbishment: new roof, complete repaint, rebuilt parking lot, addition of landscaping and lighting.
September 1998	B. Dodd left on a leave of absence to the International Atomic Energy Agency. S. E. Binney became new Director.

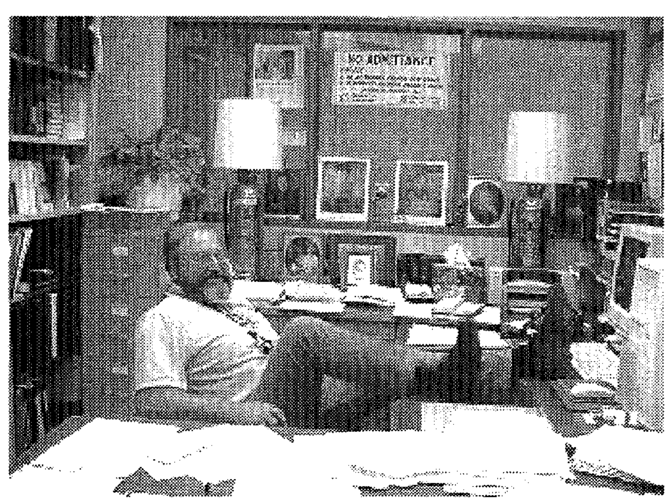
January 1999	Installation of the Argon Production Facility in the OSTR.
April 1999	Completion of ATHRL facility brings the Radiation Center complex to a total of 47,198 square feet.

Part II

People







Part II

PEOPLE

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

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

A. Professional and Research Faculty

Attfield, Martin P.
Faculty Research Associate
Chemistry

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

*Brock, Kathryn M.
Faculty Research Assistant
Health Physicist

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

Craig, A. Morrie
Professor
College of Veterinary Medicine

Daniels, Malcolm
Professor Emeritus
Chemistry

* OSTR users for research and/or teaching.

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

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

Haggerty, Roy
Assistant Professor
Geosciences

Hamby, David
Associate Professor
Nuclear Engineering

Hart, Lucas P.
Faculty Research Associate
Chemistry

Harvey, Richard
Faculty Research Assistant
Nuclear Engineering

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

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

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

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* OSTR users for research and/or teaching.

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

*Krane, Kenneth S.
Professor
Physics

Krebs, Rolf
Faculty Research Associate
Crop and Soil Science

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

*Loveland, Walter D.
Professor
Chemistry

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

Mommer, Niels K.
Faculty Research Associate
Physics

*Palmer, Todd S.
Assistant Professor
Nuclear Engineering

*Pastorek, Christine
Senior Instructor
Chemistry

Popovich, Milosh
Vice President Emeritus

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* OSTR users for research and/or teaching.

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

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

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

Ringle, John C.
Professor Emeritus
Nuclear Engineering

Robinson, Alan H.
Department Head Emeritus
Nuclear Engineering

*Schmitt, Roman A.
Professor Emeritus
Chemistry

*Schütfort, Erwin G.
Faculty Research Assistant
Project Manager

*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

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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*
Cloughsey, Michael	ASE Summer Student	W. D. Loveland
Gallant, Aaron	Saturday Academy Mentorship Program Crescent Valley High School Corvallis, Oregon	W. D. Loveland
Miranda, Pedro	Visiting Scientist, Chemistry	W. D. Loveland
Peterson, Don	Postdoctoral Assistant, Chemistry	W. D. Loveland

C. OSU Graduate Students

Name	*Degree Program*	*Field*	*Advisor*
Abel, Kent	MS	Nuclear Engineering	J. N. Reyes
Antoine, Stephanie	MS	Nuclear Engineering	R. N. Reyes
*Bergman, Joshua J.	MS	Radiation Health Physics	S. E. Binney
Bittle, Whitney	MS	Nuclear Engineering	T. S. Palmer
Coleman, Joseph	MS	Radiation Health Physics	D. M. Hamby
Duffy, William	MS	Radiation Health Physics	A.C. Klein
Ellis, Chris	MS	Nuclear Engineering	J. N. Reyes
Hart, Kevin	MS	Radiation Health Physics	K. A. Higley
Haugh, Brandon	MS	Nuclear Engineering	A. C. Klein
Kim, Kang Seog	PhD	Nuclear Engineering	T. S. Palmer
Marianno, Craig M.	PhD	Radiation Health Physics	K. A. Higley
Menn, Scott A.	PhD	Radiation Health Physics	K. A. Higley
Moss, Stephen C.	MS	Radiation Health Physics	K. A. Higley
Nes, Elena	MS	Radiation Health Physics	K. A. Higley
Nes, Razvan	MS	Nuclear Engineering	T. S. Palmer
*Povetko, Oleg G.	PhD	Radiation Health Physics	K. A. Higley
Rains, Bruce	MS	Nuclear Engineering	A. C. Klein
Saiyut, Kittiphong	PhD	Nuclear Engineering	J. F. Higginbotham
*Schütfort, Erwin G.	MS	Geosciences	C. Field
Tang, Hong	PhD	Nuclear Engineering	Q. Wu
Welter, Kent B.	PhD	Nuclear Engineering	T. S. Palmer
Wiltman, Timothy	MS	Nuclear Engineering	T. S. Palmer
Yao, You	PHD	Nuclear Engineering	Q. Wu
Young, Eric	MS	Nuclear Engineering	A. C. Klein

* OSTR users for research and/or teaching.

D. Business, Administrative and Clerical Staff

Director, Radiation Center .... S. E. Binney
Business Manager .... S. C. Campbell
Office Coordinator .... J. M. Stueve
Office Specialists .... E. D. Jordan
L. M. James
Custodian .... E. Cimbri
Office Coordinator (Nuclear Engineering) .... R. A. Keen
Word Processing Technician (Nuclear Engineering) .... L. J. Robinson
Word Processing Technician (ATHRL – Nuclear Engineering) .... T. L. Culver

E. Reactor Operations Staff

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

F. Radiation Protection Staff

Senior Health Physicist .... (to Nov. 2000) D. S. Pratt
(from Nov. 2000) K. M. Brock
Health Physicist .... (to Nov. 2000) K. M. Brock
Health Physicist .... S. A. Menn
Health Physicist .... J. J. Bergman
Health Physics Monitors (Students) .... M. Cheyne
K. Fenton
M. Hackett
M. Helie
C. Hepler
J. Wallace

G. Scientific Support Staff

Analytical Support Manager .... M. R. Conrady

Projects Manager	E. G. Schütfort
Neutron Activation Analysis Technicians (Students)	S. Antoine E. Nes R. Nes A. Shimanoff
Scientific Instrument Technician	S. P. Smith
Nuclear Instrumentation Support	Z. Kenney

H. OSU Radiation Safety Office Staff

Radiation Safety Officer	R. H. Farmer
Assistant Radiation Safety Officers	D. L. Harlan M. E. Bartlett
Office Manager	K. L. Miller
Lab Technician	P. A. Schoonover
Student Technicians	W. Duffy A. Maple

I. Committees

1. Reactor Operations Committee

Name	*Affiliation*
J. F. Higginbotham, Chair	Nuclear Engineering
S. E. Binney	Radiation Center and Nuclear Engineering
A. D. Hall	Radiation Center
A. C. Klein	Nuclear Engineering
D. S. Pratt	(to Nov. 2000) Radiation Center
K. M. Brock	Radiation Center
W. J. Richards	McClellan Nuclear Radiation Center
J. C. Ringle	Nuclear Engineering
S. R. Reese	Radiation Center and Nuclear Engineering
M. H. Schuyler	Chemistry
W. H. Warnes	Mechanical Engineering

2. Radiation Safety Committee (OSU)

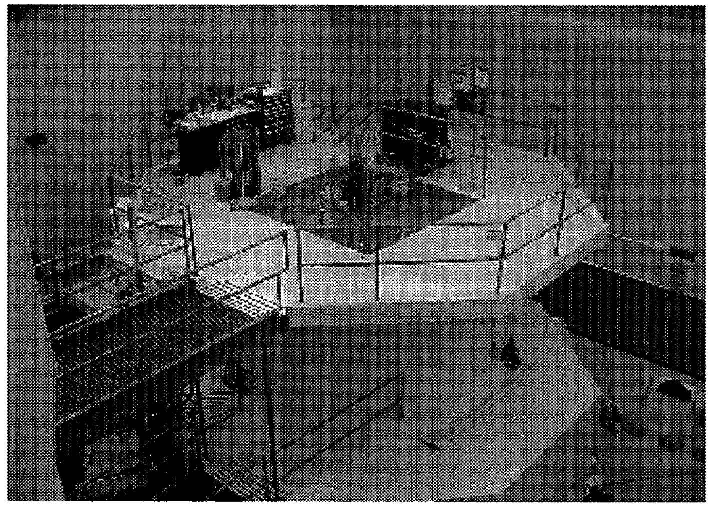
Name	*Affiliation*
R. Collier, Chair	Oceanic and Atmospheric Sciences
J. Higginbotham, Vice Chair	Graduate School and Nuclear Engineering

R. Farmer, Secretary and RSO	Radiation Safety Office
T. Dreher	Agricultural Chemistry
B. Francis	Environmental Health and Safety
M. Leid	Pharmacy
C. Snow	Exercise and Sport Science
J. Steiner	USDA-ARS/Crop and Soil Science
I. Wong	Biochemistry/Biophysics
T. Wolpert	Botany and Plant Pathology

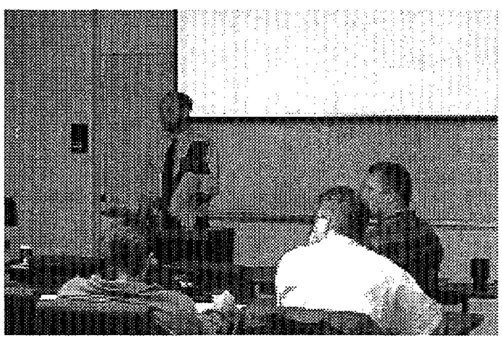
3. Radiation Center Safety Committee

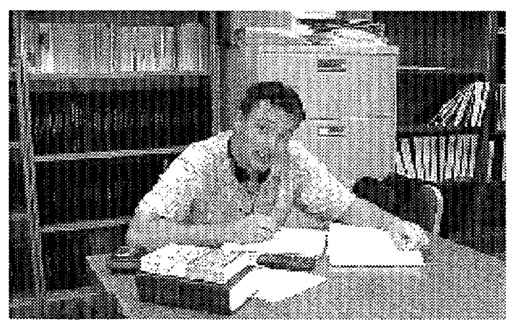
Name	*Affiliation*
W. D. Loveland, Chair	Chemistry
K. M. Brock	Radiation Center
M. R. Conrady	Radiation Center
J. T. Groome	Nuclear Engineering
J. F. Higginbotham	Nuclear Engineering
K. L. Miller	Radiation Safety
D. S. Pratt	(to Nov. 2000) Radiation Center

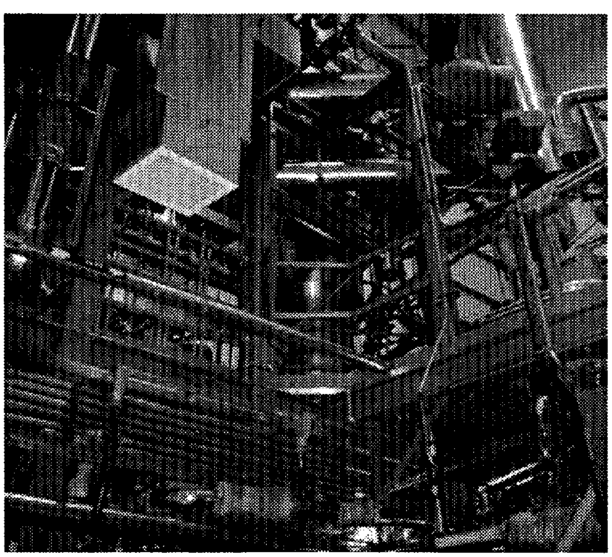
Part III

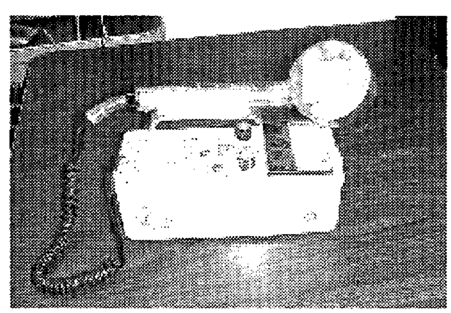


Facilities









Part III

FACILITIES

A. Research Reactor

1. Description

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

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

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

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

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

The **beam ports** are tubular penetrations in the reactor's main concrete shield which enable neutron and gamma radiation to stream from the core when a beam port's shield plugs are removed. One of the beam ports contains the **Argon Production Facility** for production of curie levels of ^{41}Ar. The other beam ports are available for a variety of experiments.

If samples which are to be irradiated require a large neutron fluence, especially from higher energy neutrons, they may be inserted into a **dummy fuel element**. This device will then be placed into one of the core's inner grid positions which would normally be occupied by a fuel element.

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

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

2. Utilization

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

a. Instruction

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

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

During this reporting period the OSTR accommodated 24 different OSU academic classes and other academic programs. In addition, portions of classes from other Oregon universities were also supported by the OSTR. The OSU teaching and training programs utilized 479 hours of reactor time. Tables III.A.1 and III.A.2, as well as Table III.D.1, provide detailed information on the use of the OSTR for instruction and training.

b. Research

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

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

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

B. Analytical Equipment

1. Description

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

2. Utilization

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

C. Radioisotope Irradiation Sources

1. Description

The Radiation Center is equipped with a 1,644 curie (as of 7/27/01) Gammacell 220 ^{60}Co irradiator which is capable of delivering high doses of gamma radiation over a range of dose rates to a variety of materials.

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

2. Utilization

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

D. Laboratories and Classrooms

1. Description

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

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

In addition to these dedicated instructional facilities, many other research laboratories and pieces of specialized equipment are regularly used for teaching. In particular, classes are routinely given

access to gamma spectrometry equipment located in Center laboratories. A number of classes also regularly use the OSTR and the Reactor Bay as an integral part of their instructional coursework.

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

This reporting period saw continued high utilization of the Radiation Center's thermal hydraulics laboratory. This laboratory is being used by Nuclear Engineering faculty member to accommodate a one-quarter scale model of the Palisades Nuclear Power reactor. 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 and operated by OSU. In addition, a new building, the Air-water Test Loop for Advanced Thermal-hydraulics Studies (ATLATS), was constructed next to the Reactor Building in 1998. Two-phase flow experiments are conducted in the ATLATS. Together APEX and ATLATS comprise the Advanced Thermal Hydraulics Research Laboratory (ATHRL).

2. Utilization

All of the laboratories and classrooms are used extensively during the academic year. For example, a listing of 119 courses accommodated at the Radiation Center during this reporting period along with their enrollments is given in Table III.D.1.

E. Instrument Repair and Calibration Facility

1. Description

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

2. Utilization

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

F. Library

1. Description

The Radiation Center has a library containing significant collections of texts, research reports, and videotapes relating to nuclear science, nuclear engineering, and radiation protection. Under the direction of John Ringle and Katie Coleman, the library was completed and rearranged this year. All documents are now listed in an Access database.

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

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

The Radiation Center videotape library has over one hundred tapes on nuclear engineering, radiation protection, and radiological emergency response topics. In addition, the Radiation Center

uses videotapes for most of the technical orientations which are required for personnel working with radiation and radioactive materials. These tapes are produced, recorded, and edited by Radiation Center staff, using the Center's videotape equipment and the facilities of the OSU Communication Media Center.

2. Utilization

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

Table III.A.1

OSU Courses Using the OSTR

Course Number	Course Name
Adventures in Learning	Visiting Students
Chem 123	General Chemistry
Chem 222	General Chemistry
Chem 225H	Honors General Chemistry
Chem 462	Experimental Chemistry II
ENGR 331	Momentum Energy and Mass Transfer
GEO 330	Environmental Conservation
Naval Science 212	Introduction to Naval Engineering
NE 114/116	Introduction to Nuclear Engineering and Radiation Health Physics
NE 236	Nuclear Radiation Detection and Instrumentation
NE 451	Neutronic Analysis and Lab I
NE 453/553	Neutronic Analysis and Lab II
RHP 480	Field Practices in Radiation Protection
RHP 488/588	Radioecology
SED 501	Science and Math Education
SMILE	Science and Math Investigative Learning Experiences

Table III.A.2

OSTR Teaching Hours

Description	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
Departmental		
Adventures in Learning	2.0	
Chemistry	37.4	
Engineering Science	2.8	
Geosciences[1]	1.3	
Naval Science	1.4	
Nuclear Engineering and Radiation Health Physics	30.0	
Science and Math Education	2.2	
SMILE	1.8	
Departmental Total	87.0	7,608
Special Classes and Projects[2]		
Center for Alternative Learning	1.8	
Chemistry	3.9	
Department of Science	0.8	
Newport Elementary Schools	1.0	
University of California at Berkeley Nuclear Engineering	0.2	
Upward Bound	1.0	
Demonstrations	4.0	
Operator Requalification Training	8.0	
Operator License Training	379.0	
Special Classes and Projects Total	392.0	5,174
TOTAL TEACHING HOURS[3,4,5]	479	12,782

(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 379 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 multiple reactor use.

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

Table III.A.3

OSTR Research Hours

Types of Research	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
OSU Research	105	8,689
Off-Campus Research	1,282	15,658
TOTAL RESEARCH HOURS[(1)]	1,387	24,347

(1) Total research hours statistics:

(a) 99.2% (1376 hours) of the total research hours were user-funded by federal, state, or other organizations.

(b) 0.8 (11 hours) of the total research hours were user-unfunded studies in support of graduate thesis research or other academic investigations. Reactor costs for this research were absorbed (funded) by the OSU Radiation Center.

Table III.B.1

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

Room	System	Rel. Effic. (%)
B100	EG&G Ortec D-Spec MCA, HPGe	26.8
B100	EG&G Ortec D-Spec MCA, HPGe	38.2
B100	EG&G Ortec D-Spec MCA, HPGe	33.6
B100	EG&G Ortec D-Spec MCA, HPGe	28.6
B125	EG&G Ortec D-Spec MCA, HPGe	24.2%
D102	EG&G Ortec D-Spec MCA, HPGe	28.5%
B100	EG&G Ortec Adcam 8k-MCA, PGT LEP	N/A
B100	EG&G Ortec Adcam 8k-MCA, EG&G Ortec LEP	N/A
B100	EG&G Ortec Adcam 8K-MCA, HPGE	29.0
D102	EG&G Ortec Adcam 8K-MCA, HPGE	27.6%
C120	EG&G Ortec Ace 4k-MCA, NaI(Tl) 3x3	N/A
A146	EG&G Ortec Ace 4k-MCA, 576A Alpha Spectrometer	N/A

Table III.B.2

Radiation Center Proportional Counting Systems

Room	System
A138	Protean MPC 9400

Table III.B.3

Thermoluminescent Dosimeter Systems

Room	System
A132	Harshaw Model 2000

Table III.C.1

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

Purpose of Irradiation	Samples	Dose Range (rads)	Number of Irradiations	Use Time (hours)
Sterilization	pine needles, syringes, wood, soil, tissue, plastic tubes, catheters, meat, water	1.7×10^6 to 3.0×10^6	52	1,342
Material Evaluation	gems, minerals, electrical components	3.8×10^4 to 9×10^6	8	315
Botanical Studies	flower seeds, bean seeds,	5.0×10^3 to 8.0×10^4	7	20
Biological Studies	tubes	1.7×10^6 one setting no range	1	18
TOTALS			68	2,675

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 2000	Winter 2001	Spring 2001	Summer 2001
Nuclear Engineering Department Courses						
NE114*	2	Introduction to Nuclear Engineering and Radiation Health Physics	19	--	--	--
RHP114*	2	Introduction to Nuclear Engineering and Radiation Health Physics	4	--	--	--
NE115	2	Introduction to Nuclear Engineering and Radiation Health Physics	--	18	--	--
RHP115	2	Introduction to Nuclear Engineering and Radiation Health Physics	--	6	--	--
NE116	2	Introduction to Nuclear Engineering and Radiation Health Physics	--	--	16	--
RHP116	2	Introduction to Nuclear Engineering and Radiation Health Physics	--	--	4	--
NE234	4	Nuclear and Radiation Physics I	15	--	--	--
RHP234	4	Nuclear and Radiation Physics I	6	--	--	--
NE235	4	Nuclear and Radiation Physics II	--	13	--	--
RHP235	4	Nuclear and Radiation Physics II	--	5	--	--
NE236*	4	Nuclear Radiation Detection and Instrumentation	--	--	13	--
RHP236*	4	Nuclear Radiation Detection and Instrumentation	--	--	4	--
NE319	3	Societal Aspects of Nuclear Technology	--	--	48	--
NE401	1-16	Research	1	1	--	--
RHP401	1-16	Research	--	--	--	--
NE405H	1-16	R&C/Low Level Radioactive Waste	--	--	--	--
NE405	1-16	Reading and Conference	--	--	--	1
RHP405	1-16	Reading and Conference	1	--	--	--
NE406	1-16	Projects	3	1	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

RHP406	1-16	Projects	--	--	1	--
NE407	1	Nuclear Engineering Seminar	13	14	16	--
NE410	1-12	Internship	2	3	1	--
RHP410	1-12	Internship	--	--	1	1
NE415	2	Nuclear Rules and Regulations	--	16	--	--
RHP415	2	Nuclear Rules and Regulations	--	9	--	--
NE450	3	ST/ Nuclear Medicine	--	7	--	--
NE451	4	Neutronic Analysis and Lab I	14	--	--	--
NE452	4	Neutronic Analysis and Lab II	--	13	--	--
NE453	4	Neutronic Analysis and Lab III	--	--	14	--
NE457**	3	Nuclear Reactor Laboratory	--	--	3	--
NE467	4	Nuclear Reactor Thermal Hydraulics	11	--	--	--
NE474	4	Nuclear Systems Design I	--	10	--	--
NE475	4	Nuclear Systems Design II	--	--	10	--
NE479	1-4	Individual Design Project	--	--	--	--
RHP479	1-4	Individual Design Project	--	--	--	--
RHP480	1-3	Field Practice in Radiation Protection	1	--	--	1
NE481	4	Radiation Protection	6	--	--	--
RHP481	4	Radiation Protection	1	--	--	--
NE482*	4	Applied Radiation Safety	10	--	--	--
RHP482*	4	Applied Radiation Safety	3	--	--	--
RHP483	4	Radiation Biology	--	3	--	--
RHP487	3	Radiation Biology	--	--	7	--
RHP488	3	Radioecology	--	--	2	--
NE490	4	Radiation Dosimetry	--	--	16	--
RHP490	4	Radiation Dosimetry	--	--	5	--

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

NE499	1-16	St/Environmental Aspects Nuclear Systems	--	1	--	--
RHP499	1-16	St/Envrionmental Aspects Nuclear Systems	--	1	--	--
NE501	1-16	Research	--	3	--	--
RHP501	1-16	Research	--	--	--	--
NE503	1	Thesis	7	5	5	--
RHP503	1	Thesis	3	3	3	--
NE505	1-16	Reading and Conference	2	--	1	--
RHP505	1-16	Reading and Conference	--	--	--	--
NE506	1-16	Projects	--	3	1	--
RHP506	1-16	Projects	--	--	--	--
NE507	1	Nuclear Engineering Seminar	6	2	2	--
NE507	1	Sem/Management of Mixed Waste	1	--	--	--
NE510	1-12	Internship	--	--	--	--
RHP510	1-12	Internship	--	1	1	--
NE515	2	Nuclear Rules and Regulations	--	1	--	--
RHP515	2	Nuclear Rules and Regulations	--	4	--	--
NE526	3	Computational Methods for Nuclear Reactors	--	--	4	--
NE535	3	Nuclear Radiation Shielding	--	5	--	--
NE539	3	ST/Nuclear Physics for Engineers and Scientists	3	--	--	--
RHP539	3	ST/Nuclear Physics for Engineers and Scientists	2	--	--	--
RHP535	3	Nuclear Radiation Shielding	--	2	--	--
NE543	3	Radioactive Waste Management	--	--	2	--
RHP543	3	Radioactive Waste Management	--	--	2	--
NE549	3	Low Level Waste	--	--	3	--
RHP549	3	Low Level Waste	--	--	--	--

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

NE550	3	Nuclear Medicine	--	2	--	--
NE551	4	Neutronic Analysis and Lab I	4	--	--	--
NE552	4	Neutronic Analysis and Lab II	--	4	--	--
NE553	4	Neutronic Analysis and Lab III	--	--	3	--
NE557**	3	Nuclear Reactor Laboratory	--	--	4	--
NE559	1	ST/Nuclear Reactor Analysis: Criticality Safety	--	10	--	--
NE567	4	Advanced Nuclear Reactor Thermal Hydraulics	4	--	--	--
NE568	3	Nuclear Reactor Safety	--	--	--	--
NE569	1-3	ST/Scaling	4	--	--	--
NE574	4	Nuclear Systems Design I	--	5	--	--
NE575	4	Nuclear Systems Design II	--	--	6	--
RHP580	1-3	Field Practice in Radiation Protection	--	--	--	--
NE581	4	Radiation Protection	1	--	--	--
RHP581	4	Radiation Protection	2	--	--	--
NE 582*	4	Applied Radiation Safety	0	--	--	--
RHP582*	4	Applied Radiation Safety	2	--	--	--
RHP583	4	Radiation Biology	--	2	--	--
NE585	3	Environmental Aspects Nuclear Systems	--	--	2	--
RHP585	3	Environmental Aspects Nuclear Systems	--	--	1	--
NE586	3	Advanced Radiation Dosimetry	--	--	--	--
RHP586	3	Advanced Radiation Dosimetry	--	--	--	--
RHP588	3	Radioecology	--	--	1	--
RHP589	1-3	ST/Radiation Protection and Risk Evaluation	--	5	--	--
NE590	4	Radiation Dosimetry	--	--	--	--
RHP590	4	Radiation Dosimetry	--	--	3	--

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

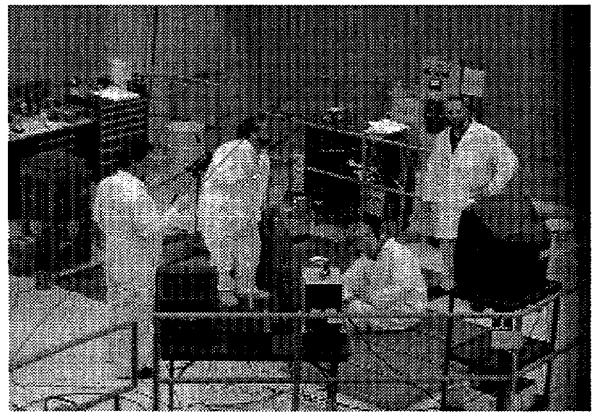
NE599	1	ST/Stochastic Transport	1	--	--	--
NE601	1-16	Research	--	--	1	--
RHP601	1-16	Research	--	--	--	--
NE603	1-16	Thesis	2	2	2	--
RHP603	1-163	Thesis	3	3	1	--
NE605	1-16	Reading and Conference	--	--	--	--
RHP605	1-16	Reading and Conference	--	--	--	--
NE606	1-16	Projects	--	--	--	--
RHP606	1-16	Projects	--	--	--	--
NE607	1	Nuclear Engineering Seminar	--	--	--	--
RHP 607	1	Nuclear Engineering Seminar	--	--	1	--
RHP610	1-12	Internship	--	--	--	--
NE654	3	Neutron Transport Theory	5	--	--	--
NE667	3	Advanced Thermal Hydraulics	4	--	--	--
Courses from Other Departments						
CH222*	5	General Chemistry (Science Majors)	--	349	--	--
CH225H	5	Honors General Chemistry	--	48	--	--
CH462*	3	Experimental Chemistry II Laboratory	--	8	--	--
CHE123	3	General Chemistry	48	--	--	--
CE356	3	Technology and Environmental Systems	--	--	45	--
SED501	1	Science and Education	13	5	--	--
Courses from Other Institutions						
CH 223*	PCC	Chemistry	18	--	--	--
RH 289	LBCC	Alternate Energy Sources	--	--	20	--
GS 105	LBCC	General Science	60	--	--	--
CH104	WOU	Chemistry	59	--	--	--

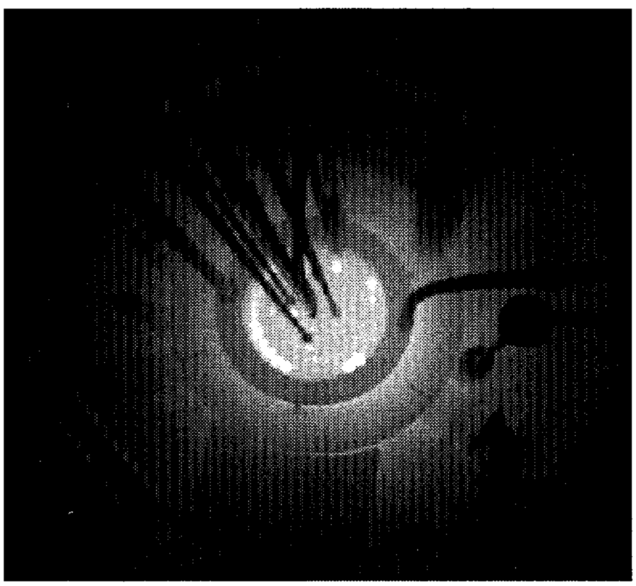
NOTE:
This table does not include the thesis courses from other OSU departments (see Table VI.C.2).

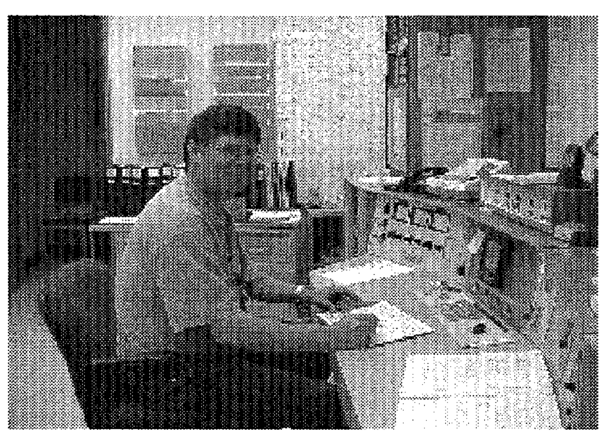
ST = Special Topics
* = OSTR used occasionally for demonstration and/or experiments.
** = OSTR used heavily.

Part IV

Reactor







Part IV

REACTOR

A. Operating Statistics

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

Thermal energy generated in the reactor during this reporting period was 37.3 megawatt days (MWD). The cumulative thermal energy generated by the FLIP core now totals 947.7 MWD from August 1, 1976 through June 30, 2001. Reactor use time averaged 88% of the normal nine-hour, five-day per week schedule. Tables IV.A.3 through IV.A.5 detail the operating statistics applicable to this reporting period.

The reactor core excess reactivity increased slightly (~12¢) over this reporting period. This slight increase is due to the erbium poison in the fuel elements burning at a faster rate than the fuel.

B. Experiments Performed

1. Approved Experiments

During the current reporting period there were seven approved reactor experiments, listed below, available for use in reactor-related programs.

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

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

A-2	Measurement of Reactor Power Level via Mn Activation.
A-3	Measurement of Cd Ratios for Mn, In, and Au in Rotating Rack.
A-4	Neutron Flux Measurements in TRIGA.
A-5	Copper Wire Irradiation.
A-6	In-core Irradiation of LiF Crystals.
A-7	Investigation of TRIGA's Reactor Bath Water Temperature Coefficient and High Power Level Power Fluctuation.
B-1	Activation Analysis of Stone Meteorites, Other Meteorites, and Terrestrial Rocks.
B-2	Measurements of Cd Ratios of Mn, In, and Au in Thermal Column.
B-4	Flux Mapping.
B-5	In-core Irradiation of Foils for Neutron Spectral Measurements.
B-6	Measurements of Neutron Spectra in External Irradiation Facilities.
B-7	Measurements of Gamma Doses in External Irradiation Facilities.
B-8	Isotope Production.
B-9	Neutron Radiography.
B-10	Neutron Diffraction.
B-13	This experiment number was changed to A-7.
B-14	Detection of Chemically Bound Neutrons.
B-15	This experiment number was changed to C-1.
B-16	Production and Preparation of ^{18}F.
B-17	Fission Fragment Gamma Ray Angular Correlations.
B-18	A Study of Delayed Status (n, γ) Produced Nuclei.
B-19	Instrument Timing via Light Triggering.

B-20	Sinusoidal Pile Oscillator.
B-21	Beam Port #3 Neutron Radiography Facility.
B-22	Water Flow Measurements Through TRIGA Core.
B-24	General Neutron Radiography.
B-25	Neutron Flux Monitors.
B-26	Fast Neutron Spectrum Generator.
B-27	Neutron Flux Determination Adjacent to the OSTR Core.
B-28	Gamma Scan of Sodium (TED) Capsule.
B-30	NAA of Jet, Diesel, and Furnace Fuels.
C-1	PuO_2 Transient Experiment.

C. Unplanned Shutdowns

There were ten unplanned reactor shutdowns 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. Due to unusual conditions or operational anomalies of a less critical nature, the reactor may also be secured by manual rod insertion. 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.

1. 10 CFR 50.59 Changes to the Reactor Facility

   There were 10 changes to the reactor facility during the reporting period.

   For additional information regarding these changes, or copies of the changes, contact the OSTR Operations staff.

(1) *00-06, Replacement of the LPG Tank for the Emergency Generator.*

a. Description

Due to numerous paintings, the installed tank markings were determined to be illegible by the tank owner, Amerigas Co. This discrepancy had also been noted as an item of non-compliance by the Corvallis Fire Department. Amerigas Co. also noted that the pressure regulator did not meet current standards. Replacement of the tank and regulator to meet updated standards was deemed the best course of action.

(b) Safety Evaluation

Replacement of the single stage regulator with a two stage regulator reduces the consequences of a regulator failure. Single diaphragm regulator failure raises the LPG supply pressure to the generator to tank pressure. Using the two stage regulator, a single stage diaphragm failure provides the generator with a higher than normal pressure, but within the generator fuel system capability.

There is no technical specification that relates directly to the emergency power system. However, certain systems described in the technical specifications are connected to the emergency power system. During a loss of power, the inverter system picks up the initial load and will maintain the load for approximately five minutes in the event the generator does not function properly. Replacement of the LPG tank does not change this.

(2) *00-07, Modification of the In-Core Irradiation Facilities*

(a) Description

This change was made to reduce the elevated radiation levels measured above the two in-core tubes while the reactor is at full power to levels normally observed on the reactor top grating while in a normal core configuration.

The proposed In Core Irradiation Tube (ICIT) and Cadmium Lined In Core Irradiation Tube (CLICIT) will have an increased offset (16") and bend angle (10°). The mounting bracket for the ICIT and CLICIT will be moved 7 inches south on the center channel to compensate for the increased offset.

(b) Safety Evaluation

The modified offset and bend angle increases the amount of water by 1.5 feet that a beam traveling through the slanted (between the bends) portion of the tube has to pass through. Considering that 1.5 feet is at least a half-value layer for fission gammas in water and the current tubes produce a dose rate of ~120 mrem/hr on the grating, the beam should be undistinguishable from other areas of the reactor top with the proposed tubes. Additionally, the slanted portion of the tube (extrapolated through the water to the top grid plate) will intersect the core at the top three inches of the F-ring due to the larger bend angle and offset. This will also help reduce the dose rate observed at the grating.

The proposed tubes will be made of the same materials (6061-T6 aluminum) as the current tubes. No change in reactivity is expected from the new ICIT because the same materials are used and the configuration will not change. The reactivity worth of the proposed CLICIT, relative to the present CLICIT, should be ≤ -$0.05 because the total mass of cadmium will be increased. Although the mass of cadmium originally placed in each tube will be the same, the difference in mass observed now arises from the burn up of cadmium in the original tube.

(3) *00-08, 01-03, Replacement of the Heating Coils for the Reactor Bay Ventilation System*

(a) Description

These changes were performed to replace both heat and pre-heat coils in the reactor bay ventilation system.

Approximately every other year, the current heating coil for the intake ventilation fan in room D-106 freezes and breaks during the winter. It is believed to be caused by a combination of low steam pressure and steam condensate collecting in the bottom of the coil tubes.

At our request, OSU Facility Services (charged with maintaining the building ventilation system) brought in a consultant to determine the best way to solve the problem. The consultant, E. S. Constant Company, recommended that the pre-heat coil be replaced with one of the same heat capacity, but only half the height. At this height, all condensate will be allowed to drain from the coils to the current condensate removal system.

Since the initial evaluation, a new HVAC contractor was chosen, Harvey & Price Co., to perform the modification. They recommended replacing

both heat and pre-heat coils fabricated by a different manufacturer than described in the original evaluation. Using coils of half the present height, raising them off the floor and baffling the lower portion of the duct, air will be forced up through both coils.

Replacing both coils provided an opportunity to change the way they are controlled. The preheat coil was controlled with a thermostat located in the supply ducting. A thermostat located in the reactor bay controlled the reheat coil. Both coils are now controlled by the thermostat in the reactor bay. The close proximity of the coils does not justify controlling them individually.

(b) Safety Evaluation

Since the coils fail by steam condensate freezing and rupturing the tubes, changing the geometry of the condensate drain to each coil will eliminated this problem. Additionally, this will have no effect upon the ability of the ventilation system to perform its primary function of maintaining negative pressure. The only consequence is a possible reduction in heating efficiency, which is something we were previously experiencing.

There are two references to the ventilation system in the Tech Specs. First, Tech Spec 3.7.1 states, "The reactor shall not be operated unless the facility ventilation system is operating. In the event of a substantial release of airborne radioactivity, the ventilation system will be secured automatically." Neither the coils nor the control system for the coils will have anything to do with the high stack CAM relays or the ventilation power. They are completely unrelated and independent systems.

Second, Tech Spec 5.6 states, "The reactor shall be housed in a facility designed to restrict leakage. The minimum free volume in the facility shall be 100,000 cubic feet. The reactor building shall be equipped with ventilation systems designed to filter and exhaust air or other gases from the reactor building and release them from a stack at a minimum of 65 feet 10 inches from ground level. Emergency shutdown controls for the ventilation system shall be located in the control room and the system shall be designed to shut down automatically in the event of a substantial release of radioactivity." Just as in the previous Technical Specifications reference, the coil and coil controls are completely independent of these systems.

(4) *00-10, Primary Water Purification System Modifications*

(a) Description

This modification involves: replacing the purification system pump; changing the suction line sampling location from the primary tank to the primary water return; and installing a relief valve.

(b) Safety Evaluation

Catastrophic failure of the current pump or the PVC piping would, in the worst case, result in a loss of primary water down to the level of the siphon breaks on the primary suction and return. This is the worst case failure of the new pump, PVC piping and the proposed relief valve. Therefore, the consequence of any accident should remain unchanged.

Installation of the new pump, relief valve, and primary suction point should not increase the frequency of failure. Over the last twelve-year operating history, we have had one water system failure involving PVC components and one involving stainless steel components. The failure rate of the new pump should be similar to that observed earlier in the life of the original pump. Together, the rate of failure should not appreciably increase over what already exists as a result of these modifications.

A catastrophic failure of the purification system would result in an accident evaluated in the Safety Analysis Report (SAR). The Safety Analysis Report of the OSTR evaluates two accidents involving complete loss of primary water. This is the appropriate scenario to consider, however incredible, for any system handling primary water.

The margin of safety for the Tech Spec requirements involving water systems will not be reduced. The requirements for water convective cooling, siphon breaks pool level alarm and bulk pool temperature alarm are not directly related and are unaffected by the proposed changes.

The margin of safety for bath temperature is directly related but should not decrease. When the purification system is on, 10 gpm of the 450 gpm primary return flow will be diverted and eventually returned. However, with the current system, there is no observed difference in temperature between the purification system and the bath temperature. This implies that the purification system itself (e.g. pump, pipes, valves, etc.) is not very efficient at adding or removing heat from the water flowing through it. It is not expected that a difference in bath temperatures will be observable given our range in typical full power operating values (33-36° C). Therefore, the margin of safety for bath temperature should not decrease.

(5) *00-11, Dashpot repairs*

(a) Description

During control rod inspections, it was discovered that the dashpot covers on the lower shim control rod barrel were not attached. These covers are thin pieces of aluminum affixed with epoxy. The Reactor Operations staff repaired both the shim and safe rod barrels by covering two of the three sets of dashpot holes on the rod barrels with one continuous piece of 0.063 inch thick anodized aluminum tack welded to the surface. The same two sets of holes that were originally covered were covered by the repair.

(b) Safety Evaluation

Failure of the new covers will result in the same consequences that we previously faced.

The new covers were tack welded on and should stay on for the life of the barrel. Tack welding will provide a permanent solution.

This repair will not change the accident evaluated in the SAR. To ensure that changes to the barrel did not result in a stuck rod, the procedures for the verification of control rod withdrawal, insertion and scram times were performed.

Loss of the covers cause the scram times for the rods to decrease. However, repeated scrams without dashpot covers might have resulted in excessive mechanical shock in the long term. Welding the covers onto the barrel eliminated this concern.

(6) *00-21, Beam Port 1 Inner Plug Repair*

(a) Description

In order to proceed with the removal of the Beam Port #1 blockhouse, the inner beam port plug had to be repaired. This plug originally was positioned in Beam Port #4. Upon removal, it was discovered that the aluminum cap on the inner end had separated from the rest of the plug. The plug has not been used since.

The plug is essentially an aluminum tube filled with layers of concrete and lead. After welding on the cap, the tube was tapered from the head to the tail (the end with the aluminum cap) by machining the entire length. The head of the tube was left with a slightly greater wall thickness than the tail. Because the original weld (which affixed the cap) was machined along with the rest of the tube, there was insufficient aluminum remaining on the original tube to support another weld. The Reactor Operations staff repaired the plug by bolting instead of welding the cap. Three holes were drilled into the four-inch layer of lead which composes the end of the plug, and the holes tapped for 3/8"-16 thread aluminum bolts.

(b) Safety Evaluation

The only consequence of the original weld failing was the dose received by the staff while retrieving the cap from the beam port terminus. The consequences of the bolts failing should remain the same. With respect to the shielding properties, three holes will be created in the lead. However, the difference should be negligible considering the ample amount of shield already in place. Once installed, the integrity of the shielding will be verified by performing a radiological survey as the reactor increased power to 1 MW.

Movement of an inner plug is a non-routine activity. Considering the small number of times the original tube was handled, the probability of the bolts failing should not be higher than that for the original weld. The use of bolts to fasten the aluminum cap onto an inner shield plug can only affect shielding of the beam port itself. As shielding is the primary concern, and the shielding integrity will be verified by the radiological survey previously mentioned, an accident of a different type than analyzed in the SAR should not occur.

(7) *01-01, Replacement of the Regulating Control Rod Drive Mechanism and Servo Unit*

(a) Description

The Reactor Operations Staff replaced the original regulating control rod drive mechanism and servo unit with a stepper motor and appropriate control unit. It was necessary to replace both the drive mechanism and the servo unit because the new stepper motor used DC instead of AC input signals for motor control. The old regulating rod drive mechanism was a rack and pinion system. The replacement stepper motor rod drive

mechanism does not require a gearbox. It is a modified rack and pinion linear actuator with a travel of 15 inches. The pinion shaft is chain-and-sprocket connected to a 5-phase stepper motor. In the half step mode the stepper motor makes one revolution for every 1000 steps. With the 3:1 reduction provided by the sprockets, full travel is achieved in 21,480 ± 30 steps. With the exception of the motor, chain, and sprockets, the stepper motor rod drive is the same as the drive it will replace.

(b) Safety Evaluation

The gearbox is the primary failure mechanism for the current rod drive system. Because the gearbox will be eliminated, the ability of the systems to perform their intended safety function will be enhanced and decrease the probability of equipment failures. The consequences and frequency of failure of the new servo system will be identical to the current system. The worst-case failure mode of the stepper motor mechanism and servo unit would involve pulling the regulating control rod out of the core at full power. Protection against the consequences of such an event is provided by the high power scrams.

None of the safety channels or interlocks will be affected by this change.

(8) *01-06, Servo System Modification*

(a) Description

The recently installed servo system was modified to improve its performance. Following installation, a series of tests were performed using the new servo system to verify satisfactory performance in all modes of operation. While the servo met or exceeded our expectations for safety, we desired to improve the system response to low power square waves.

A series of square were performed both before and after the installation of the new servo system. One of them was a $0.70 square wave to 50 kW. These parameters were selected to provide a fairly rapid square wave without temperature effects. The overshoot on the square wave performed after installation of the new servo system was significantly higher than the one performed prior to installation.

When the mode switch is placed in square wave, the period circuit in the left hand drawer of the console is disabled and the demand signal is reduced by a preset amount. After the transient rod is fired, power

increases. When the power exceeds the reduced demand, a rod-IN signal is produced. This enables the flux controller and the rod moves in, causing power to level off. After a 1.5 second delay, the period channel is enabled and the reducing factor for the demand is removed.

Increasing the amount by which demand was reduced had little effect on the overshoot. It appears that pulsing of the regulating rod stepper motor is insufficient to turn power quickly enough.

The solution was to provide a continuous rod movement rather than the modulated pulse rod movement for the 1.5 seconds after the first rod-IN signal. A relay currently exists on the flux controller PCA that is timed to drop out 1.5 seconds after the first rod-IN signal. This relay inhibits the period circuit and understates the demand during square wave. A second relay was added, driven by the same timing circuit the period inhibit/demand reduction relay is driven by, which switches the flux controller to steady rod movement mode during the 1.5 seconds. This second relay drops out after the 1.5 seconds, returning rod movement to pulse mode.

(b) Safety Evaluation

The failure mechanism for the newly installed relay would be for it to stay closed, instead of open as expected. This would keep the flux controller (and rod movement) in steady mode instead of the intended pulse mode. If this happened when the reactor is in automatic, the operator would observe more movement of the regulating rod than normal. The behavior would be very similar to an operator manually maintaining power in steady state mode. The speed of rod movement would be identical to manual rod movement through the use of the up/down switches on the console. Therefore, a failure of this relay would not increase the consequence or probability of a malfunction because the function of the servo system would be unaffected.

The current SAR addresses an accident involving a fuel element cladding failure accompanied with a complete loss of primary water. Loss of the pulse width modulation (the primary failure mechanism) would not result in an increased reactivity insertion rate, alter the console scram circuit, or affect the measuring channels.

There are two sections of the Tech Specs that specifically address reactor control systems. The first specifies the measuring channels required for various operational modes. The addition of the relay will have no impact

upon any of the measuring channels. The second outlines the safety channels and interlocks required for operation. None of the safety channels or interlocks will be affected by this change.

(9) *01-02, Scram Response Time Tester*

(a) Description

The method used to measure control rod drop times has changed by using a scram response time tester (SRTT). The present rod drop timer measures the time from when the individual rod scram switch is pressed to when the rod reaches the foot switch. The resolution of this timer is 0.01 second.

This method is being replaced by the SRTT, which is a timer that measures the time it takes from a step change in the fuel element temperature display, causing a scram signal, to a control rod drop to its fully inserted position. Functionally, the SRTT is connected to the console and the fuel element temperature multipoint selector. It will introduce a false signal into the fuel element temperature circuit 10% below the limiting safety system setting of 510° C. By flipping a switch on the SRTT, the false signal will move to 10% above 510° C. This will start a timer that will end upon actuation of a foot switch. The fuel element temperature scram circuit was chosen because it is our limiting safety system setting and the slowest of the scram circuits.

The resolution of this timer is 0.001 second. This is an order of magnitude greater resolution than the present system. However, a resolution of 0.1 seconds would just as easily have met the Tech Spec requirement of 2 seconds.

(b) The purpose of this modification is to functionally test control rod scram times. It serves no safety function. With respect to the console, the only changes will involve rerouting the termination points of selected wiring. It will not interfere with the fuel element temperature scram circuit. No other equipment will be involved.

The current SAR addresses an accident involving a fuel element cladding failure accompanied with a complete loss of primary water. Worst-case malfunction of the SRTT would result in rod scram times that were longer than indicated. However, this is not functionally different from our current system.

Technical Specifications state, "The scram time, measured from the instant the input signal reaches the value of the Safety System setting to the instant that the slowest scrammable control rod reaches its fully inserted position shall not exceed 2 seconds." This is precisely what will be measured.

2. 10 CFR 50.59 Changes to Reactor Procedures

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

For additional information regarding these changes, or copies of the changes, contact the OSTR Operations staff.

(1) *00-02, 03, 14 and 01-05, Revisions to OSTROP 6, "Adminstrative and Personnel Procedures"*

(a) Description

The revisions made to this procedure included: Organizational chart corrections to reflect title and personnel changes, Clerical clarifications in writing style, Addition of requirements for Emergency Response and Physical Security Plan changes to be reviewed by the ROC prior to implementation, and the implementation of new 10 CFR 50.59 requirements.

(b) Safety Evaluation

In the case of position title changes related to the Technical Specifications, equivalent authority, responsibility and chain of command is maintained.

The NRC has deemed that the new regulations found in 10 CFR 50.59 are acceptable replacements for the current procedures for the safety evaluation of changes, tests or experiments.

All other clerical corrections were considered minor text editing.

(2) *00-04, Revision to OSTROP 18, "Procedures for the Approval and Use of Reactor Experiments"*

(a) Description

The changes made here reflect the Reactor Operations staff's desire to comply with policies established by the OSU Radiation Safety Committee for:

- The location of form completion instructions,
- Approval requirements for production of radionuclides with half-lives greater than 24 hours,
- Clerical error corrections.

(b) Safety Evaluation

These changes bring OSTROP 18 in compliance with policy set forth by the OSU Radiation Safety Committee to ensure tracking of inventories of radioactive material held on the general license issued by the State of Oregon.

(3) *00-09, Revision to OSTROP 26, "Procedures for the Connection of External Monitoring and Recording Devices"*

(a) Description

A generic reference to all types of external monitoring devices was inserted in place of the specific software program previously used to monitor desired parameters. This allows the procedure to extend to all types of devices, as the procedure title implies.

(b) Safety Evaluation

This change does not alter the intent of the OSTROP, but seeks to eliminate specific references to brand name software and hardware.

(4) *00-13, Revision to OSTROP 17, "Reactor Room Ventilation System Procedures"*

(a) Description

This change deals with minor clerical corrections to the main body text.

(b) Safety Evaluation

These changes represent only minor text editing. They do not reduce or alter the intent of the OSTROP.

3. 10 CFR 50.59 Changes to Reactor Experiments

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

E. Surveillance and Maintenance

1. Non-Routine Maintenance

July 14, 2000	Replaced worn key switch contact plate (A deck).
September 20, 2000	Fabricated and installed new rotary contact plates for reactor top fishing pole.
December 15, 2000	Replaced high voltage capacitor on stack particulate channel rate meter assembly.
December 25, 2000	Completed water line tie in to new Hazardous Waste Material Building.
December 28, 2000	Facility Services replaced damaged linoleum flooring in D102 caused by nitrogen overflow.
January 19, 2001	Re-stacked BP#3 shield bricks from pallets to storage stack.
March 28, 2001	Facility Services repaired broken hinge pin on reactor building roof hatch.
April 10, 2001	Replaced cracked Lazy Susan vent hose with like type.
April 12, 2001	Replaced Cooling Tower #1 fan disconnect switchbox and internals
April 16 2001	Three batteries in emergency power system inverter replaced.
April 26, 2001	Replaced reactor bay ventilation system intake filters with non-pleated type provided by Facility Services.
April 27, 2001	Completed fabrication of new 10" offset ICIT and CLICIT tubes.
May 24, 2001	Replaced two fire detection thermal switches in reactor bay roof area, and one in C corridor.

June 12, 2001	Completed painting the control room and office area.
June 14, 2001	Facility Services replaced the steam flow meter and replaced reactor bay intake system ventilation filters.

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 this reporting period. These events included the self-identification of a security plan violation and a failure to meet required SRO medical examination criteria.

Table IV.A.1
OSTR Operating Statistics (Using the FLIP Fuel Core)

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

Table IV.A.1 (Continued)

OSTR Operating Statistics (Using the FLIP Fuel Core)

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

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	July 1, 1999 Through June 30, 2000
Operating Hours (critical)	1180	1248	1262	1226	1124	1029	1241	949	983
Megawatt Hours	1026	1122	1117	1105	985	927	1115	852	896
Megawatt Days	42.7	46.7	46.6	46.0	41.0	38.6	46.5	35.5	37.3
Grams ^{235}U Used	53.6	58.6	58.4	57.8	51.5	48.5	58.3	44.6	46.8
Hours at Full Power (1 MW)	1000	1109	1110	1101	980	921	1109	843	890
Numbers of Fuel Elements Added or Removed (-)	0	0	0	-1(5)	-1, +1(7)	0	-1(5)	0	0
Number of Irradiation Requests	329	303	324	268	282	249	231	234	210

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

Table IV.A.2

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

Operational Data for 20% Enriched Core	Mar 8, 67 Through Jun 30, 68	Jul 1, 68 Through Jun 30, 69	Jul 1, 69 Through Mar 31, 70	Apr 1, 70 Through Mar 31, 71	Apr 1, 71 Through Mar 31, 72	Apr 1, 72 Through Mar 31, 73	Apr 1, 73 Through Mar 31, 74	Apr 1, 74 Through Mar 31, 75	Apr 1, 75 Through Mar 31, 76	Apr 1, 76 Through Jul 26, 76	TOTAL: March 67 Through July 76
Operating Hours (critical)	904	610	567	855	598	954	705	563	794	353	6903
Megawatt Hours	117.2	102.5	138.1	223.8	195.1	497.8	335.9	321.5	408.0	213.0	2553.0
Megawatt Days	4.9	4.3	5.8	9.3	8.1	20.7	14.1	13.4	17.0	9.0	106.4
Grams ^{235}U Used	6.1	5.4	7.2	11.7	10.2	26.0	17.6	16.8	21.4	10.7	133.0
Hours at Full Power (250 kW)	429	369	58	---	---	---	---	---	---	---	856
Hours at Full Power (1 MW)	---	---	20	23	100	401	200	291	460	205	1700
Number of Fuel Elements Added to Core	70 (Initial)	2	13	1	1	1	2	2	2	0	94
Number of Irradiation Requests	429	433	391	528	347	550	452	396	357	217	4100
Number of Pulses	202	236	299	102	98	249	109	183	43	39	1560

(1) Reactor went critical on March 8, 1967 (70 element core; 250kW). Note: This period length is 1.33 years as initial criticality occurred in March of 1967.

(2) Reactor shutdown August 22, 1969 for one month for upgrading to 1MW (did not upgrade cooling system). Note: This period length is only 0.75 years as there was a change in the reporting period from July-June to April-March.

(3) Reactor shutdown June 1, 1971 for one month for cooling system upgrading.

(4) Reactor shutdown July 26, 1976 for one month for refueling reactor with a new full FLIP fuel core. Note: This period length is 0.33 years.

Table IV.A.3
Present OSTR Operating Statistics

Operational Data for FLIP Core	Annual Values (2000/2001)	Cumulative Values for FLIP Core
MWH of energy produced	896	22,744
MWD of energy produced	37.3	947.7
Grams ^{235}U used	46.8	1,189.3
Number of fuel elements added to (+) or removed from (-) the core	0	80 + 3 FFCR[(1)]
Number of pulses	17	1,356
Hours reactor critical	983	27,776
Hours at full power (1 MW)	890	22,331
Number of startup and shutdown checks	252	6317
Number of irradiation requests processed[(2)]	210	8,314
Number of samples irradiated	3705	103,325

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

(2) Each irradiation request could authorize from 0 to 146 samples. The number of samples per irradiation request averaged 17.6 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]	479	13,106
OSU research[2]	105	8,689
Off-campus research[2]	1,282	15,658
Forensic services	0	231[3]
Reactor preclude time	1,015	19,642
Facility time[4]	7	7,093
TOTAL REACTOR USE TIME	2,888[5]	64,419

(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) 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	299	4,153
Three	90	1,287
Four	35	481
Five	0	115
Six	0	45.5
Seven	0	11
TOTAL MULTIPLE USE TIME	424[2]	6,092.5[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 21.9% 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)

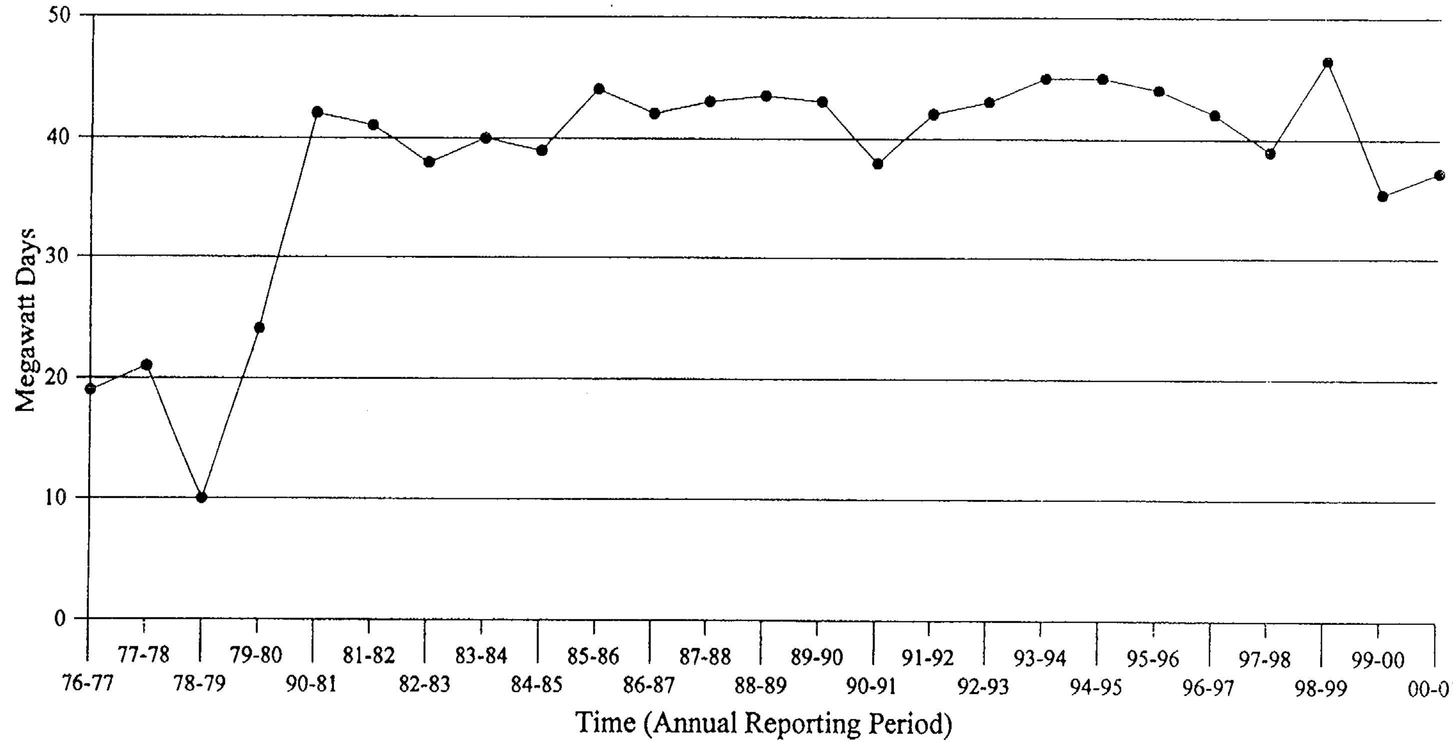


Table IV.B.1

Use of OSTR Reactor Experiments[1]

Reactor Experiment Number[2]	Research	Teaching	Forensic	NRC License Requirement	TOTAL
A-1	3	24	0	2	29
B-3	141	31	3	0	172
B-31	9	0	0	0	9
TOTAL	153	55	0	2	210

(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-31 TRIGA Flux Mapping

Table IV.C.1

Unplanned Reactor Shutdowns and Scrams

Type of Event	Number of Occurrences	Cause of Event
Safety Power Scram	1	Operator error. Automatic scram on high Safety Power Channel due to Lazy Susan samples shielding effect on monitored power channel during power increase.
Percent Power Scram	1	Operator error. Automatic scram on high Percent Power Channel due to Lazy Susan samples shielding effect on monitored power channel during power increase.
Period Scram	3	AC spike noise on period channel. Power at <0.1 watt. Noise occurs when moving rods. Twice occurred during licensee NRC exam. Scrams received while withdrawing shim rod to 15 watts. Determined to be caused by instrument noise at low power.
High Voltage 1 Scram	1	HV1 annunciated scram occurred at the same time left hand drawer was touched by Reactor Supervisor. Static discharge to LHD noted at the same time.
Manual Reactor Scram	1	Seismic activity felt in Control Room. Received later information confirming earthquake occurrence.
Manual Reactor Scram	1	Reactor shutdown prompted by loss of off-site power. Cause of loss later determined to mylar balloons hitting a substation.
Manual Reactor Shutdown	1	High stack gas alarm required shutdown. High level determined to be caused by change out of reactor top Lazy Susan filter, increasing system flow and causing "slug" effect through detector.
Manual Reactor Shutdown	1	Manual shutdown prompted by loss of #1 Cooling Tower Fan. Fuse in disconnect panel blew due to high resistance connection.

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

OSTROP 13 — SURVEILLANCE & MAINTENANCE FOR THE MONTH OF

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

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

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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	a) TIME	b) OPERATING EXERCISE			
	NAME						
13	CHECK FILTER TAPE SPEED ON STACK MONITOR	1"/HR ± 0.2					
14	INCORPORATE 50.59 & ROCAS INTO DOCUMENTATION	QUARTERLY					
15	(NOT BEING USED)						
16	FUNCTIONAL CHECK OF EVACUATION ALARMS	ALL FUNCTIONAL					
17	(NOT BEING USED)						
18	STACK MONITOR ALARM CIRCUIT CHECKS	ALARM ON CONTACT					
19	ALARM TESTING OF VITAL AREA DOUBLE DOORS	FUNCTIONAL					

‡ Physical Security Plan Requirement
* License Requirement
** Date not t[illegible] exceeded is only applicable to marked (*) items. It is equal to the date com[illegible]ed last quarter plus four months.

Figure IV.E.3

Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP.15 | SEMI-ANNUAL SURVEILLANCE AND MAINTENANCE FOR ______________

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

* License Requirements.

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

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Figure IV.E.3 (Continued)

Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP 15 (continued) SEMI-ANNUAL SURVEILLANCE AND MAINTENANCE FOR ____________

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

* License Requirements.

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

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

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

No.	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 + 78 DAYS)		NOV 1		OCT 1	NOV 1		
*3	CONTROL ROD CALIBRATION:	a) SAFE	OSTROP 9.0					
		b) SHIM						
		c) REG						
		d) TRANS						
*4	REACTOR POWER CALIBRATION		OSTROP 8.0					
*5	CALIBRATION OF REACTOR TANK WATER TEMPERATURE METERS		OSTROP 16.5					
*6	CONTINUOUS AIR MONITOR CALIBRATION:	a) Particulate Monitor	RCHPP 18.0					
		b) Gas Monitor						
*7	STACK MONITOR CALIBRATION:	a) Particulate Monitor	RCHPP 18 & 26					
		b) Gas Monitor						
*8	AREA RADIATION MONITOR CALIBRATION		RCHPP 18.0					
*9	WATER MONITOR CALIBRATION		RCHPP 18.0					
10	REACTOR TANK AND CORE COMPONENT INSPECTION		NO POWDERY WHITE SPOTS					
*11	SNM PHYSICAL INVENTORY		OSTROP 20.0					
*12	EMERGENCY RESPONSE PLAN DRILL							
*13	STANDARD CONTROL ROD DRIVE INSPECTION		OSTROP 16.13					
*14	OSU POLICE AND SECURITY RETRAINING							
*15	50.59 REPORT		NOV 15		OCT 15	NOV 15		
*16	INTRUSION ALARM RESPONSE DRILL (OSU POLICE AND SECURITY)		RESPONSE ≤5 MIN					

* License Requirements.

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

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

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

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

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

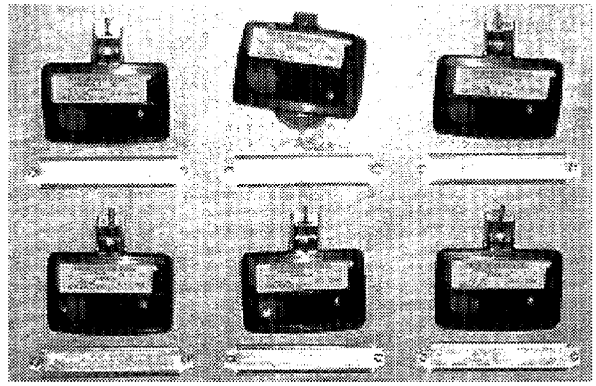
23	NAME	ANNUAL - CPR		EVERY 3 YEARS - FIRST AID	
		REMINDER DATE	EXPIRY DATE	REMINDER DATE	EXPIRY DATE

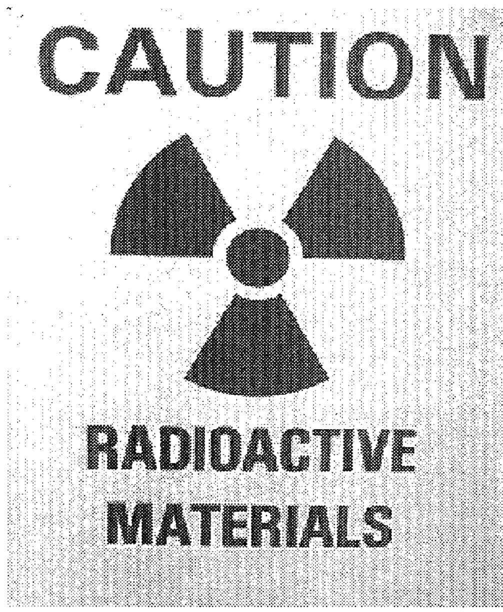
* License Requirements.
** Date not to be exceeded is only applicable to marked (*) items. It is equal to the date completed last year plus 15 months. For biennial license requirements, it is equal to the date completed last time plus 2½ years

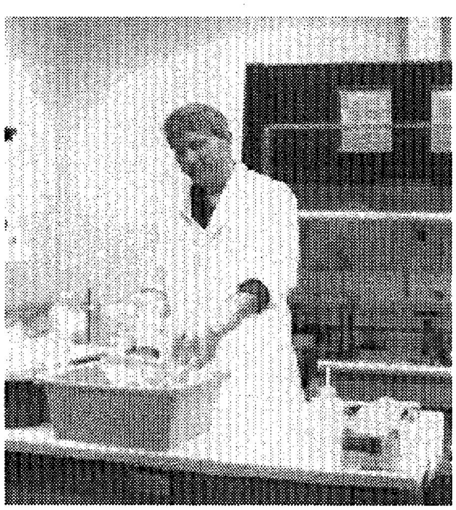
ev. 5/94

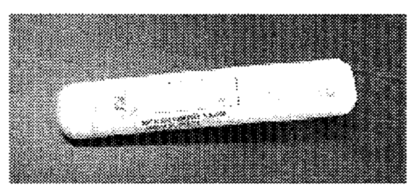
Part V

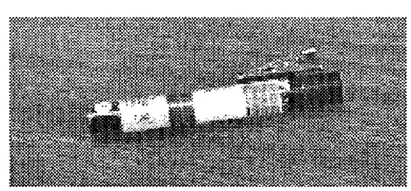
Protection











Part V

PROTECTION

A. Introduction

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

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

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

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

B. Environmental Releases

The annual reporting requirements in the OSTR Technical Specifications state that the licensee (OSU) shall include "a summary of the nature and amount of radioactive effluents released or discharged to the environs beyond the effective control of the licensee, as measured at, or prior to, the point of such release or discharge." The liquid and gaseous effluents released, and the solid waste generated and transferred are discussed briefly below. Data regarding these effluents are also summarized in detail in the designated tables.

1. Liquid Effluents Released

a. Liquid Effluents Released

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

b. Liquid Waste Generated and Transferred

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

2. Airborne Effluents Released

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

a. Gaseous Effluents

Gaseous effluents from the reactor facility are monitored by the reactor stack effluent monitor. Monitoring is continuous, i.e., prior to, during, and after reactor operations. It is normal for the reactor facility stack effluent monitor to begin operation as one of the first systems in the morning and to cease operation as one of the last systems at the end of the day. All gaseous effluent data for this reporting period are summarized in Table V.B.2.

b. Particulate Effluents

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

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

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

3. Solid Waste Released

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

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

C. Personnel Doses

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

Facility operating personnel include the reactor operations and health physics staff. The dosimeters used to monitor these individuals include quarterly TLD badges, quarterly track-etch/albedo neutron dosimeters, monthly 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 quarterly TLD film badge and TLD (finger) extremity dosimeters. If the possibility of neutron exposure exists, researchers are also monitored with a track-etch/albedo neutron dosimeter.

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

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

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

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

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

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

D. Facility Survey Data

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

1. Area Radiation Dosimeters

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

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.

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

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

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

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

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

b. Off-site Monitoring

The off-site gamma environmental radiation monitoring program consists of twenty monitoring stations surrounding the Radiation Center (see Figure V.E.2) and six stations located within a 5 mile radius of the Radiation Center.

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

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

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

2. Soil, Water, and Vegetation Surveys

The soil, water, and vegetation monitoring program consists of the collection and analysis of a limited number of samples in each category on a quarterly basis. The program monitors highly unlikely radioactive material releases from either the TRIGA reactor facility or the OSU Radiation Center, and also helps indicate the general trend of the radioactivity

concentration in each of the various substances sampled. See Figure V.E.1 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.1.

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

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

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

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

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

F. Radioactive Material Shipments

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

G. References

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

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

Table V.A.1

Radiation Protection Program Requirements and Frequencies

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

Table V.B.1.a

Monthly Summary of Liquid Effluent Releases to the Sanitary Sewer[1,2]

(OSTR Contribution Shown in ( ) and Bold Print)

Date of Discharge (Month and Year)	Total Quantity of Radioactivity Released (Curies)	Detectable Radionuclides in the Waste	Specific Activity For Each Detectable Radionuclide in the Waste, Where the Release Concentration Was $>1 \times 10^{-7}$ μCi/cm^3 (μCi ml^{-1})	Total Quantity of Each Detectable Radionuclide Released in the Waste (Curies)	Average Concentration of Released Radioactive Material at the Point of Release (μCi ml^{-1})	Percent of Applicable Monthly Average Concentration for Released Radioactive Material (%) [3]	Total Volume of Liquid Effluent Released Including Diluent [4] (gal)
August 2000	6.34×10^{-5}	^{3}H	1.19×10^{-5}	6.34×10^{-5}	1.19×10^{-5}	0.12%	1408
June 2001	0	---	0	0	0	0	2372
Annual Total for Radiation Center	6.34×10^{-5}	^{3}H	1.19×10^{-5}	6.34×10^{-5}	1.19×10^{-5}	0.04%	3780
OSTR Contribution to Above	N/A	N/A	N/A	N/A	N/A	N/A	N/A

(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	---	---	---	---
Radiation Center Laboratories	0.13	^{3}H, ^{14}C, ^{131}I	2.1×10^{-6}	3/27/01	---
TOTAL	0.13	^{3}H, ^{14}C, ^{131}I	2.1×10^{-6}	---	---

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

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

Table V.B.2

Monthly Summary of Gaseous Effluent Releases[(1)]

Date of Discharge (Month and Year)	Total Estimated Radioactivity Released (Curies)	Total Estimated Quantity of Argon-41 Released[(2)] (Curies)	Estimated Average Atmospheric Diluted Concentration of Argon-41 at Point of Release (Reactor Stack) ($\mu Ci/ml^{-1}$)	Percent of the Applicable MPC for Diluted Concentration of Argon-41 at Point of Release (Reactor Stack) (%)
July 00	0.25	0.25	1.97E-08	0.49
August 00	0.30	0.30	2.32E-08	0.58
September 00	0.28	0.28	2.27E-08	0.57
October 00	0.28	0.28	2.16E-08	0.54
November 00	0.32	0.32	2.54E-08	0.63
December 00	0.33	0.33	2.60E-08	0.65
January 01	0.33	0.33	2.57E-08	0.64
February 01	0.48	0.48	4.18E-08	1.04
March 01	0.53	0.53	4.15E-08	1.04
April 01	0.19	0.19	1.79E-08	0.45
May 01	0.17	0.17	1.33E-08	0.33
June 00	0.26	0.26	2.09E-08	0.52
ANNUAL VALUE	3.74	3.74	2.50E-08	0.62

(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	25.25(3)	^{46}Sc, ^{47}Sc, ^{58}Co, ^{60}Co, ^{124}Sb, ^{152}Eu,	7.2×10^{-4}	10/27/00, 12/6/00, 3/27/01	12/20/00, 3/15/01, 5/23/01
Radiation Center Laboratories	13.25	^{3}H, ^{14}C, ^{46}Sc, ^{47}Sc, ^{232}Th, ^{60}Co, ^{153}Sm, ^{238}U	1.65×10^{-5}	10/27/00, 3/27/01	5/23/01
TOTAL	38.5	See Above	7.4×10^{-4}	---	---

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

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

(3) Includes 4 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	33	14	215	863	711	2576
Key Facility Research Personnel	3	1	21	41	237	97
Facilities Services Maintenance Personnel	<1	N/A	19	N/A	78	N/A
Laboratory Class Students	<1	4	28	39	401	629
Campus Police and Security Personnel	2	N/A	20	N/A	250	N/A
Visitors	<1	N/A	27	N/A	108	N/A

(1) "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)]	
		$x\beta(\gamma)$ (mrem)	Neutron (mrem)
MRCTNE	D104: North Badge East Wall	127	ND
MRCTSE	D104: South Badge East Wall	53	ND
MRCTSW	D104: South Badge West Wall	260	ND
MRCTNW	D104: North Badge West Wall	60	ND
MRCTWN	D104: West Badge North Wall	41	ND
MRCTEN	D104: East Badge North Wall	384	ND
MRCTES	D104: East Badge South Wall	638	ND
MRCTWS	D104: West Badge South Wall	250	ND
MRCTTOP	D104: Reactor Top Badge	292	ND
MRCTHXS	D104A: South Badge HX Room	282	ND
MRCTHXW	D104A: West Badge HX Room	97	ND
MRCD-302	D302: Reactor Control Room	169	ND
MRCD-302A	D302A: Reactor Supervisor's Office	13	N/A
MRCBP1	D104: Beam Port Number 1	16	ND
MRCBP2	D104: Beam Port Number 2	138	ND
MRCBP3	D104: Beam Port Number 3	486	ND
MRCBP4	D104: Beam Port Number 4	294	ND

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

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

Table V.D.2

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

Monitor I.D.	Radiation Center Facility Location (See Figure V.D.1)		Total Recorded Dose Equivalent[1]	
			$x\beta(\gamma)$ (mrem)	Neutron (mrem)
MRCA100	A100:	Receptionist's Office	ND	N/A
MRCBRF	A102H:	Front Personnel Dosimetry Storage Rack	11	N/A
MRCA120	A120:	Stock Room	14	N/A
MRCA120A	A120A:	NAA Temporary Storage	ND	N/A
MRCA126	A126:	Campus RSO's Isotope Receiving Lab	221	N/A
MRCCO-60	A128:	^{60}Co Irradiator Room	316	N/A
MRCA130	A130:	Shielded Exposure Room	12	N/A
MRCA132	A132:	TLD Equipment Room	ND	N/A
MRCA134-2	A134:	Graduate Student Office	169	N/A
MRCA138	A138:	Health Physics Laboratory	11	N/A
MRCA146	A146:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCB100	B100:	Gamma Analyzer Room (Storage Cave)	264	N/A
MRCB114	B114:	α Lab (^{226}Ra Storage Facility)	1,384	ND
MRCB119-1	B119:	Source Storage Room	168	N/A
MRCB119-2	B119:	Source Storage Room	338	N/A
MRCB119A	B119A:	Sealed Source Storage Room	5268	2,133
MRCB120	B120:	Instrument Calibration Facility	14	N/A
MRCB122-2	B122:	Radioisotope Storage Hood	78	N/A
MRCB122-3	B122:	Radioisotope Research Laboratory	11	N/A
MRCB124-1	B124:	Radioisotope Research Lab (Hood)	ND	N/A
MRCB124-2	B124:	Radioisotope Research Laboratory	11	N/A
MRCB124-6	B124:	Radioisotope Research Laboratory	11	N/A
MRCB128	B128:	Instrument Repair Shop	ND	N/A
MRCC100	C100:	Radiation Center Director's Office	ND	N/A
MRCC106A	C106A:	Staff Lunch Room	10	N/A
MRCC106B	C106:	Solvent Storage Room	ND	N/A
MRCC106-H	C106H:	East Loading Dock	12	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(γ) (mrem)	Neutron (mrem)
MRCC118	C118:	Radiochemistry Laboratory	ND	N/A
MRCC120	C120:	Student Counting Laboratory	11	N/A
MRCF100	F100:	APEX Facility	ND	N/A
MRCF102	F102:	APEX Control Room	ND	N/A
MRCB125N	B125:	Gamma Analyzer Room (Storage Cave)	11	N/A
MRCB125S	B125:	Gamma Analyzer Room	ND	N/A
MRCC124	C124:	Student Computer Laboratory	32	N/A
MRCC130-1	C130:	Radioisotope Laboratory (Hood)	ND	N/A
MRCC134	C134:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCD100	D100:	Reactor Support Laboratory	250	N/A
MRCD102	D102:	Pneumatic Transfer Terminal Lab	142	ND
MRCD102-H	D102H:	1st Floor Corridor at D102	63	ND
MRCD106-H	D106H:	1st Floor Corridor at D106	95	N/A
MRCD200	D200:	Reactor Administrators's Office	194	ND
MRCD202	D202:	Senior Health Physicist's Office	189	ND
MRCBRR	D200H:	Rear Personnel Dosimetry Storage Rack	24	N/A
MRCD204	D204	Health Physicist Office	97	ND
MRCF104	F104:	ATHRL	11	ND
MRCD300	D300:	3rd Floor Conference Room	98	ND

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

Table V.D.3

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

Accessible Location (See Figure V.D.1)	Whole Body Radiation Levels (mrem h^{-1})		Contamination Levels[1] (dpm/100 cm^2)	
	Average	Maximum	Average	Maximum
TRIGA Reactor Facility:				
Reactor Top (D104)	1	130	<500	<500
Reactor 2nd Deck Area (D104)	5	31	<500	<500
Reactor Bay SW (D104)	<1	2	<500	<500
Reactor Bay NW (D104)	<1	2	<500	1800
Reactor Bay NE (D104)	<1	3	<500	680
Reactor Bay SE (D104)	<1	21	<500	<500
Class Experiments (D104, D302)	<1	60	<500	<500
Demineralizer Tank--Outside Shielding (D104A)	<1	2	<500	<500
Particulate Filter--Outside Shielding (D104A)	<1	1	<500	<500
Radiation Center:				
NAA Counting Rooms (A146, B100, C134)	<1	<1	<500	<500
Health Physics Laboratory (A138)	<1	<1	<500	<500
^{60}Co Irradiator Room and calibration rooms (A128, A130, B120)	<1	1	<500	<500
Radiation Research Labs (B108, B114, B122, B124, C130, C132A)	<1	<1	<500	<500
Radioactive Source Storage (A120A, B119, B119A)	<1	1	<500	<500
Student Chemistry Laboratory (C118)	<1	<1	<500	<500
Student Counting Laboratory (C120)	<1	<1	<500	<500
Operations Counting Room (B136, C123)	<1	<1	<500	<500
Pneumatic Transfer Laboratory (D102)	<1	3	<500	<500
TRIGA Tube Wash Room (D100)	<1	2	<500	<500

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

Table V.E.1

Total Dose Equivalent at the TRIGA Reactor Facility Fence

Fence Environmental Monitoring Station (See Figure V.E.1)	Total Recorded Dose Equivalent (Including Background) Based on ICN TLDs[1] (mrem)	Total Recorded Dose Equivalent (Including Background) Based on OSU TLDs[2][3] (mrem)	Total Calculated Dose Equivalent (Including Background) Based on the Annual Average $\mu rem\ h^{-1}$ Dose Rate[3] (mrem)
MRCFE-1	85 ± 3	71 ± 5	80 ± 15
MRCFE-2	71 ± 2[4]	59 ± 3	66 ± 9
MRCFE-3	68 ± 1[4]	57 ± 3	63 ± 10
MRCFE-4	82 ± 3	72 ± 6	78 ± 8
MRCFE-5	72 ± 2[4]	61 ± 4	65 ± 10
MRCFE-6	77 ± 3	61 ± 4	75 ± 13
MRCFE-7	76 ± 4	62 ± 4	64 ± 10
MRCFE-8	72 ± 4	60 ± 5	67 ± 7
MRCFE-9	71 ± 3	57 ± 3	65 ± 8

(1) Average Corvallis area natural background using ICN TLDs totals 64 ± 11 mrem for the same period.

(2) OSU fence totals include a measured natural background contribution of 54 ± 6 mrem.

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

(4) Unusual element result observed. The total mrem includes one quarter that is the average of three quarters.

Table V.E.2

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

Off-Site Radiation Monitoring Station[1] (See Figure V.E.2)	Total Recorded Dose Equivalent (Including Background) Based on ICN TLDs[2] (mrem)	Total Recorded Dose Equivalent (Including Background) Based on OSU TLDs[3][4] (mrem)	Total Calculated Dose Equivalent (Including Background) Based on the Annual Average μrem/h Exposure Rate[4] (mrem)
MRCTE-2L	---	50 ±4	47 ± 10
MRCTE-3	83 ± 2	54 ± 2	61 ± 11
MRCTE-4	74 ± 2	68 ± 10	61 ± 12
MRCTE-5L	---	53 ± 1	68 ± 15
MRCTE-6	77 ± 2	53 ± 3	67 ± 10
MRCTE-7L	---	50 ± 6	68 ± 9
MRCTE-8	87 ± 3	52 ± 4	73 ± 8
MRCTE-9	76 ± 3	46 ± 2	63 ± 10
MRCTE-10	70 ± 2	119 ± 32	53 ± 11
MRCTE-12	80 ± 3	54 ± 5	67 ± 12
MRCTE-13L	---	50 ± 4	67 ± 10
MRCTE-14L	---	53 ± 4	47 ± 11
MRCTE-15	65 ± 1	48 ± 3	51 ± 9
MRCTE-16L	---	67 ± 5	66 ± 9
MRCTE-17	74 ± 2	59 ± 4	55 ± 9
MRCTE-18L	---	67 ± 7	65 ± 12
MRCTE-19	80 ± 2[5]	60 ± 2	70 ± 7
MRCTE-20L	---	56 ± 5	64 ± 10
MRCTE-21	62 ± 1	77 ± 23	52 ± 10
MRCTE-22	66 ± 2	50 ± 4	50 ± 10

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

(2) Average Corvallis area natural background using ICN TLDs totals 64 ± 11 mrem for the same period.

(3) OSU off-site totals include a measured natural background contribution of 54 ± 6 mrem.

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

(5) Unusual element result observed. The total mrem includes one quarter that is the average of three quarters.

Table V.E.3

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

Sample Location (See Figure V.E.2)	Sample Type	Annual Average Concentration of the Total Net Beta (Minus ^3H) Radioactivity[(1)]	Reporting Units
1-W	Water	6.72E-07 ± 1.16E-06[(2)]	µCi ml^{-1}
4-W	Water	9.08E-07 ± 1.87E-06[(2)]	µCi ml^{-1}
11-W	Water	5.89E-08 ± 1.12E-09[(2)]	µCi ml^{-1}
19-RW	Water	7.14E-08 ± 4.91E-08[(2)]	µCi ml^{-1}
3-S	Soil	7.66E-05 ± 6.32E-05	µCi g^{-1} of dry soil
5-S	Soil	4.90E-05 ± 5.29E-05	µCi g^{-1} of dry soil
20-S	Soil	5.58E-05 ± 4.13E-05	µCi g^{-1} of dry soil
21-S	Soil	7.65E-05 ± 1.99E-05	µCi g^{-1} of dry soil
2-G	Grass	3.27E-04 ± 1.82E-04	µCi g^{-1} of dry ash
6-G	Grass	2.30E-04± 1.69E-04	µCi g^{-1} of dry ash
7-G	Grass	3.55E-04 ± 8.98E-05	µCi g^{-1} of dry ash
8-G	Grass	3.76E-04 ± 1.03E-04	µCi g^{-1} of dry ash
9-G	Grass	3.80E-04 ± 8.84E-05	µCi g^{-1} of dry ash
10-G	Grass	3.05E-04 ±2.51E-04	µCi g^{-1} of dry ash
12-G	Grass	4.00E-04 ± 2.80E-04	µCi g^{-1} of dry ash
13-G	Grass	3.68E-04 ±1.28E-04	µCi g^{-1} of dry ash
14-G	Grass	2.11E-04 ± 2.18E-04	µCi g^{-1} of dry ash
15-G	Grass	3.75E-04 ± 2.13E-04	µCi g^{-1} of dry ash
16-G	Grass	1.61E-04 ± 1.13E-04	µCi g^{-1} of dry ash
17-G	Grass	3.29E-04 ± 1.46E-04	µCi g^{-1} of dry ash
18-G	Grass	2.84E-04 ± 8.19E-05	µCi g^{-1} of dry ash
22-G	Grass	3.53E-04 ± 2.97E-05	µCi g^{-1} of dry ash

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

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

Table V.E.4

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

Sample Type	Average LLD Value	Range of LLD Values	Reporting Units
Soil	2.11E-05	1.20E-05 *to* 4.42E-05	μCi g^{-1} of dry soil
Water	3.76E-07	5.82E-08 *to* 2.23E-06	μCi ml^{-1}
Vegetation	7.12E-05	2.81E-06 *to* 1.57E-04	μCi g^{-1} of dry ash

Table V.F.1

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

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	Yellow II	Yellow III	Total
,	4.91E-06	0	0	0	0
Berkeley Geochronology Center Berkeley, CA USA	3.43E-06	9	0	0	9
Berkeley Geochronology Center Berkeley, California USA	2.86E-06	9	0	0	9
Brigham Young University Provo, UT USA	3.56E-08	1	0	0	1
C.O.R.D. University of Wisconsin-Madison Madison, WI USA	1.30E-05	0	1	0	1
Columbia University Palisades, NY USA	9.50E-06	5	0	0	5
Idaho State University Pocatello, ID USA	1.74E-05	0	4	0	4
Idaho State University Pocatello, Idaho USA	7.14E-05	0	4	0	4
Lawrence Berkeley National Laboratory Berkeley, California USA	4.07E-06	0	1	0	1
Motorola Scottsdale, Arizona USA	1.17E-06	1	0	0	1
Oregon State University Corvallis, OR USA	7.63E-06	1	2	0	3
Oregon State University Oceanography Department Corvallis, OR USA	2.54E-06	0	1	0	1
Plattsburgh State University Plattsburgh, NY USA	2.02E-06	3	0	0	3
Stanford University Stanford, CA USA	2.67E-06	4	0	0	4
Stanford University Stanford, California USA	2.76E-07	4	0	0	4

Table V.F.1

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

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	Yellow II	Yellow III	Total
Union College Schenectady, New York USA	3.40E-07	6	0	0	6
Union College Schenectady, NY USA	2.05E+08	6	0	0	6
University of California at Berkeley Berkeley, CA USA	4.45E-06	3	3	0	6
University of California at Berkeley Berkeley, California USA	1.22E-05	3	3	0	6
University of California at Santa Barbara Santa Barbara, CA USA	4.98E-06	4	0	0	4
University of California at Santa Barbara Santa Barbara, California USA	4.19E-07	4	0	0	4
University of Washington Seattle, WA USA	1.18E-06	1	0	0	1
University of Wisconsin Madison, Wisconsin USA	5.21E-07	0	1	0	1
University of Wisconsin-Madison Madison, WI USA	5.37E+07	2	1	0	3
University of Wyoming Laramie, WY USA	1.22E-06	1	1	0	2
Totals	2.59E+08	67	22	0	89

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				
		LSA - 1	Limited Quantity	White I	Yellow II	Total
Colorado State University Fort Collins, CO USA	1.74E-07	0	1	0	0	1
Lawrence Berkeley National Laboratory Berkeley, CA USA	6.17E-10	3	0	0	1	4
Lawrence Berkeley National Laboratory Berkeley, California USA	1.49E-05	3	0	0	1	4
Oregon Office of Energy Salem, OR USA	3.70E-08	0	1	0	0	1
Oregon State University Corvallis, OR USA	4.96E-06	0	3	0	1	4

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				
		LSA - 1	Limited Quantity	White I	Yellow II	Total
Sandia National Laboratory Albuquerque, New Mexico USA	1.39E-06	0	1	0	0	1
University of California at Davis Davis, CA USA	4.30E-08	0	1	0	0	1
Totals	2.15E-05	6	7	0	3	16

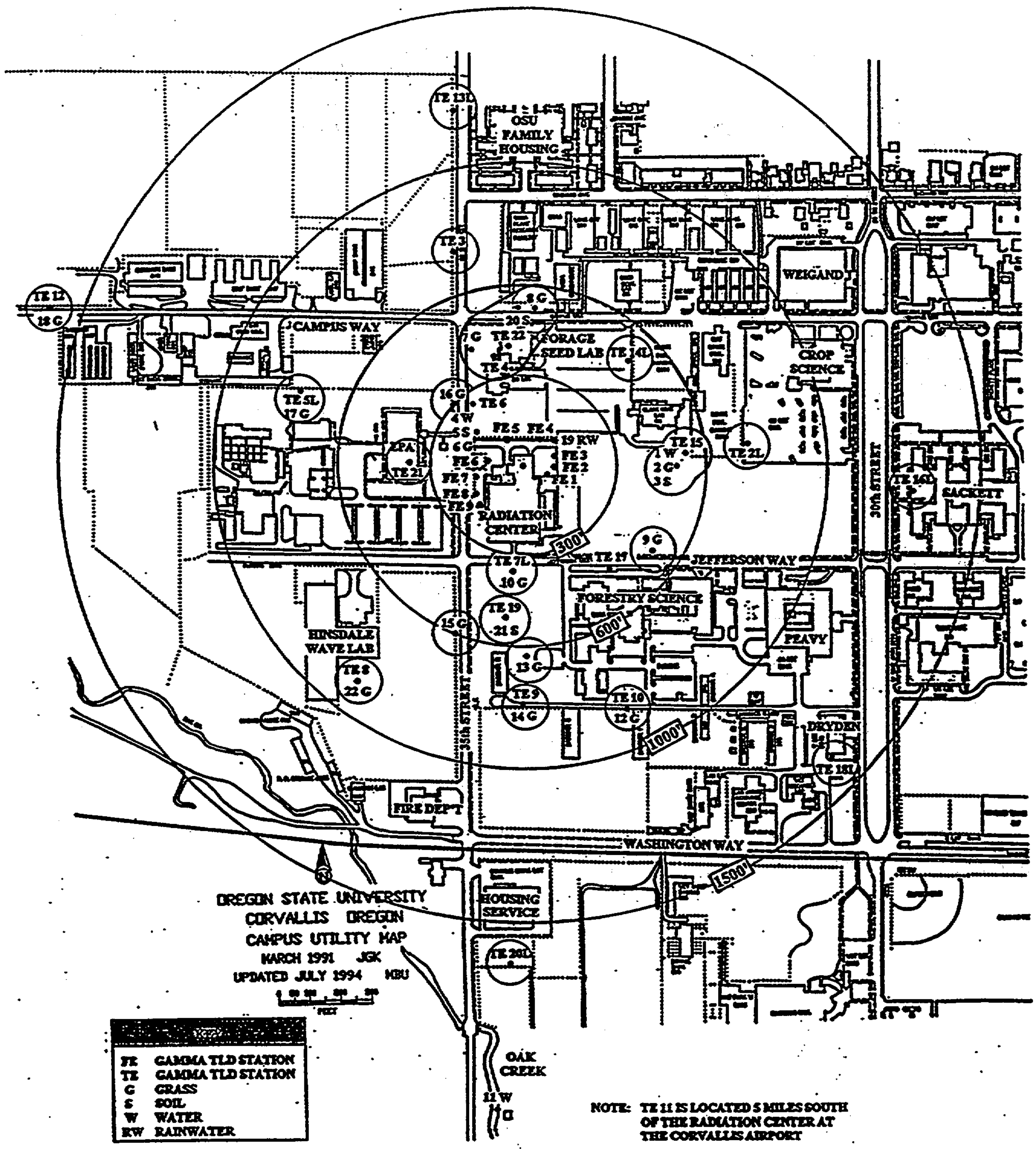
Table V.F.3

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

Shipped To	Total Activity (TBq)	Number of Shipments			
		Limited Quantity	Yellow II	Yellow III	Total
Ruhr-Universitat Bochum Bochum, GERMANY	8.55E-07	1	0	0	1
Scottish Universities Research and Reactor Centre East Kilbride, SCOTLAND	9.56E-07	0	1	0	1
Universita' Degli Studi di Bologna Bologna, ITALY	9.25E-07	2	0	0	2
Universitat Potsdam Postdam, GERMANY	8.09E-07	2	0	0	2
Universitat Tubingen Tubingen, GERMANY	3.91E-07	1	0	0	1
Universite Paris-Sud Paris, France	2.01E-05	0	2	0	2
University of Geneva Geneva, SWITZERLAND	2.97E-07	1	0	0	1
University of Queensland Brisbane, Queensland AUSTRALIA	7.33E-07	1	0	0	1
University of Tuebingen Tuebingen, GERMANY	9.18E-08	2	0	0	2
Vrije Universiteit Amsterdam, THE NETHERLANDS	4.89E-06	0	2	0	2
Totals	3.00E-05	10	5	0	15

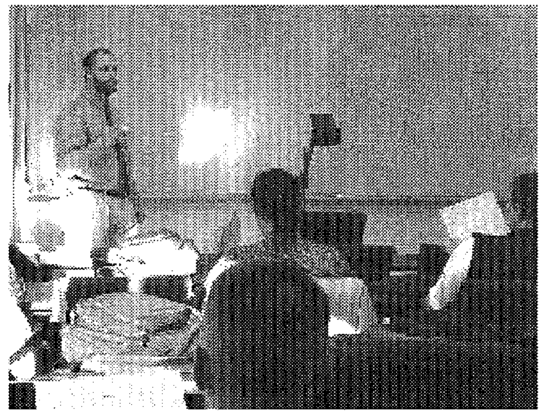
Figure V. E. 1

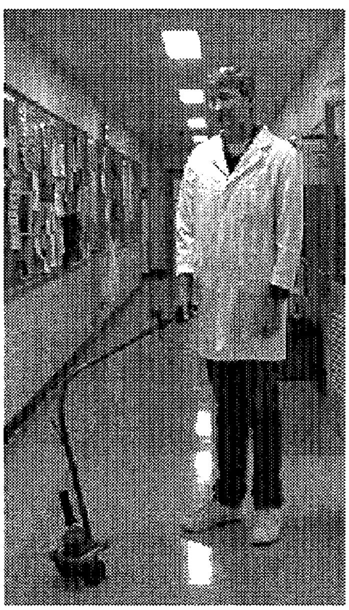
Monitoring Stations for the OSU TRIGA Reactor

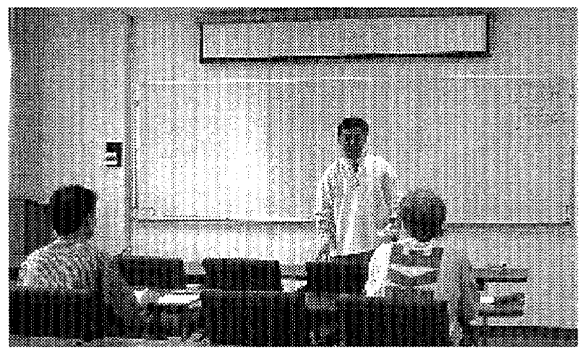


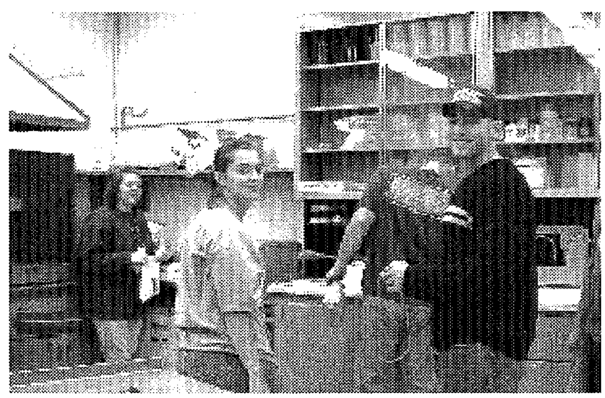
Part VI

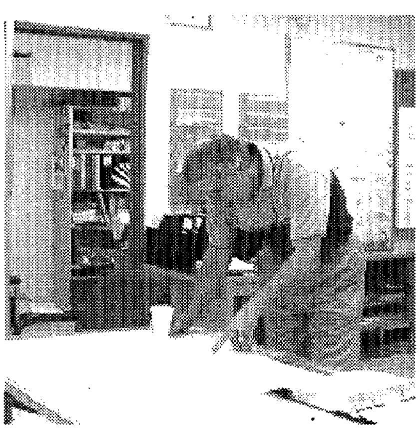
Work

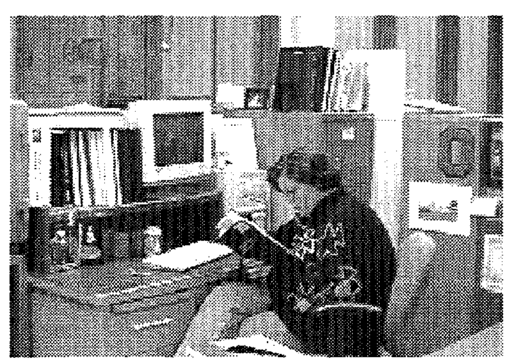












Part VI

WORK

A. Summary

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

B. Teaching

An important responsibility of the Radiation Center and the reactor is to support OSU's academic programs. Implementation of this support occurs through direct involvement of the Center's staff and facilities in the teaching programs of various departments and through participation in University research programs. For example, during the current reporting period, the Radiation Center accommodated 119 academic classes involving a number of different academic departments from OSU and other Oregon universities. The OSU teaching programs (not including research) utilized 479 hours of reactor time. Tables III.A.1 and III.D.1 plus Section VI.C.5 provide more detailed information on the use of the Radiation Center and reactor for instruction and training.

C. Research and Service

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

Table VI.C.1 provides a summary of institutions 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'spresence. Computerized data reduction of the gamma ray spectra then yields the concentrations of the various elements in samples being studied. With sequential instrumental NAA it is possible to measure quantitatively about 35 elements in small samples (5 to 100 mg), and for activable elements the lower limit of detection is on the order of parts per million or parts per billion, depending on the element.

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

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

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

2. Forensic Studies

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

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

3. Irradiations

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

4. Radiological Emergency Response Services

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

The Radiation Center maintains dedicated stocks of radiological emergency response equipment and instrumentation. These items are located at the Radiation Center and at the Good Samaritan Hospital.

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

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

5. Training and Instruction

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

Special training programs generally fall into one of several categories: visiting faculty and research scientists; International Atomic Energy Agency fellows; special short-term courses; or individual reactor operator or health physics training

programs. During this reporting period there were a large number of such people as shown in Part II.B.

As has been the practice since 1985, Radiation Center personnel annually present a HAZMAT Response Team Radiological Course. This year the course was held at the Hammer Facility in Richland, WA.

6. Radiation Protection Services

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

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

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

7. Radiological Instrument Repair and Calibration

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

The Center'sscientific instrument repair facility performs maintenance and repair on all types of radiation detectors and other nuclear instrumentation. Since the Radiation Center's own programs regularly utilize a wide range of nuclear instruments, components for most common repairs are often on hand and repair time is therefore minimized.

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

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

8. Consultation

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

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

9. Public Relations

The continued interest of the general public in the OSTR 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 128 scheduled tours including 1,499 people were given during this reporting period. See Table VI.F.1 for statistics on scheduled visitors.

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

	Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
	*Central Oregon Community College Bend, OR USA	1	1	0	1
	* Crescent Valley High School Corvallis, OR USA	1	0	0	1
	*Life Gate High School Eugene, OR USA	1	1	0	1
	*McKay High School Salem, OR USA	1	0	0	1
	*Newport Elementary Schools Newport, OR USA	1	1	0	1
(1)	*Oregon State University Corvallis, OR USA	46	39	20	193
	*West Albany High School Albany, OR USA	1	0	0	1
	*Western Oregon University Monmouth, OR USA	1	1	0	1
	*Willamette Valley Community School Corvallis, OR USA	1	1	0	1
	*Geovic Ltd. Beaverton, OR USA	1	0	0	1
	Good Samaritan Hospital Corvallis, OR USA	1	0	0	7
	U. S. Department of Agriculture Corvallis, OR USA	1	1	0	1
	AVI Bio Pharma Corvallis, OR USA	1	0	0	0
	*Corvallis School District Corvallis, OR USA	1	1	0	2
	Evanite Fiber Corporation Corvallis, OR USA	1	0	0	1

* Project which involves the OSTR.

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

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

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
*Linn Benton Community College Albany, OR USA	1	0	0	2
Oregon Office of Energy Salem, OR USA	3	0	0	21
Oregon Department of Transportation Salem, OR USA	1	0	0	1
SIGA Technologies, Inc. Corvallis, OR USA	1	0	0	2
*University of Oregon Eugene, OR USA	1	2	3	1
US Environmental Protection Agency Corvallis, OR USA	2	0	0	0
USDOE Albany Research Center Albany, OR USA	1	0	0	0
Valley Landfills Corvallis, OR USA	1	0	0	2
Army Corps of Engineers Portland, OR USA	1	0	0	1
Bay Area Hospital Coos Bay, OR USA	1	0	0	1
ESCO Corporation Portland, OR USA	1	0	0	11
Oregon Public Utilities Commission Salem, OR USA	1	0	0	4
Oregon State Health Division Salem, OR USA	1	0	0	24
Federal Aviation Administration Portland, OR USA	1	0	0	2
Occupational Health Lab Portland, OR USA	1	0	0	1

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

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
Oregon Health Sciences University Portland, OR USA	1	0	0	22
Oregon Medical Laser Center Portland, OR USA	1	0	0	16
* Pacific University Forest Grove, OR USA	1	1	0	8
*Portland Community College Portland, OR USA	1	1	0	1
*Portland State University Portland, OR USA	2	2	1	3
Radiation Protection Services Portland, OR USA	1	0	0	0
Rogue Community College Grants Pass, OR USA	1	0	0	2
US Environmental Protection Agency Newport, OR USA	2	0	0	5
Veterinary Diagnostic Imaging & Cytopathology Clackamas, OR USA	1	0	0	1
Hot Cell Services Kent, WA USA	1	0	0	3
*Idaho State University Pocatello, ID USA	1	1	4	2
Kirner Consulting, Inc Tacoma, WA USA	1	0	0	1
*University of Washington Seattle, WA USA	1	1	0	1
*Berkeley Geochronology Center Berkeley, CA USA	1	0	5	19

* Project which involves the OSTR.

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

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

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
M.K. Gems and Minerals La Habra, CA USA	1	0	0	4
*Stanford University Stanford, CA USA	2	2	3	4
*Tru-Tec Edmonton, Alberta CANADA	2	0	0	2
*University of California at Berkeley Berkeley, CA USA	3	3	3	8
*University of California at Santa Barbara Santa Barbara, CA USA	1	1	5	5
*Brigham Young University Provo, UT USA	1	1	1	1
*University of Wyoming Laramie, WY USA	1	1	4	2
*General Dynamics Scottsdale, AZ USA	2	0	0	4
*Otero Junior College La Junta, CO USA	1	1	0	1
*Tracerco Houston, TX USA	1	0	0	1
*University of Wisconsin Madison, WI USA	1	1	2	7
Mississippi State University Mississippi State, MS USA	1	0	0	1
Becton Dickenson Technologies Research Triangle Park, NC USA	1	0	0	1
*City College of New York New York, NY USA	1	1	2	2
*Columbia University Palisades, NY USA	4	4	5	9

* Project which involves the OSTR.

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

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

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
*George Washington University Washington, DC USA	1	1	2	1
*North Carolina State University Raleigh, NC USA	1	1	3	2
*Plattsburgh, State University Plattsburgh, NY USA	3	3	0	4
*Syracuse University Syracuse, NY USA	1	1	0	1
*Union College Schenectady, NY USA	1	1	0	1
*University of Georgia Aiken, SC USA	2	2	1	10
*University of Rochester Rochester, NY USA	1	1	1	1
*University of Florida Gainesville, FL USA	1	1	1	1
FAPIG Radiation Research Laboratory Ltd. Yokosuka Kanagawa, JAPAN	1	0	0	1
*Scottish Universities Research and Reactor Centre East Kilbride, SCOTLAND	1	1	15	1
*Universite Paris-Sud Paris, FRANCE	1	1	0	2
*Vrije Universiteit Amsterdam, THE NETHERLANDS	1	1	4	2
*Ruhr-Universitat Bochum Bochum, GERMANY	1	1	0	2
*Universita'Degli Studi di Bologna Bologna, ITALY	1	2	0	2

* Project which involves the OSTR.

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

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

Table VI.C.1

Institutions and Agencies Which Utilized the Radiation Center

Institutions and Agencies	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
*Universitat Tubingen Tubingen, GERMANY	1	1	0	2
*University of Geneva Geneva, SWITZERLAND	1	1	4	1
*University of Oslo Oslo, NORWAY	1	1	0	1
*University of Tuebingen Tuebingen, GERMANY	1	1	3	4
*The University of Waikato Hamilton, NEW ZEALAND	1	1	1	1
*University of Queensland Brisbane, Queensland AUSTRALIA	1	1	0	1
Totals:	142	96	97	474

* Project which involves the OSTR.

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

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

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Berkeley Geochronology Center					
Baxter, Ethan	PhD	Earth and Planetary Science	DePaolo	920	Kinetics of Isotopic Exchange in Metamorphic Reactions
Culler, Timothy	PhD	Earth and Planetary Science	Alvarez	920	Lunar Impact History from Analysis of Impact Melt Spherules
Kyoungwon, Min	MA	Earth and Planetary Science	Renne	920	Reduction of Systematic Errors in 40Ar/39Ar Geochronology
Knight, Kimberly	MA	Earth and Planetary Science	Renne	920	Geochemical and Isotopic Insights into Continental Flood Basalts
Zhou, Zhensheng	MA	Earth and Planetary Science	Renne	920	Rates and Tempo of Permian-Triassic Boundary Events.
Brigham Young University					
Hae Hae, Kevin	MS	Geology	Kowallis	335	Subsidence and Uplift History of the Uinta Basin from Apatite Fission Track Analysis
City College of New York					
Rudolph, Elizabeth	PhD	Earth and Atmospheric Sciences	Steiner	1484	Morphological and Geochemical Study of Molluscs, Hudson River, New York
Columbia University					
Machlus, Malka	PhD	Earth Sciences	Olsen	1550	Milankovitch cyclicity in the Eocene Green River Formation, including dating tuff beds within the formation by Ar-Ar dating.
Machlus, Malka	PhD	Earth Sciences	Olsen	1267	Milankovitch cyclicity in the Eocene Green River Formation, including dating tuff beds within the formation by Ar-Ar dating.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Young, Amy	PhD	UCLA Geology	Turrin	1423	Petrology and geochemical evolution of the Damavand trachyandesite volcano in northern Iran.
Zhong, Jian	MS	Geosciences	Hanson	1553	The Grain Size and Provenance of Long Island Loess
Idaho State University					
Chen, Songqiao	MS	Hazardous Waste Mangement	Hughes	1474	Stream Water Chemistry and Pollutant Migration in Streams Near Pocatello
Hitchcock, Paul	MS	Geology	Hughes	1474	Characterization of Fissures in the Great Rift, Eastern Snake River Plain: Implications for the Nature and Timing of Dike Injection in Basaltic Lava Plains
Pickett, Katharine	MS	Geology	Hughes	1474	Geochemistry and Volcanology of the Blackfoot Lava Fields, Southeastern Idaho
Pope, Arron	MS	Geology	Hughes	1474	Geology of South Hawkins Basin Volcanic Center and Elkhorn Range, Southern Idaho
North Carolina State University					
Hamilton, Cara	MS	Marine, Earth, and Atmospheric Sciences	Fodor	1493	Trace-metal abundances in sediments in the drainage basin of Wake County, NC: environmental impact of urban society on the watershed
McCarter, Renee	MS	Marine, Earth, and Atmospheric Sciences	Fodor	1493	Petrology of the Stone Mountain granitoid pluton, North Carolina
Palmer, John	MS	Marine, Earth, and Atmospheric Sciences	Fodor	1493	Trace-metal abundances of the Neuse River system, North Carolina: environmental impact of urbanization from Wake County to New Bern, NC

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Oregon State University					
Choi, Jin Young	PhD	Agricultural Chemistry	Kerkvliet	931	Undecided
Dearstyne, Erica	PhD	Agricultural Chemistry	Kerkvliet	931	Fate of T Cells in TCDD-Treated Mice: Anergy of Apoptsis?
Kang, Sung Mo	MS	Forest Products	Morrell	815	Fungi Colonization of Douglas Fir Sapwood and their Role in Biological Discoloration
Keillor, Martin	PhD	Nuclear Engineering	Binney	1490	Principal Component Analysis of Low Resolution Energy Spectra to Identify Gamma Sources in Moving Vehicle Traffic
Mankowski, Mark	PhD	Forest Products	Morrell	815	Biology of Carpenter Ants in the Pacific Northwest and its Relationship with Fungal Decay in Buildings
McKee, Claire	MS	Geosciences	Grunder	1501	Petrology of Volcan Mino
Prell, Rodney	PhD	Agricultural Chemistry	Kerkvliet	931	Role of B7 Co-stimulation in TCDD Immunotoxicity
Ruby, Carl	PhD	Agricultural Chemistry	Kerkvliet	931	Involvement of NFKB in TCDD Immunotoxicity
Shepherd, David	PhD	Agricultural Chemistry	Kerkvliet	931	A T-Cell Receptor-Transgenic Model for Immunoticity Testing
Sinton, Christopher	PhD	Oceanography	Duncan	444	Age and Composition of Two Large Igneous Provinces: The North Atlantic Volcanic Rifted Margin and the Caribbean Plateau
Stapels, Christopher	PhD	Physics	Krane	1451	Gamma ray spectroscopy of Ho-167

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Vorderstrasse, Beth	PhD	Agricultural Chemistry	Kerkvliet	931	Dendritic Cells: Role in TCDD-Induced Suppression of CTL Activity
Portland State University					
Pretorius, Megan	MS	Geology	Streck	1445	Petrology of Three Successively Emptied Ash-Flow Tufts from the San Luis Caldera
Scottish Universities Research and Reactor Centre					
Barry, T.	PhD	Leicester University	Pringle	1073	Mongolian Basalts/Tectonics
Blecher, J.	PhD	Oxford University	Pringle	1073	Aden Volcanic Differentiation
Carn, S.	PhD	Cambridge University	Pringle	1073	Indonesian Volcanics
Chambers, L.	PhD	Edinburgh University	Pringle	1073	North Atlantic Tertiary Province
Dixon, H.	PhD	Bristol University	Pringle	1073	Subglacial Volcanics
Harford, C.	PhD	Bristol University	Pringle	1073	Montserrat Volcanic Hazards
Heath, E.	PhD	Lancaster University	Pringle	1073	St. Vincent Volcano Hazards
May, G.	PhD	Aberdeen University	Pringle	1073	Chilean Basins
McElderry, S.	PhD	Liverpool University	Pringle	1073	Chilean Tertiary Faulting
Najman, Y.	PhD	Edinburgh University	Pringle	1073	Himalayan Foredeep

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Purvis, M.	PhD	Edinburgh University	Pringle	1073	Turkish Basin Tectonics
Shelton, R.	PhD	Queens University	Pringle	1073	North Channel Basin Evolution
Sowerbutts, A.	PhD	Edinburgh University	Pringle	1073	Sardinia Evolution
Steele, G.	PhD	Aberdeen University	Pringle	1073	Cerro Rico Silver
White, R.	PhD	Leicester University	Pringle	1073	Caribean Crustal Growth
University of California at Berkeley					
Patin, Joshua	PhD	College of Chemistry	Hoffman	1468	Study of Production Mechanisms in Heavy Ion Actinide and Lead Target Reactions
University of California at Santa Barbara					
Calvert, Andy	PhD	Geological Sciences	Gans	1020	Tectonic Studies in Eastern-Most Russia
Nauert, Jon	MS	Geological Sciences	Gans	1020	Volcanism in the Eldorado Mountains, Southern Nevada
University of Geneva					
Bachmann, Olivier	PhD	Mineralogy	Dungan	1413	Volcanic, petrologic, and geochronologic studies of the Fish Canyon magmatic system, Colorado
Parat, Fleurice	PhD	Mineralogy	Dungan	1413	Petrology and geochronology of the Eagle Mountain volcanic center, San Juan Mountains, Colorado

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Rapaille, Cedric	PhD	Mineralogy	Marzoli	1413	Le Filon de Messejana (Espagne et Portugal): Pétrologie et Géochronologie
Thon-That, Thao	PhD	Mineralogy	Singer	1413	40Ar/39Ar Dating of Young Tephra in the Ionian Sea
University of Georgia					
Tostowaryk, Tracy	MS	Radiological Health Sciences	Whicker	1475	The elimination and assimilation of cesium by freshwater invertebrates
University of Oregon					
Fitzpatrick, Scott	Ph.D.	Anthropology	Ayres	1482	Pacific Islands archaeology, including geochemistry of calcite materials from Palau, Micronesia
Winterhoff, Quent	M.A.	Anthropology	Ayres	1482	Pacific Islands archaeology
Wozniak, Joan	Ph.D.	Anthropology	Ayres	1482	Easter Island archaeological settlement and early agriculture
University of Rochester					
Saha, Aniki	Ph.D.	Earth and Environmental Sciences	Basu	1480	Trace element geochemistry of rocks from the Franciscan Formation
University of Tuebingen					
Angelmaier, Petra	PhD	Institut fur Geologie und Palaotologie	Dunkl	1519	Exhumation path of different tectonic blocks along the central part of the Transalp-Traverse (Eastern Alps).
Most, Thomas	PhD	Institut fur Geologie und Palaontologie	Dunkl	1519	Mesozoic and Tertiary Tectonometamorphic Evolution of Pelagonian Massif
Schwab, Martina	PhD	Institut fur Geologie und Palaontologie	Dunkl	1519	Thermochronology and Structural Evolution of Pamir Mts.

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Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
University of Wisconsin					
Jicha, Brian	MS	Geology and Geosciences	Singer	1465	
Relle, Monica	MS	Geology and Geophysics	Singer	1465	
University of Wyoming					
Beland, Peter	MS	Geology and Geophysics	Murphy	321	
Kirkwood, Robert	MS	Geology and Geophysics	Murphy	321	
Leier, Andrew	MS	Geology and Geophysics	Murphy	321	
McMillan, Beth	PhD	Geology and Geophysics	Murphy	321	
Vrije Universiteit					
Beintema, Kike	PhD	Department of Structural Geology	White/Wijbrans	1074	The Kinematics and Evolution Major Structural Units of the Archean Pilbara Craton, Western Australia
Carrapa, Barbara	MA	Isotope Geochemistry	Wijbrans/Bertotti	1074	The tectonic record of detrital minerals on sun-orogenics clastic sediments
Kuiper, Klaudia	PhD	Isotope Geochemistry	Hilgen/Wijbrans	1074	Intercalibration of astronomical and radioisotopic timescales

Table VI.C.3

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

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

INAA = Instrumental Neutron Activation Analysis   REE = Rare Earth Elements

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

Project	Users	Organization Name	Project Title	Description	Funding
665	Reese	Oregon State University	Instrument Calibration	Calibration of radiation survey instruments.	OSU Radiation Center
815	Morrell	Oregon State University	Sterilization of Wood Samples	Sterilization of wood samples to 2.5 Mrads in Co-60 irradiator for fungal evaluations.	OSU Forest Products
920	Becker	Berkeley Geochronology Center	Ar-39/Ar-40 Age Dating	Production of Ar-39 from K-39 to determine ages in various anthropologic and geologic materials.	Berkeley Geochronology Center
930	McWilliams	Stanford University	Ar-40/Ar-39 Dating of Geological Samples	Irradiation of mineral grain samples for specified times to allow Ar-40/Ar-39 dating.	Stanford University Geophysics Department
931	Kerkvliet	Oregon State University	TCDD Effects on T-Cell Activation	Co-60 irradiation of spleen cells from mice to study the effects of TCDD on T-cell activation using T-h cell clones.	OSU Environmental and Molecular Toxicology
932	Dumitru	Stanford University	Fission Track Dating	Thermal column irradiation of geological samples for fission track age-dating.	Stanford University Geology Department
1018	Gashwiler	Occupational Health Lab	Calibration of Nuclear Instruments	Calibrate radiation survey meters.	Occupational Health Laboratory
1020	Gans	University of California at Santa Barbara	Tectonic Studies in Eastern-Most Russia	Irradiation for Ar-40/Ar-39 dating using the CLICIT or dummy fuel element.	National Science Foundation
1072	Rasmussen	Army Corps of Engineers	Instrument Calibration	Calibration of radiation detection instruments.	U.S. Army Engineer District, Portland.

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Project	Users	Organization Name	Project Title	Description	Funding
1073	Pringle	Scottish Universities Research and Reactor Centre	Argon 40/39 Dating of Rock Minerals	Age dating of various materials using the Ar-40/Ar-39 ratio method.	Scottish Universities Research and Reactor Centre
1074	Wijbrans	Vrije Universiteit	40Ar-39 Ar Dating of Rocks and Minerals	40Ar-39Ar dating of rocks and minerals.	Vrije Universiteit, Amsterdam
1075	Lederer	University of California at Berkeley	Activation Analysis Experiment for NE Class	Irradiation of small, stainless steel discs for use in a nuclear engineering radiation measurements laboratory.	University of California at Berkeley
1118	Larson	Oregon State University	Primary Phytoplankton Production Studies at Crater Lake	Evaluation of the primary production of phytoplankton in Crater Lake and lakes in Mount Rainier, Olympic, and North Cascades National Parks.	OSU Forest Resources
1127	Numata	FAPIG Radiation Research Laboratory Ltd.	Kyoto Fission Track Age Dating	Irradiation of samples in the thermal column for fission track age dating.	FAPIG Radiation Research Laboratory
1177	Garver	Union College	Fission Track Analysis of Rock Ages	Use of thermal column irradiations to perform fission track analysis to determine rock ages.	Union College, NY
1186	Fitzgerald	Syracuse University	Fission Track Dating	Thermal column irradiation of geological samples for fission track age-dating.	University of Arizona

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Project	Users	Organization Name	Project Title	Description	Funding
1188	Salinas	Rogue Community College	Photoplankton Growth in Southern Oregon Lakes	C-14 liquid scintillation counting of radiotracers produced in a photoplankton study of southern Oregon lakes: Miller Lake, Lake of the Woods, Diamond Lake, and Waldo Lake.	Rogue Community College
1191	Vasconcelos	University of Queensland	Ar-39/Ar-40 Age Dating	Production of Ar-39 from K-39 to determine ages in various anthropologic and geologic materials.	Earth Sciences, University of Queensland
1267	Hemming	Columbia University	Geochronology by Ar/Ar Methods	Snake River plain sanidine phenocrysts to evaluate volcanic stratigraphy; sandine and biotite phenocrysts from a late Miocene ash, Mallorca to more accurately constrain stratigraphic horizon; hornblends and feldspar from the Amazon to assess climatic changes and differences in Amazon drainage basin provenance.	Columbia University
1290	Kahn	M. K. Gems and Minerals	Mineral Irradiations	Irradiations of various minerals to evaluate colorization effects.	M. K. Gems & Minerals
1302	Niles	Oregon Office of Energy	Calibration of Emergency Response Instruments	Routine calibration of radiological monitoring instruments associated with the Oregon Office of Energy's programs supporting HazMat and other emergency response teams.	Oregon Office of Energy
1341	Schmitt	Oregon State University	INAA of Deep Sea Drilling Project samples	INAA of Deep Sea Drilling Project samples	USDOE Reactor Sharing

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

Project	Users	Organization Name	Project Title	Description	Funding
1346	Schutfort	Oregon State University	Analysis of Arsenic on Membrane Filters	Gathering of preliminary data on detection limit of arsenic in groundwater using extraction filters to preconcentrate As on filter membranes.	USDOE Reactor Sharing
1350	Vergin	Oregon State University	Sterilization of Micropipets and Labware	Irradiation of micropipets and other laboratory equipment used in the study of DNA.	OSU Microbiology Department
1351	Dalrymple	Oregon State University	Age Dating of Lunar Samples	Use of Ar-40/Ar-39 ratio methodology to date lunar rock samples about 4 billion years old.	OSU Oceanography Department
1352	Niles	Oregon Office of Energy	General Consultation	Radiological and radioactive material transport consulting services	Oregon Office of Energy
1353	Kamp	The University of Waikato	Fission Track Thermochronology of New Zealand	Determination of history and timing of denudation of basement terranes in New Zealand and thermal history of late Cretaceous-Cenozoic sedimentary basins.	University of Waikato
1354	Wright	Radiation Protection Services	Radiological Instrument Calibration	Routine calibration of radiological monitoring instruments.	Oregon Health Division
1357	Krane	Oregon State University	Neutron Cross Section Measurements	Irradiation and gamma spectrometry of germanium, gadolinium, and other elements to determine thermal capture cross sections of certain radionuclides.	OSU Radiation Center

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Project	Users	Organization Name	Project Title	Description	Funding
1359	Niles	Oregon Office of Energy	State Laboratory Support	Maintenance of state radiological monitoring support capability, including QA, counting standards and calibrations of gamma spectrometer systems for measuring low lradioactivities in environmental and foodstuff samples.	Oregon Office of Energy
1365	Schutfort	Oregon State University	Quality Assurance Program	Irradiation of various samples for QA, including Au and Mn solutions both with and without cadmium covers to determine neutron flux ratios.	OSU Radiation Center
1366	Quidelleur	Universite Paris-Sud	Ar-Ar Geochronology	Determination of geological samples via Ar-Ar radiometric dating.	Universite Paris-Sud
1368	Buckovic	Geovic Ltd.	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.
1376	Proebsting	Oregon State University	Genetics of Peas	Produce deletion mutants of peas on the SN and NP genes	OSU Horticulture
1390	Bottomley	Oregon State University	Soil Study	Soil Study	OSU Crop and Soil Science
1397	Teach	Oregon Medical Laser Center	Sterilization of various biological materials	Sterilization of various biological materials for St. Vincents Hospital, Portland	Oregon Medical Laser Institute

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

Project	Users	Organization Name	Project Title	Description	Funding
1399	Olander	University of California at Berkeley	Volatilization of uranium material	Irradiation of vapor from depleted uranium loaded on resin and heated to high temperatures in reducing atmosphere. U-235 in vapor deposits fissions; U-238 absorbs neutrons. Gamma ray spectrometry determines amount of uranium volatilized.	University of California at Berkeley
1404	Riera-Lizarau	Oregon State University	Evaluation of wheat DNA	Gamma irradiation of wheat seeds	OSU Crop and Soil Science
1406	Pate	Tracerco	Production of Argon-41	Production of Argon-41 for various field uses	Tracerco
1407	Roden-Tice	Plattsburgh State University	Apatite and Zircon Fission Track Dating	Apatite and zircon fission track dating to determine thermal and uplift histories of Hartford Basin sedimentary rocks and Bronson Hill terrrane crystalline rocks, CT.	Plattsburgh State University
1413	Webb	University of Geneva	Argon Geochronology	Ar-39/Ar-40 dating of pure mineral and whole rock separates.	University of Geneva
1415	McGinness	ESCO Corporation	Calibration of Instruments	Instrument calibration	ESCO Corporation
1417	Loveland	Oregon State University	Production of Radionuclides for LBNL	Various radionuclides will be produced for research to be conducted at LBNL.	OSU Chemistry / Loveland DOE
1419	Krane	Oregon State University	Nuclear Structure of N=90 Isotones	Study of N=90 isotone structure (Sm-152, Gd-154, Dy-156) from decays of Eu-152, Eu-152m, Eu-154, Tb-154, and Ho-156. Samples will be counted at LBNL.	OSU Physics Department

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Project	Users	Organization Name	Project Title	Description	Funding
1421	Krane	Oregon State University	Measurement of Pb-208 capture cross section	Measurement of Pb-208 capture cross section by activation technique by looking at beta decay of Pb-209.	OSU Physics Department
1423	Turrin	Columbia University	40Ar/39Ar Analysis	Petrology and geochemical evolution of the Damavand trachyandesite volcano in Northern Iran.	Columbia University
1424	Yasinko	Tru-Tec	Argon 41 Production	Irradiation of argon gas to produce argon 41.	Tru-Tec
1429	Stone	Valley Landfills	Monitoring of Radioactive Landfill Samples	Landfill samples are monitored for isotopic analysis.	Valley Landfills
1430	Bottomley	Oregon State University	Atrazine Remediation in a Wetland Environment	Characterization of fate of atrazine in wetland mesocoms and a constructed wetland; investigation of presence of atrazine degrading microorganisms in rhizosphere soil.	ATX412-T407
1431	Stein	AVI Bio Pharma	Instrument Calibrations	Instrument calibration	AVI Bio Pharma
1440	Hinton	University of Georgia	Cesium analyses	Determination of cesium concentrations in environmental systems	Savannah River Ecology Laboratory
1445	Streck	Portland State University	Interpretation of igneous processes at San Luis Caldera, CO	Investigation of magmatic processes leading to formation of large rhyolite magma chambers by studying ash flow tuffs by INAA.	USDOE Reactor Sharing

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

Project	Users	Organization Name	Project Title	Description	Funding
1448	Krane	Oregon State University	Measurement of Tb-160 neutron capture cross section	Measurement of Tb-160 neutron capture cross section by irradiation of Tb-159 to produce Tb-161.	USDOE Reactor Sharing
1450	Krane	Oregon State University	Measurement of Au-194 neutron capture cross section	Measurement of Au-194 neutron capture cross section by irradiation of Hg-194.	USDOE Reactor Sharing
1451	Krane	Oregon State University	Gamma ray spectroscopy of Ho-167	Study of Ho-167 decay to improve gamma ray spectrum information	OSU Physics Department
1452	Conrady	Oregon State University	Department of Chemistry Tours/Experiments	Reactor tour and half life experiment for OSU general chemistry classes.	USDOE Reactor Sharing
1457	Palmer	Oregon State University	NE 451/452/453/551/552/553 Reactor Laboratory Experiments	Various experiments conducted on the OSTR for the NE 451/452/453/551/552/553 courses.	USDOE Reactor Sharing
1463	Andresen	University of Oslo	Ar-Ar study of differential block movement, S. Norway	Sampling of white mica, amphibole, and K-feldspar in traverses across shear zone to determine exhumation history of high grade Bamble Blocks and medium grade Telemark Block	University of Oslo
1464	Slavens	USDOE Albany Research Center	Instrument Calibration	Instrument calibration	USDOE Albany Research Center
1465	Singer	University of Wisconsin	Ar-40/Ar-39 Dating of Young Geologic Materials	CLICIT irradiation of geological materials such as volcanic rocks from sea floor, etc. for Ar-40/Ar-39 dating.	University of Wisconsin

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Project	Users	Organization Name	Project Title	Description	Funding
1466	Lerner	Oregon State University	Fluorine Analysis	Fluorine analysis in two graphite sample.	OSU Chemistry Department
1467	Kirner	Kirner Consulting, Inc	Instrument Calibration	Instrument calibration	Kirner Consulting
1468	Nitsche	University of California at Berkeley	Chemistry 146 Experiment	Sample irradiation	University of California at Berkeley
1470	Bolken	SIGA Technologies, Inc.	Instrument Calibration	Instrument calibration	Siga Pharmaceuticals
1471	Bartlett	Oregon State University	Irradiation of Golf Balls	Irradiation of golf balls	OSU Radiation Center
1473	Alarcon	Becton Dickenson Technologies	Gamma Irradiations	Gamma Irradiation to 5k, 3k, & 2k.	Becton Dickenson Technologies
1474	Hughes	Idaho State University	NAA of Geologic Materials to Support Student and Faculty Research	NAA support for GEOL 615 (Neutron Activation Analysis), GEOL 625 (Quantative Geochemical Analysis), GEOL 482, 648 (Independent Studies), and pilot projects with an emphasis on petrology and geochemistry.	USDOE Reactor Sharing
1475	Hinton	University of Georgia	Cesium Cycling in a Freshwater Ecosystem	Cesium transfer rates among ecosystem components are being determined in a freshwater ecosystem. Stable cesium was added to the entire pond and the dynamics are being followed using INAA to assay the cesium.	Savannah River Ecology Laboratory

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

Project	Users	Organization Name	Project Title	Description	Funding
1476	Garver	Union College	Fission Track Dating to Determine Evolution of Exhumation of Mountain Belts	Fission track dating of zircon and apatite from sediments derived from orogenic belts.	USDOE Reactor Sharing
1477	Roden-Tice	Plattsburgh State University	Thermal history of early Proterozoic Saskatchewan Craton and Trans-Hudson Orogen	Analysis for apatite fission track ages to determine the thermal uplift history of the region.	USDOE Reactor Sharing
1478	Mueller	University of Florida	Nature of the Wyoming-Hearne Collision	Examination of proterozoic rocks trapped within and produced by the collision of the Wyoming and Hearne microcontinents in the NW U.S.	USDOE Reactor Sharing
1479	Paul	Oregon State University	Biological Toxin Sensor	Multidisciplinary development of a biological toxin sensor using arethrophore cells for the Defense Advanced Research Projects Agency.	OSU Industrial & Manufacturing Engineering
1480	Basu	University of Rochester	Trace Element Geochemistry of Franciscan Metamorphic Rocks	Trace element geochemistry, including rare earth elements of the metasedimentary and metaigneous rocks of the Franciscan Formation.	USDOE Reactor Sharing
1481	Ruzicka	Portland State University	Trace Element Studies of the Portales Valley Meteorite	INAA for various mineralogic fractions of the Portales Valley meteorite to elucidate its origin.	USDOE Reactor Sharing
1482	Ayres	University of Oregon	Archaeological Stone Materials from Easter Island, Polynesia	Provenance determination of basaltic stone from quarries used in prehistoric times to assess early stone tool manufacture and use on Easter Island, Polynesia.	USDOE Reactor Sharing

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1483	Enochs	Oregon State University	Support of SED 501 Research Practicum	Research practicum for science education majors. The students are involved in active research projects at the Radiation Center. The objective is to gain insight into scientific methods.	USDOE Reactor Sharing
1484	Steiner	City College of New York	Colloidal Chemistry of Aerosols and Mollusc Shell Chemistry	Examination of New York City aerosol samples and Hudson River molluscs for trace elements, including, if possible, radionuclides.	USDOE Reactor Sharing
1485	Tollo	George Washington University	Petrology /geochemistry of Basement Lithologies and Associated Mafic Dikes, Blue Ridge Province, VA	Petrology study of leucocratic granitoids exposed in the basement core of the Blue Ridge anticlinorium in northern VA.	USDOE Reactor Sharing
1486	Hockmuth	General Dynamics	Irradiation of Electronic Components	Study radiation effects on electronic components for the Nuclear and Space Radiation Effects Group	Motorola
1487	Fleischer	Union College	Hiroshima Neutron Dosimetry and Radionuclide Leaching	Irradiation of Hiroshima glass for dose calibration and measurement of U-235 in glass.	USDOE Reactor Sharing
1488	Gartner	Oregon State University	Determinants of sapwood quantity and composition	Sterilization of wood cores from tree stems to 3 Megarads.	OSU Forest Products

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1489	Roden-Tice	Plattsburgh State University	Thermochronologic evidence linking Adirondack and New England regions Connecticut Valley Regions	The integration of apatite fission-track ages and track length based model thermal histories, zircon fission-track ages, and U-Th/He analyses to better define the pattern of regional post-Early Cretaceous differential unroofing in northeastern New York's Adirondack region and adjacent western New England.	Plattsburgh State University
1490	Binney	Oregon State University	Measurement of High Enrichment Uranium Gamma Ray Spectrum	Measurement of FLIP TRIGA fuel gamma ray spectrum	OSU Radiation Center
1491	Hockmuth	General Dynamics	Gamma irradiation of electronic components	Study radiation effects on electronic components for the Nuclear and Space Radiation Effects Group	Motorola
1492	Stiger	Federal Aviation Administration	Instrument Calibration	Instrument calibration	Federal Aviation Administration
1493	Fodor	North Carolina State University	NAA of eastern North Carolina river sediments and Stone Mountain, NC plutons	Measurement of toxic metal trace elements in eastern North Carolina rivers; detailed geochemical investigation of igneous Stone Mountain pluton in North Carolina.	USDOE Reactor Sharing
1494	Hall	Oregon State University	Flux Measurements in OSTR Irradiation Facilities	Measurement of the thermal, epithermal, and fast fluxes in the various OSTR irradiation facilities	OSU Radiation Center
1495	Mathews	Bay Area Hospital	Neutron Measurement	Use of neutron rem meter to determine dose rates at a new accelerator.	OSU Radiation Center

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1496	Brosing	Pacific University	Measurement of Reactor Flux	Measurements, using foil activation techniques, of the neutron energy spectrum in various irradiation facilities of the OSTR.	USDOE Reactor Sharing
1497	Dick	Oregon State University	Tracing C-13 Signatures from Pine Litter Raised under Elevated CO2 into Soil C Storage Pools	Using pine litter as a tracer for C into soil pools, looking for C sequestered from a set amount of pine litter. Will put the litter into EPA terracosm chambers. Need to sterilize pine needles.	OSU Crop and Soil Science
1498	Doyle	Evanite Fiber Corporation	Technical assistance to Evanite Fiber Corporation	Technical assistance to Evanite Fiber Corporation	Evanite Fiber Corporation
1499	Farkas	Oregon State University	Irradiation of Hamburger	Irradiate frozen hamburger to 2 kGy for tasting.	OSU Radiation Center
1500	Johannesmeyer	Otero Junior College	Origin of alkaline mafic and subalkaline felsic rocks of the Boulder batholith, MT	Quantification of crustal differentiation processes responsible for compositional variation with the Cretaceous Boulder batholith of Montana.	USDOE Reactor Sharing
1501	Grunder	Oregon State University	Petrologic Evolution of Volcan Mino, northern Chilean Andes	Examination of the processes that lead to the compositional simplicity, yet textural complexity, of an andesite volcano built on unusually thick crust.	USDOE Reactor Sharing
1502	Teaching and Tours	Portland Community College	Portland Community College Tours/Experiments	Reactor tour and half life experiment.	USDOE Reactor Sharing
1503	Teaching and Tours	Oregon State University	Non-class related tours	Non-class related tours.	OSU Radiation Center

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1504	Teaching and Tours	Oregon State University	OSU Nuclear Engineering class tours	OSU Nuclear Engineering class tours.	USDOE Reactor Sharing
1505	Teaching and Tours	Oregon State University	OSU Chemistry class tours	OSU Chemistry class tours.	USDOE Reactor Sharing
1506	Teaching and Tours	Oregon State University	OSU Geosciences class tours	OSU Geosciences class tours.	USDOE Reactor Sharing
1507	Teaching and Tours	Oregon State University	OSU Physics class tours	OSU Physics class tours.	USDOE Reactor Sharing
1508	Teaching and Tours	Oregon State University	Adventures in Learning class tours	Adventures in Learning class tours.	USDOE Reactor Sharing
1509	Teaching and Tours	Oregon State University	HAZMAT course tours	First responder training tours.	Oregon Office of Energy
1510	Teaching and Tours	Oregon State University	SMILE	Science and Mathematics Investigative Learning Experience tours.	USDOE Reactor Sharing
1511	Teaching and Tours	Oregon State University	Reactor Operator Training	Training for Reactor Operator trainees.	OSU Radiation Center
1512	Teaching and Tours	Linn Benton Community College	Linn Benton Community College Tours/Experiments	Reactor tour and half life experiment.	USDOE Reactor Sharing
1513	Ayres	Oregon State University	Absorption of Pharmaceuticals in the Colon	Pharmaceuticals tagged with Sm-153 are used to determine their absorption in the colon.	OSU Pharmacy
1514	Sobel	Universitat Potsdam	Apatite Fission Track Analysis	Age determination of apatites by fission track analysis.	Universitat Potsdam

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1515	Sberlo	Oregon State University	Detection of Organically Bound Tritium in Wood	Tritium will be produced by irradiating a lithium/wood mixture in the thermal column. The tritium will exchange with organically bound hydrogen in the wood. The wood will be sampled and counted in an LSC to determine the amount of organically bound tritium present.	USDOE Reactor Sharing
1516	McConica	Oregon State University	Analysis of Fouled Harvester Engine Pistons	Residue from severely fouled harvester engine pistons was analyzed by INAA to determine silicon and metals content.	Chemical Engineering
1517	Parikh	Mississippi State University	Evaluation of Treated 'OSB' Boards Against Brown Rot Fungi and White Rot Fungi	After sterilization of 'OSB' Blocks, the blocks will be placed in fungi to determine the biocide toxic threshold level.	Mississippi State University
1519	Dunkl	University of Tuebingen	Fission Track Dating	Fission track dating method on apatites: use of fission tracks from decay of U-238 and U-235 to determine the cooling age of apatites.	University of Tuebingen
1520	Teaching and Tours	Western Oregon University	Reactor tours	Reactor tour and half life experiment.	USDOE Reactor Sharing
1521	Loveland	Oregon State University	INAA of water and n-octanol solutions of metal chelate complexes	INAA of water and n-octanol solutions of metal chelate complexes.	USDOE Reactor Sharing
1522	Control Room	Oregon State University	General Reactor Operation	Reactor operation when no other project is involved.	OSU Radiation Center

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1523	Zattin	Universita' Degli Studi di Bologna	Fission track analysis of apatites	Fission track analysis of apatites.	Universita' Degli Studi di Bologna
1524	Thomson	Ruhr-Universitat Bochum	Fission track analysis of apatites and zircon	Fission track analysis of apatites and zircon.	Ruhr-Universitat Bochum
1525	Teaching and Tours	Life Gate High School	Production of Al for T1/2 lab	Tour of OSTR.	USDOE Reactor Sharing
1526	Crawford	Hot Cell Services	Instrument calibration	Calibration of radiation detectors.	Hot Cell Services
1527	Teaching and Tours	Oregon State University	Odyssey orientation class	Introduction to OSU, including tour of OSU Radiation Center.	USDOE Reactor Sharing
1528	Teaching and Tours	Oregon State University	Upward Bound	Upward Bound recruitment program for prospective science and engineering majors.	USDOE Reactor Sharing
1529	Teaching and Tours	Oregon State University	OSU Connect	Orientation program for new students.	USDOE Reactor Sharing
1530	Teaching and Tours	Newport Elementary Schools	Reactor tour	Tour of OSTR.	USDOE Reactor Sharing
1531	Teaching and Tours	Central Oregon Community College	Reactor tour	Tour of OSTR.	USDOE Reactor Sharing

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1532	Binney	Oregon State University	Development of a Neutron Activation Analysis Program for the McClellan Nuclear Radiation Center	Assistance will be provided to help the MNRC set up a neutron activation analysis program. NAA courses will be taught, software will be developed, and suggestions will be made to implementation of the program.	University of California Davis
1533	Teaching and Tours	Oregon State University	Groups or Organizations from Educational Institutions	Tours of OSTR for individual groups or organizations associated with educational institutions other than academic courses.	USDOE Reactor Sharing
1534	Teaching and Tours	Oregon State University	Student Recruitment Tours	Reactor tours for the purpose of student recruitment into OSU academic programs.	USDOE Reactor Sharing
1535	Teaching and Tours	Corvallis School District	Center for Alternative Learning tours	Reactor tours.	USDOE Reactor Sharing
1536	Nuclear Engineering Faculty	Oregon State University	Gamma Irradiations for NE/RHP 114/115/116	Irradiation of samples for Introduction to Nuclear Engineering and Radiation Health Physics courses NE/RHP 114/115/116.	OSU Radiation Center
1537	Teaching and Tours	Oregon State University	Naval Science tours	Tour of OSTR by Naval Science classes.	USDOE Reactor Sharing
1538	Teaching and Tours	Oregon State University	OSTR tours	Tour of the OSTR.	USDOE Reactor Sharing
1539	Most	Universitat Tubingen	Fission track studies	Age dating by the fission track method.	Universitat Tubingen
1540	Teaching and Tours	McKay High School	Reactor Tours	Tour of the OSTR.	USDOE Reactor Sharing

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1541	Teaching and Tours	Crescent Valley High School	Reactor Tours	Tour of OSTR.	USDOE Reactor Sharing
1542	Teaching and Tours	Oregon State University	OSTR tours for Engineering Sciences classes	Tours of the OSTR.	USDOE Reactor Sharing
1543	Bailey	Veterinary Diagnostic Imaging & Cytopathology	Instrument Calibration	Calibration of radiation detection instrumentation.	Veterinary Diagnostic Imaging & Cytopathology
1544	Teaching and Tours	West Albany High School	Reactor tours and experiments	Tour of the OSTR and half life experiment.	USDOE Reactor Sharing
1545	Teaching and Tours	Oregon State University	OSTR Tours	Tours of the OSTR.	USDOE Reactor Sharing
1546	Istok	Oregon State University	Elimination of microorganism activity in groundwater	Gamma irradiation to eliminate microorganism activity in groundwater samples.	OSU Civil, Constr., and Environmental Engineering
1547	Poklemba	U.S. Department of Agriculture	Mutations in lolium tenulentum flowering	Mutations in lolium tenulentum ("Ceres") to affect flowering.	Agricultural Research Service
1548	Teaching and Tours	Willamette Valley Community School	Reactor tours and experiments	Tour of the OSTR.	USDOE Reactor Sharing
1549	Giovannoni	Oregon State University	Irradiation of Vivaspin concentrators	Gamma irradiation of Vivaspin concentrators to destroy any contaminating DNA.	OSU Microbiology Department
1550	Hemming	Columbia University	Time constraints on volcanic ash layers within Green River Formation	Placing of time constraints on the volcanic ash layers within the Green River Formation.	USDOE Reactor Sharing

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Table VI.C.3

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

Project	Users	Organization Name	Project Title	Description	Funding
1551	Rizo	Tru-Tec	Production of high-activity solid radionuclides	Production of Na-24 and other solid high activity radionuclides.	Tru-Tec
1552	Higley	Oregon State University	Radioecology Experiment for RHP 488/588	Measurement of radionuclide transport in an aquatic environment.	USDOE Reactor Sharing
1553	Hemming	Columbia University	Provenance of Long Island Loess	Dating of single grain Muscovite and biotite in Long Island loess by Ar/Ar method and correlating mica ages with possible hinterland.	USDOE Reactor Sharing
1554	Fleischer	Union College			USDOE Reactor Sharing
1556	Karchesy	Oregon State University	Determination of chlorine in wood products	The objective of this study is to determine the concentration of chlorine in plywood products.	USDOE Reactor Sharing
1557	Garver	Union College	Fission Track Age Dating	Use of fission tracks from U-235 to determine the location and concentration of U-238 in zircon crystals to determine the fission track age of unknown samples.	USDOE Reactor Sharing

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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
Alpha Detectors	3
GM Detectors	41
Ion Chambers	11
Micro-R Meters	3
Personal Dosimeters	45
TOTAL	103

Table VI.C.5

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

Department/Agency	Number of Calibrations
OSU Departments	
Animal Science	4
Biochemistry/Biophysics	10
Botany and Plant Pathology	7
Center for Gene Research	1
Chemistry	1
Civil Engineering	2
Crop Science	3
Electrical and Chemical Engineering	1
E.M.T.	7
Entomology	1
Exercise and Sport Science	1
Fish and Wildlife	2
Food Science and Nutrition	2
Forest Science	2
Horticulture	2
Linus Pauling Institute	2
Microbiology	7
Oceanic and Atmospheric Sciences	1
Pharmacy	4
Physics	2
Radiation Safety Office	12
Veterinary Medicine	7
Zoology	3
OSU Departments Total	84
Non-OSU Agencies	
Army Corps of Engineers	1
ESCO Corporation	11
Federal Aviation Administration	2
Good Samaritan Hospital	7
Hot Cell Services	3
Kirner Consulting	1
Occupational Health Laboratory	1
Oregon Office of Energy	21
Oregon Department of Transportation	1
Oregon Health Sciences University	22
Oregon Public Utilities Commission	4
Oregon State Health Division	24
Rogue Community College	1
Siga Technologies	2
U.S. Environmental Protection Agency	5
Valley Landfills, Inc.	2
Veterinary Diagnostic Imaging Cytopathology	1
Non-OSU Agencies Total	104

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
7/14/2000	6	Research Experience Undergraduate Physics Students
7/19/2000	18	PCC Lab Tour
7/20/2000	16	Adventures in Learning
7/21/2000	16	Adventures in Learning
7/24/2000	2	Ron and Linda Grayson
7/25/2000	39	Upward Bound (10th graders)
7/26/2000	6	OSU SED 501
7/27/2000	8	OSU SED 501
7/31/2000	8	OSU SED 501
8/1/2000	8	OSU SED 501
8/2/2000	7	OSU SED 501
8/2/2000	2	Geology Students
8/7/2000	5	OSU SED 501
8/14/2000	15	OSU CH 123
8/15/2000	18	OSU CH 123
8/16/2000	15	OSU CH 123
8/25/2000	3	Minton Family
9/14/2000	1	Koichiro Watanabe
9/18/2000	1	Tessa Williams
9/21/2000	12	First Year Experience
9/22/2000	1	Ben Danielson
9/25/2000	1	Thuan Tran
9/28/2000	20	LBCC GS 105

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
9/28/2000	20	LBCC GS 105
9/28/2000	20	LBCC GS 105
10/3/2000	10	Dixon Lodge Students
10/4/2000	2	Amanda Maple
10/13/200(	19	Boy Scouts
10/14/200(	41	Dad's Weekend
10/16/200(	2	Chuck Oien and Alec Wills
10/17/200(	23	OSU Odyssey Class
10/17/200(	5	OSU SED 501
10/19/200(	21	Orientation Class from Central Oregon Community College
10/19/200(	5	OSU SED 501
10/20/200(	2	Puget Sound Naval Shipyard (Mike Heesacket, Stephen Wright)
10/23/200(	0	Heedo Lee and Youngho Shin
10/23/200(	35	Newport 5th Graders
10/24/200(	5	OSU SED 501
10/26/200(	5	OSU SED 501
10/31/200(	1	Moshe Kroupp
10/31/200(	5	OSU SED 501
11/2/2000	5	OSU SED 501
11/7/2000	15	OSU Odyssey Class
11/8/2000	11	OSU Odyssey Class
11/15/200(	13	OSU Odyssey Class

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
11/16/2000	5	OSU SED 501
11/21/2000	22	WOU CH 104
11/21/2000	19	WOU CH 104
11/21/2000	18	WOU CH 104
11/30/2000	12	Instrument Society of America
12/8/2000	1	Melanie Marshall from OSU Foundation
12/12/2000	3	Mike Conway and David and Melinda Spoor
12/20/2000	5	John Ringle and Family
1/11/2001	12	Center for Alternative Learning, Corvallis School District
1/11/2001	4	OSU CH 462
1/11/2001	2	Nate Carsten's relatives
1/12/2001	20	REED College
1/16/2001	4	OSU CH 462
1/18/2001	2	State of Oregon, Auditors
1/19/2001	1	Relatives
1/24/2001	2	Thermo CIDTEC
1/24/2001	10	Life Gate High School, Freshman
1/26/2001	1	Peter Carlich
1/30/2001	4	Engineering Students
1/30/2001	1	Melissa Moore
1/31/2001	2	OSU SED 501
1/31/2001	1	Spencer Davis
2/2/2001	1	Stacey Malloy

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
2/8/2001	3	OSU SED 501
2/8/2001	7	OSU NAVY 212
2/8/2001	9	OSU NAVY 212
2/12/2001	8	OSU CH 225H
2/13/2001	20	OSU CH 225H
2/14/2001	11	Cross Connection Inspectors
2/14/2001	20	OSU GEO 300
2/14/2001	2	Barometer personnel
2/15/2001	20	OSU CH 225H
2/22/2001	3	OSU COMM 322
3/1/2001	3	OSU SED 501
3/6/2001	24	OSU CH 222
3/6/2001	28	OSU CH 222
3/6/2001	21	OSU CH 222
3/6/2001	21	OSU CH 222
3/7/2001	22	OSU CH 222
3/7/2001	22	OSU CH 222
3/8/2001	3	OSU SED 501
3/8/2001	23	OSU CH 222
3/8/2001	17	OSU CH 222
3/8/2001	23	OSU CH 222
3/8/2001	21	OSU CH 222
3/9/2001	11	Oregon Office of Energy

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
3/13/2001	10	OSU ENGR 331
3/13/2001	9	OSU ENGR 331
3/13/2001	6	OSU ENGR 331
3/13/2001	10	OSU ENGR 331
3/13/2001	21	OSU CH 222
3/13/2001	23	OSU CH 222
3/13/2001	19	OSU CH 222
3/14/2001	21	OSU CH 222
3/14/2001	23	OSU CH 222
3/15/2001	20	OSU CH 222
3/15/2001	21	OSU CH 222
3/15/2001	19	OSU CH 222
3/16/2001	24	SMILE students
3/16/2001	24	SMILE students
3/16/2001	12	Boy Scouts
3/26/2001	15	Future Farmers of America
4/4/2001	15	OSU NE 116
4/5/2001	8	Advanced Physics
4/17/2001	20	McKay HS Chem Class
4/18/2001	3	Mr. Fedock - NW Universities Accredidation Board
4/18/2001	2	Argonne National Laboratory-West, visitors
4/19/2001	39	Youth Leadership Group
4/23/2001	7	Cooperative Directors

Table VI.F.1

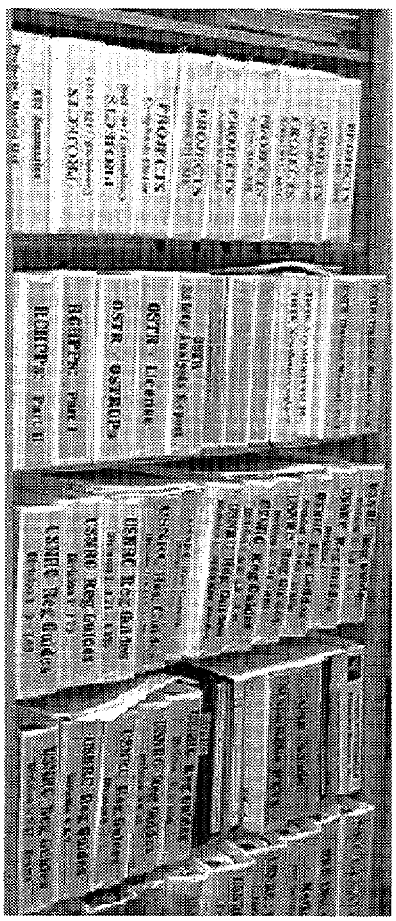
Summary of Visitors to the Radiation Center

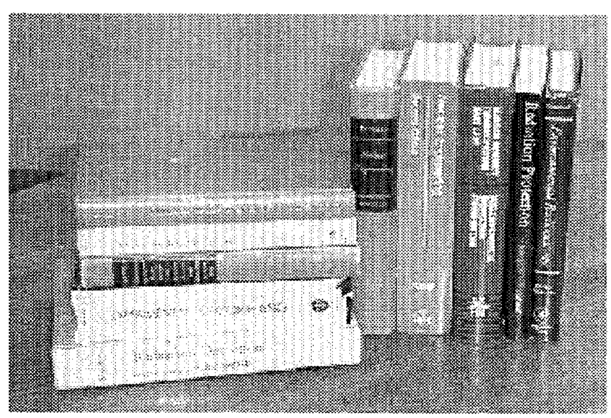
Date	No. of Visitors	Name of Group
4/24/2001	2	Mel Holst- President of Rieglelmann Technologies, INC
4/25/2001	21	West Albany High School
4/25/2001	9	West Albany High School
5/1/2001	9	Willamette Valley Community School
5/4/2001	1	Nate Carsten's relatives
5/5/2001	53	Mom's Weekend
5/8/2001	2	Jim Barrett and Wade Richards
5/14/2001	2	Paul and Jean Rose
5/15/2001	2	Chuck and Jan Halligan
5/17/2001	8	Center for Alternative Learning, Corvallis School District
5/21/2001	1	Michael Thomas, OSU Marketing
6/8/2001	20	LBCC Physical Science and Energy and Society Class
6/18/2001	3	Menn Family
6/18/2001	8	Ammon Family

Total Tours: 128 **Total Visitors: 1499**

Part VII

Words





Part VII

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