RADIATION CENTER

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October 8, 2003

U.S. Nuclear Regulatory Commission
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, 2002 through June 30, 2003.

The 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 had yet another successful and productive year. I would like to emphasize that the achievements of this last year would not have been possible without the support and assistance we received from the invaluable programs administered by the USDOE. In particular, the Reactor Sharing program and the University Research Reactor Upgrades program are very cost-effective in providing invaluable support to the university reactor community and its users. Thanks for all the help we get from USDOE.

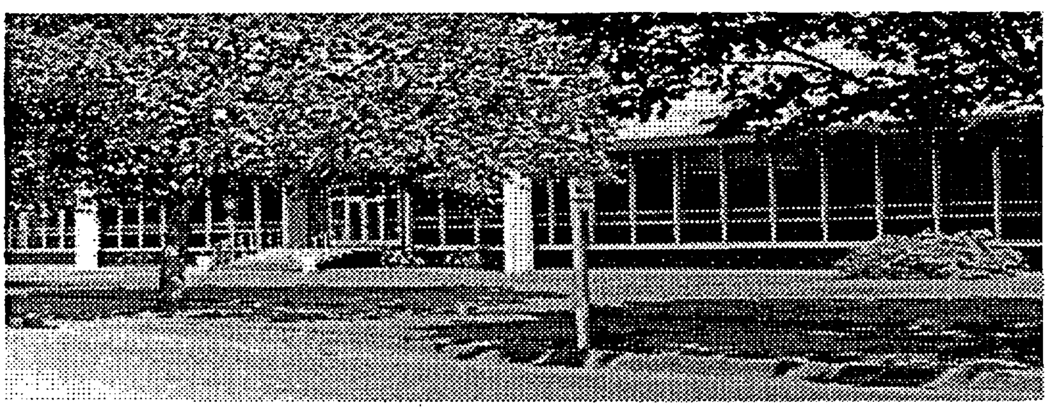
Sincerely,

Andrew C. Klein
Director

A020

lm:srr
Enclosure
cc: Alexander Adams
Craig Bassett
David Stewart-Smith
Edward Ray
Time White
Rich Holdren
Steve Reese
Gary Wachs
Shirley Campbell
Robin Keen

Oregon State University Radiation Center and TRIGA Reactor



Annual Report

July 1, 2002 - June 30, 2003

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

July 1, 2002 - June 30, 2003

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:

A. C. Klein, Director

With contributions from:

A. C. Klein, Director
S. C. Campbell, Business Manager
M. R. Conrady, Analytical Support Manager
J. E. Darrough, Health Physicist
L. Mauer, Receptionist
S. A. Menn, Senior Health Physicist
S. R. Reese, Reactor Administrator
J. M. Stueve, Office Specialist
S. P. Smith, Scientific Instrument Technician
G.M. Wachs, Reactor Supervisor

Submitted by:

A. C. Klein
Director, Radiation Center

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October 2003

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

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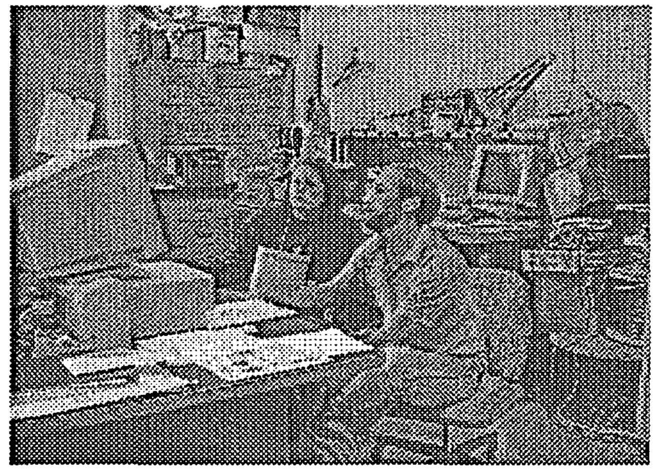
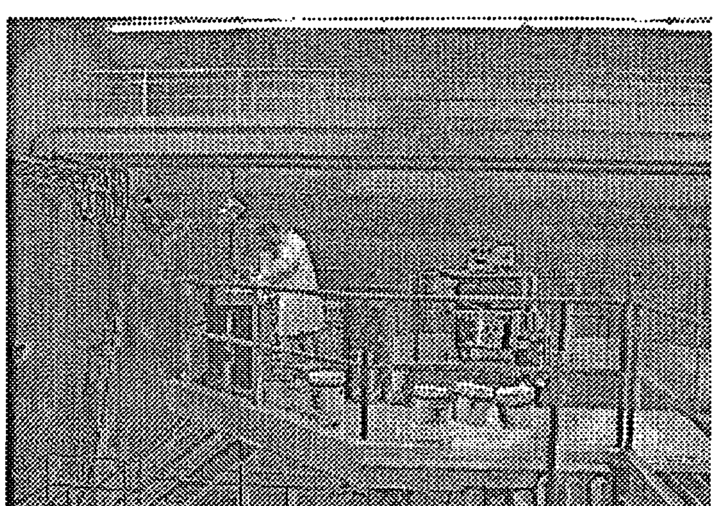




Part I

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."

Putting this report together each year is a major effort for two people. This year, the burden of collecting the information, "twisting arms," and generally making the document before you was placed upon LaVon. Erin has once again made collecting the information much easier by automating many of the tables in this report. The amount of person-hours she has saved all of us is more than we probably would like to admit. A special "thanks" goes out to each of them.

B. Executive Summary

In November 2002, S. A. Menn assumed the position of Senior Health Physicist after the resignation of K. M. Brock. Both Shari Brumbach and LaVon Mauer have come on board as the Radiation Center secretary and receptionist, respectively.

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 74 different courses this year, mostly in the Department of Nuclear Engineering. About 20% of these courses involved the OSTR. The number of OSTR hours used for academic courses and training was 28, while 1869 hours were used for research projects. Seventy-three percent of the OSTR research hours were in support of off-campus research projects, which reflects the use of the OSTR nationally and internationally. Radiation Center users published 56 articles this year, with 13 more submitted for publication. There were also 10 theses completed and 29 presentations made by Radiation Center users. The number of samples irradiated in the reactor during this reporting period was 2000. Funded OSTR use hours

comprised 94% of the research use. This is consistent with the move to a more full cost recovery basis for services provided by the Center.

Personnel at the Radiation Center conducted 94 tours of the facility, accommodating 1,287 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 $2.75 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 145. Reactor projects comprised 75% of all projects. The total research supported by the Radiation Center, as reported by our researchers, was $1,764,500). The actual total is likely considerably higher. This year the Radiation Center provided service to 66 different institutions, 33% 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, 2002 through June 30, 2003. 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, 2003. 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 Radiation Health Physics, 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. History

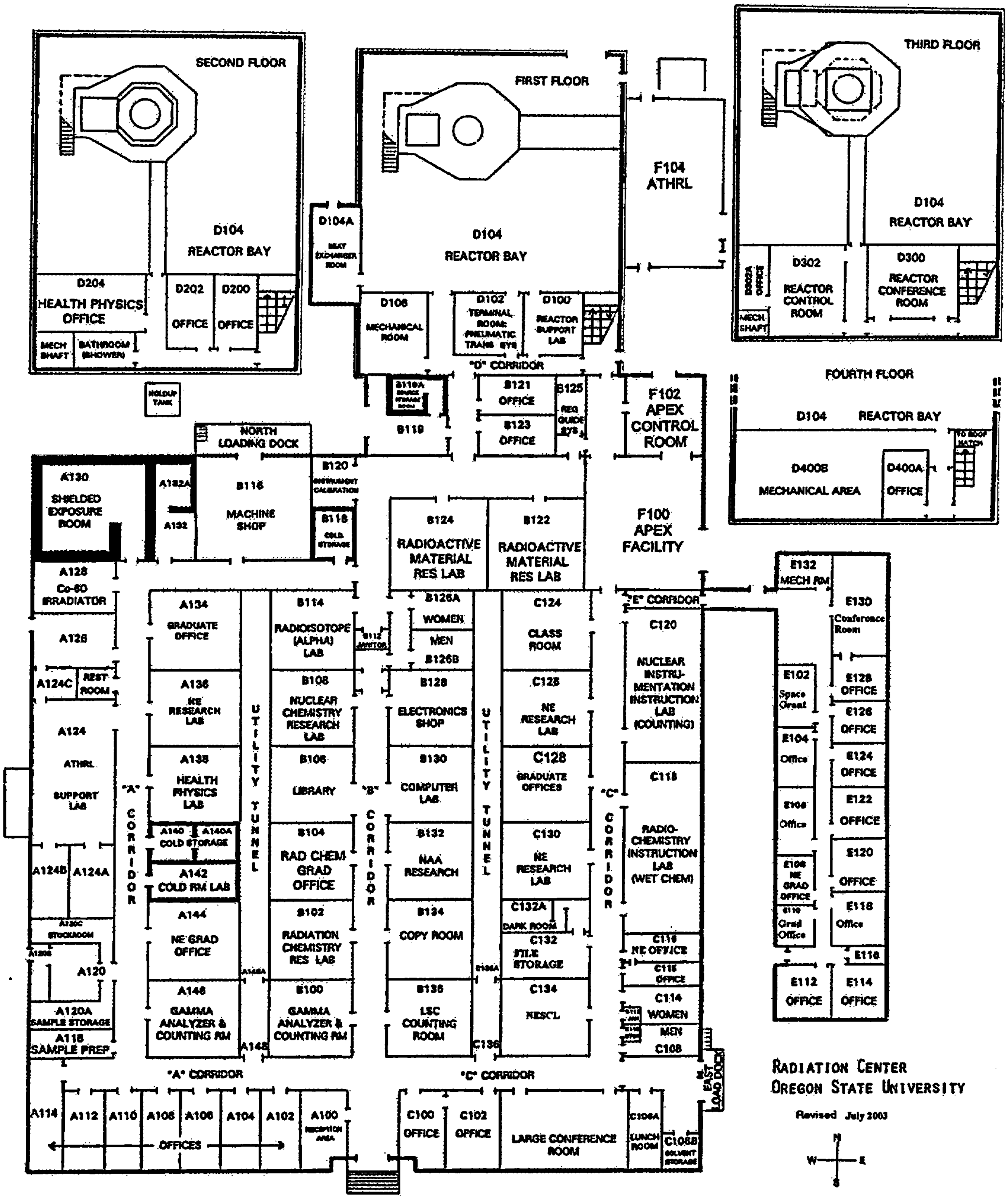
A brief chronology of the key dates and events in the history of the OSU Radiation Center and the TRIGA reactor is given below:

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

June 1971	OSTR cooling capacity upgraded to allow continuous operation at 1 MW.
April 1972	OSTR Site Certificate issued by the Oregon Energy Facility Siting Council.
September 1972	OSTR area fence installed.
December 1974	AGN-201 reactor permanently shut down.
March 1976	Completion of 1600 square feet of additional space to accommodate the rapidly expanding nuclear engineering program.
July 1976	OSTR refueled with 70% enriched FLIP fuel.
July 1977	Completion of a second 1600 square feet of space to bring the Radiation Center complex to a total of 45,553 square feet.
January 1980	Major upgrade of the electronics in the OSTR control console.
July 1980	AGN-201 reactor decommissioned and space released for unrestricted use.
June 1982	Shipment of the original 20% enriched OSTR fuel to Westinghouse Hanford 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.

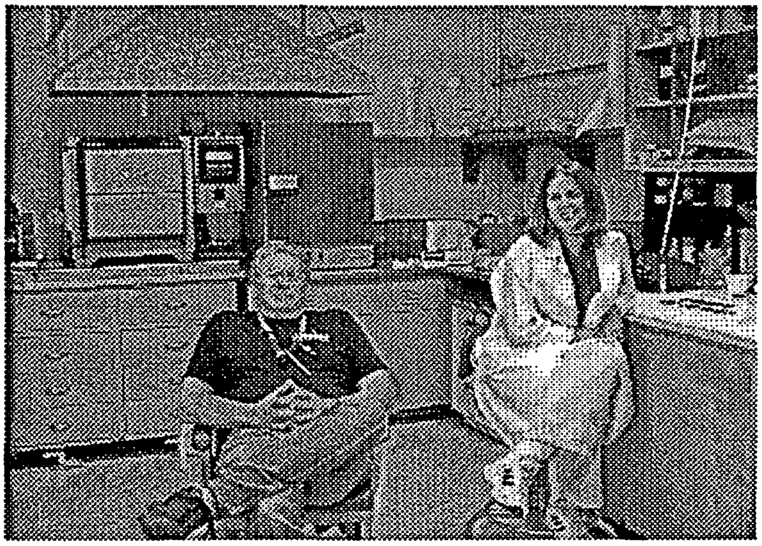
August 1994	APEX inauguration ceremony.
August 1995	Major external refurbishment: new roof, complete repaint, rebuilt parking lot, addition of landscaping and lighting.
September 1998	B. Dodd left on a leave of absence to the International Atomic Energy Agency. S. E. Binney became new Director.
January 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.
July 2002	S. E. Binney retired. J. F. Higginbotham became interim director.
October 2002	A. C. Klein became new director.

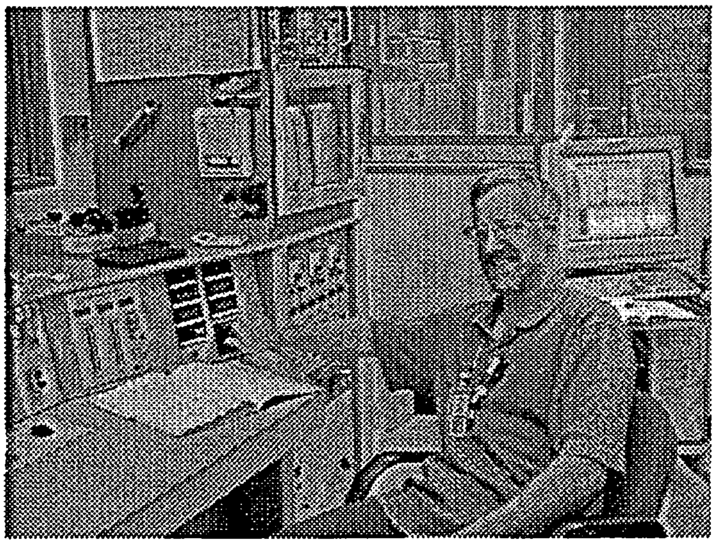
Figure I.D.1
Floor Plan of the Radiation Center



Part II

People





Part II

PEOPLE

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

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

*Binney, Stephen E.
Professor Emeritus
Nuclear Engineering and Radiation Health Physics

*Brock, Kathryn M.
Senior Health Physicist
Radiation Center

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

Craig, A. Morrie
Professor
College of Veterinary Medicine

Daniels, Malcolm
Professor Emeritus
Chemistry

Fleischmann, Tom
Research Associate
Veterinary Medicine

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* OSTR users for research and/or teaching.

Groome, John T.
Faculty Research Assistant
ATHRL Facility Operations Manager
Nuclear Engineering and Radiation Health Physics

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

*Hamby, David
Associate Professor
Nuclear Engineering and Radiation Health Physics

Hart, Lucas P.
Faculty Research Associate
Chemistry

*Higginbotham, Jack F.
Interim Director, Oregon Space Grant
Professor
Nuclear Engineering and Radiation Health Physics

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

Hopson, John
ATHRL DAS Coordinator/Test Engineer
Nuclear Engineering and Radiation Health Physics

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

Klein, Andrew C.
Director, Radiation Center
Department Head, Department of Nuclear Engineering and Radiation Health Physics
Director, Oregon Space Grant Program (to 10/31/02)
Professor
Nuclear Engineering and Radiation Health Physics

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* OSTR users for research and/or teaching.

*Krane, Kenneth S.
Professor
Physics

Lafi, Abd Y.
Assistant Professor Senior Research
ATHRL Research Analyst
Nuclear Engineering and Radiation Health Physics

*Loveland, Walter D.
Professor
Chemistry

*Menn, Scott A.
Senior Health Physicist

*Palmer, Todd S.
Associate Professor
Nuclear Engineering and Radiation Health Physics

*Paulenova, Alena
Assistant Professor Senior Research
Radiation Center

Popovich, Milosh
Vice President Emeritus

*Reese, Steven R.
Reactor Administrator
Radiation Center

Reyes, Jr., José N.
ATHRL Principal Investigator
Professor
Nuclear Engineering and Radiation Health Physics

Ringle, John C.
Professor Emeritus
Nuclear Engineering and Radiation Health Physics

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* OSTR users for research and/or teaching.

Robinson, Alan H.
Department Head Emeritus
Nuclear Engineering and Radiation Health Physics

*Schmitt, Roman A.
Professor Emeritus
Chemistry

*Schütfort, Erwin G.
Faculty Research Assistant
Project Manager

*Wachs, Gary
Reactor Supervisor
Radiation Center

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

Woods, Brian
Assistant Professor
Nuclear Engineering and Radiation Health Physics

Wu, Qiao
Assistant Professor
Nuclear Engineer and Radiation Health Physics

Young, Roy A.
Professor Emeritus
Botany and Plant Pathology

* OSTR users for research and/or teaching.

B. Visiting Scientists and Special Trainees

Name	*Field (Affiliation)*	*Advisor or Research Program Director*
Cloughsey, Michael	Visiting student, Notre Dame	W. D. Loveland
Gallant, Aaron	Visiting student, Univ. Rochester	W. D. Loveland
Nicholas Myers	Saturday Academy Mentorship Program Summer Student	W. D. Loveland
Peterson, Don	Postdoctoral Assistant, Chemistry	W. D. Loveland

C. OSU Graduate Students

Name	*Degree Program*	*Field*	*Advisor*
Abel, Kent	PhD	Nuclear Engineering	J. N. Reyes
Bak, Michael	MS	Radiation Health Physics	K. A. Higley
Bittle, Whitney	MS	Nuclear Engineering	T. S. Palmer
Buchholz, Matthew	MS	Radiation Health Physics	J. F. Higginbotham
Coleman, Joseph	MS	Radiation Health Physics	S.E. Binney
Davidson, Gregory	MS	Nuclear Engineering	T. S. Palmer
Davis, Ian	PhD	Nuclear Engineering	T. S. Palmer
Frey, Wesley	MS	Radiation Health Physics	J. F. Higginbotham
Huang, Zhongliang	PhD	Nuclear Chemistry	W. D. Loveland
Jones, Quyen	MS	Radiation Health Physics	D.M. Hamby
Keller, S. Todd	MS	Nuclear Engineering	T. S. Palmer
Kincaid, Kevin	MS	Nuclear Engineering	A. C. Klein
Kriss, Aaron	PhD	Radiation Health Physics	D. M. Hamby
Lin, Lan	PhD	Radiation Health Physics	D. M. Hamby
Mallory, Stacy	MS	Radiation Health Physics	D. M. Hamby
Napier, Bruce	PhD	Radiation Health Physics	D. M. Hamby
Nes, Elana	MS	Radiation Health Physics	S.R. Reese
Nes, Razvan	PhD	Nuclear Engineering	T. S. Palmer
Rajan, Ajith	MS	Radiation Health Physics	D. M. Hamby
Rezvyi, Aleksey	PhD	Nuclear Engineering	J. N. Reyes
Rock, Mollie	MS	Radiation Health Physics	D. M. Hamby
Sabharwall, Piyush	MS	Nuclear Engineering	Q. Wu
Slauson, Marjorie	MS	Radiation Health Physics	K. A. Higley
Sriprisan, Sirikul	MS	Nuclear Engineering	D. M Hamby
Staples, Christopher	MS	Physics	K. Krane

* OSTR users for research and/or teaching.

Stringham, Michael	MS	Nuclear Engineering	T. S. Palmer
Tang, Hong	PhD	Nuclear Engineering	Q. Wu
Tavakoli, Farsoni	PhD	Radiation Health Physics	D. M. Hamby
Villamar, Glenda	MS	Radiation Health Physics	K. A. Higley
Welter, Kent B.	PhD	Nuclear Engineering	Q. Wu
Yao, You	PhD	Nuclear Engineering	Q. Wu
Yoo, Yeon-Jong	PhD	Nuclear Engineering	J. N. Reyes
Young, Eric	MS	Nuclear Engineering	J. N. Reyes

D. Business, Administrative and Clerical Staff

Interim Director, Radiation Center through 9/30/02 .... J.F. Higginbotham
Director, Radiation Center from 10/1/02 .... A. C. Klein
Business Manager, Radiation Center and
  Nuclear Engineering and Radiation Health Physics .... S. C. Campbell
Office Coordinator, Radiation Center through 10/31/02 .... J. M. Stueve
Administrative Assistant, Radiation Center and
  Nuclear Engineering and Radiation Health Physics from 11/1/02 .... R. A. Keen
Office Specialist, Radiation Center through 11/30/02 .... E. D. Jordan
Office Specialist, Radiation Center and
  Nuclear Engineering and Radiation Health Physics from 11/18/02 S.M. Brumbach
Office Specialist, Radiation Center from l/2/03 .... L. Mauer
Custodian .... E. Cimbri
Office Coordinator, Nuclear Engineering and Radiation Health Physics
  through 10/31/02 .... R. A. Keen
Office Specialist, Nuclear Engineering and
  Radiation Health Physics from 11/1/02 .... J. M. Stueve
Office Specialist, ATHRL–Nuclear Engineering and Radiation Health Physics T.L. Culver
Word Processing Technician, Nuclear Engineering and Radiation Health Physics
  through 9/30/02 .... L. J. Robinson

E. Reactor Operations Staff

Principal Security Officer through 9/30/02 .... J.F. Higginbotham
Principal Security Officer from 10/1/02 .... A. C. Klein
Reactor Administrator .... S. R. Reese
Reactor Supervisor, Senior Reactor Operator .... G. M. Wachs
Senior Reactor Operator .... S. P. Smith
S. T. Keller

F. Radiation Protection Staff

Senior Health Physicist through 9/3/02 .... K. M. Brock
Senior Health Physicist from 10/1/02 .... S. A. Menn

Health Physicist through 9/30/02 .... S. A. Menn
Health Physicist .... J. E. Darrough
Health Physics Monitors (Students) .... C. Hepler
L. Dart
A. Dombrowski
A. Ernst
J. Juarez
J. Jun
S. Kleeb

G. Scientific Support Staff

Analytical Support Manager .... M. R. Conrady
Projects Manager .... E. G. Schütfort
Neutron Activation Analysis Technicians (Students) .... K. Gray
J. Nazir
M. Whittaker
Scientific Instrument Technician .... S. P. Smith
Nuclear Instrumentation Support .... M. M. Conrady

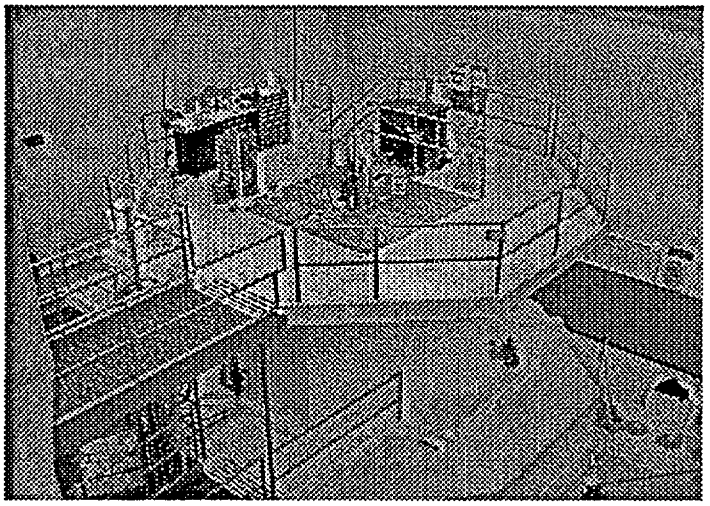
H. Committees

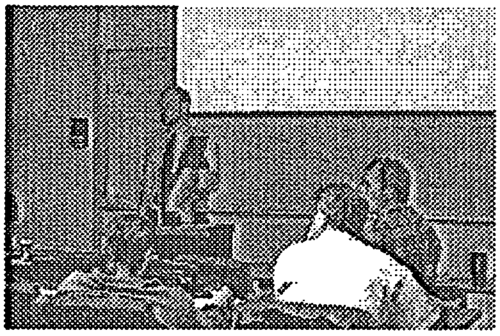
1. Reactor Operations Committee

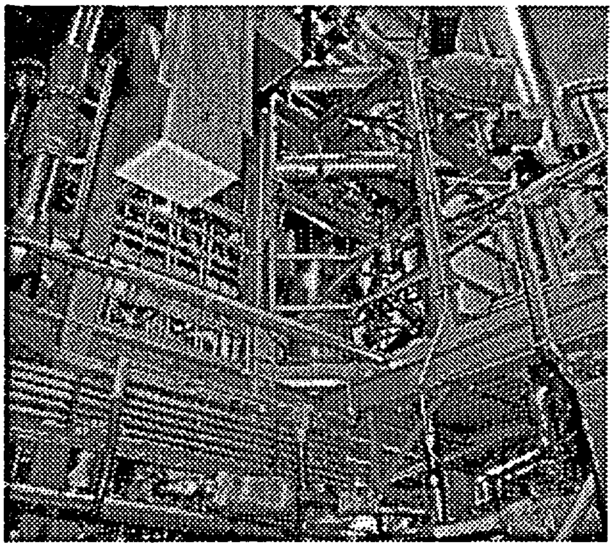
Name	*Affiliation*
J.C. Ringle, Chair	Nuclear Engineering and Radiation Health Physics
S. E. Binney	Nuclear Engineering and Radiation Health Physics
G. M. Wachs	Radiation Center
A. C. Klein	Radiation Center and Nuclear Engineering and Radiation Health Physics
K. M. Brock through 9/30/02	Radiation Center
W. J. Richards	McClellan Nuclear Radiation Center
S. R. Reese	Radiation Center and Nuclear Engineering and Radiation Health Physics
M. H. Schuyler	Chemistry
W. H. Warnes	Mechanical Engineering
S. A. Menn from 10/1/02	Radiation Center
D. M. Hamby	Nuclear Engineering and Radiation Health Physics
T. S. Palmer	Nuclear Engineering and Radiation Health Physics
R. H. Farmer	Radiation Safety Office

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 20 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 10 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 28 hours of reactor time. Tables III.A.1 and 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.

Details of the reactor's use are given in Table III.A.4. 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 82 courses accommodated at the Radiation Center during this reporting period along with their enrollments is given in Table III.D.1.

E. Instrument Repair and Calibration Facility

1. Description

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

2. Utilization

The Center's instrument repair and calibration facility is used regularly throughout the year and is absolutely essential to the continued operation of the many different programs carried out at the Center. In addition, the absence of any comparable facility in the state has led to a greatly

expanded instrument calibration program for the Center, including *calibration of essentially all radiation detection instruments used by state and federal agencies in the state of Oregon.* This includes instruments used on the OSU campus and all other institutions in the Oregon University System, plus instruments from the Oregon Health Division's Radiation Protection Services, the Oregon Office of Energy, the Oregon Public Utilities Commission, the Oregon Health Sciences University, the Army Corps of Engineers, and the U. S. Environmental Protection Agency. Additional information regarding instrument repair and calibration efforts is given in Tables VI.C.4, VI.C.5, and VI.C.6.

F. Library

1. Description

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

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

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

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

2. Utilization

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

Table III.A.1

OSU Courses Using the OSTR

Course Number	Course Name
Chem 462	Experimental Chemistry II
Chem 103	General Chemistry
Chem 205	General Chemistry
Chem 225H	Honors General Chemistry
NE 114	Introduction to Nuclear Engineering and Radiation Health Physics
NE 116	Introduction to Nuclear Engineering III
NE 451	Neutronic Analysis and Lab 1
NE 452/552	Neutronic Analysis and Lab II
NE 453/553	Neutronic Analysis and Lab III
SMILE	Science and Math Investigative Learning Experiences

Table III.C.1

Gammacell 220 ^{60}Co Irradiator Use
(1276 Ci: 7/1/03)

Purpose of Irradiation	Samples	Dose Range (rads)	Number of Irradiations	Use Time (hours)
Sterilization	wood, bioflex strips, sponges, biological samples	2×10^4 to 2.5×10^6	53	1,477
Material Evaluation	electronic components	5.0×10^4 to 9×10^6	1	3
Bio-Medical Studies	anticancer vaccine	2.0×10^4 to 8.0×10^4	1	3
TOTALS			55	1,481

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 2002	Winter 2003	Spring 2003	Summer 2003
Nuclear Engineering and Radiation Health Physics Department Courses						
NE/RHP114*	2	Introduction to Nuclear Engineering and Radiation Health Physics	21	–	–	–
NE/RHP115	2	Introduction to Nuclear Engineering and Radiation Health Physics	–	28	–	–
NE/RHP116*	2	Introduction to Nuclear Engineering and Radiation Health Physics	–	–	27	–
NE/RHP234	4	Nuclear and Radiation Physics I	27	–	–	–
NE/RHP235	4	Nuclear and Radiation Physics II	–	26	–	–
NE/RHP236*	4	Nuclear Radiation Detection and Instrumentation	–	–	25	–
NE319	3	Societal Aspects of Nuclear Technology	–	75	–	–
NE/RHP401	1-16	Research	–	–	1	–
NE405H	1-16	R&C/Used Nuclear Fuel: Garbage or Gold	–	4	–	–
NE405	1-16	Reading and Conference	–	1	–	–
RHP405	1-16	Reading and Conference	–	–	–	–
NE/RHP406	1-16	Projects	–	–	1	1
NE/RHP407	1	Nuclear Engineering Seminar	14	14	17	–
NE/RHP410	1-12	Internship	3	2	2	1
NE/RHP415	2	Nuclear Rules and Regulations	–	32	–	–
NE416**	4	Radiochemistry	–	–	7	–
NE450	3	ST/ Nuclear Medicine	–	–	–	–
NE451**	4	Neutronic Analysis and Lab I	8	–	–	–
NE452**	4	Neutronic Analysis and Lab II	–	8	–	–
NE453**	4	Neutronic Analysis and Lab III	–	–	7	–

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

NE457**	3	Nuclear Reactor Laboratory	–	–	–	–
NE467	4	Nuclear Reactor Thermal Hydraulics	11	–	–	–
NE474	4	Nuclear Systems Design I	–	9	–	–
NE475	4	Nuclear Systems Design II	–	–	9	–
NE/RHP479	1-4	Individual Design Project	–	1	–	–
NE/RHP481	4	Radiation Protection	13	–	–	–
NE/RHP482*	4	Applied Radiation Safety	–	–	–	–
RHP483	4	Radiation Biology	–	5	–	–
RHP487	3	Radiation Biology	–	–	–	–
RHP488	3	Radioecology	–	3	–	–
NE/RHP490	4	Radiation Dosimetry	–	–	8	–
RHP493	3	Non-reactor Radiation Protection	–	–	–	–
NE/RHP499	1-16	St/Environmental Aspects Nuclear Systems	–	–	–	–
NE/RHP501	1-16	Research	1	–	–	–
NE/RHP503	1	Thesis	9	9	9	–
NE/RHP505	1-16	Reading and Conference	–	–	–	2
NE/RHP506	1-16	Projects	–	–	1	–
NE/RHP507/607	1	Nuclear Engineering Seminar	13	11	12	–
NE/RHP510	1-12	Internship	6	5	7	–
NE/RHP515	2	Nuclear Rules and Regulations	–	6	–	–
NE526	3	Computational Methods for Nuclear Reactors	–	3	–	–
NE/RHP535	3	Nuclear Radiation Shielding	–	–	–	–
NE/RHP539	3	ST/Nuclear Physics for Engineers and Scientists	6	–	–	–

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

Table III.D.1 (continued)

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

NE/RHP543	3	Hi-Level Radioactive Waste Management	–	–	–	–
NE/RHP549	3	Low Level Waste	–	–	–	–
NE550	3	Nuclear Medicine	–	–	–	–
NE551**	4	Neutronic Analysis and Lab I	2	–	–	–
NE552**	4	Neutronic Analysis and Lab II	–	1	–	–
NE553**	4	Neutronic Analysis and Lab III	–	–	1	–
NE557**	3	Nuclear Reactor Laboratory	–	–	–	–
NE559	1	ST/Nuclear Reactor Analysis: Criticality Safety	5	–	–	–
NE567	4	Advanced Nuclear Reactor Thermal Hydraulics	1	–	–	–
NE568	3	Nuclear Reactor Safety	–	–	–	–
NE569	1-3	ST/Thermal Hydraulic Instumentation	–	–	10	–
NE574	4	Nuclear Systems Design I	–	2	–	–
NE575	4	Nuclear Systems Design II	–	–	1	–
NE/RHP581	4	Radiation Protection	2	–	–	–
NE /RHP582*	4	Applied Radiation Safety	–	–	–	–
RHP583	4	Radiation Biology	–	4	–	–
NE585	3	Environmental Aspects Nuclear Systems	–	–	–	–
RHP585	3	Environmental Aspects Nuclear Systems	–	–	–	–
NE/RHP586	3	Advanced Radiation Dosimetry	–	–	–	–
RHP588	3	Radioecology	–	3	–	–
RHP589	1-3	ST/Radiation Protection and Risk Assessment	–	–	–	–
RHP593	3	Non-Reactor Radiation Protection	–	–	–	–
NE599	1	ST/Principles of Nuclear Medicine	–	–	–	–

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

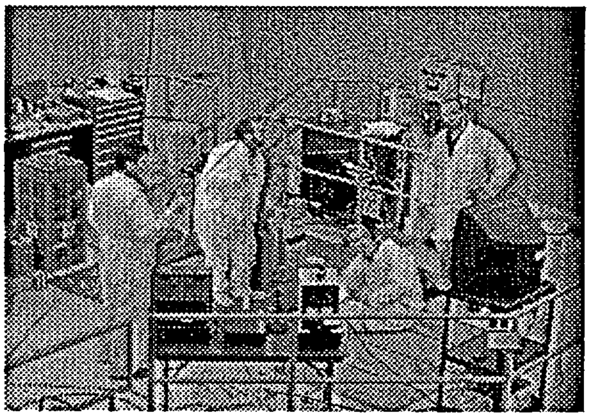
NE/RHP601	1-16	Research	–	–	1	–
NE/RHP603	1-16	Thesis	3	4	6	2
NE/RHP605	1-16	Reading and Conference	–	–	–	–
RHP610	1-12	Internship	6	3	2	–
NE654	3	Neutron Transport Theory	–	–	–	–
NE667	3	Advanced Thermal Hydraulics	5	–	–	–
Courses from Other Departments						
CH103*		General Chemistry	–		–	–
CH222*	5	General Chemistry (Science Majors)	–	247	–	–
CH225H	5	Honors General Chemistry	–	39	–	–
CH462*	3	Experimental Chemistry II Laboratory	–	4	–	–
ENGR331	4	Momentum, Energy and Mass	–	–	–	–
GEO300	3	Environmental Conservation	130	–	–	–
PH202	5	General Physics	–	217	–	–
Courses from Other Institutions						
ENGR111	COCC	Engineering	18	–	–	–
GS105*	LBCC	General Science	27	29	30	–

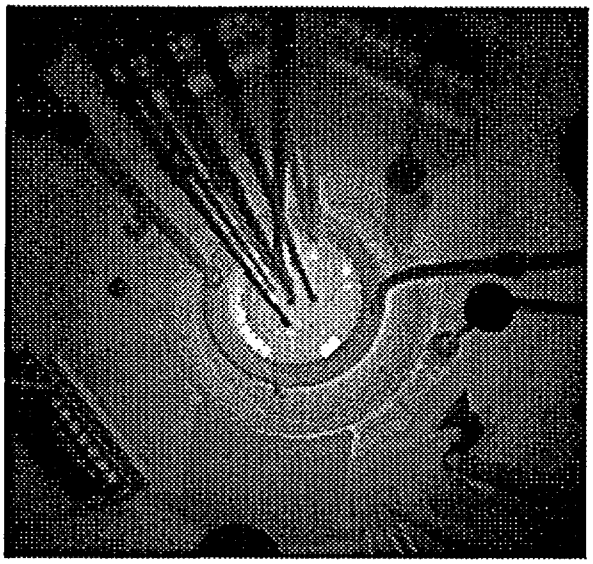
NOTE:
This table does not include the thesis courses from other OSU departments (see Table VI.C.2).

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

Part IV

Reactor





Part IV

REACTOR

A. Operating Statistics

Reactor operations to meet customer demand, operational testing and calibrations, and to maintain core activity requirements resulted in the generation of 1,025,472 kW Hours of thermal power during this reporting period. This equates to 42.7 megawatt days generated between July 1, 2002 and June 30, 2003. The cumulative thermal energy generated by the OSTR FLIP core now totals 1028.6 MWD from August 1, 1976 through June 30, 2003. The productivity of the reactor irradiation facilities can be calculated based on reactor availability in accordance with specific use categories. A normal nine-hour, five-day per week schedule sets the total available reactor operating hours. Critical reactor operation averaged 48.9% of each day. Of the 2250 total available annual operating hours, 1100 were at power, 481 hours were spent conducting facility startup and shutdown operations, 430 hours were expended for maintenance and sample decay delays and 239 hours the reactor was not operating for reasons other than listed above.

Table IV.A.1 provides information related to the OSTR annual energy production, fuel usage and use requests. Table IV.A.2 summarizes statistics for the original 20% enriched fuel loading.

Tables IV.A.3 through 5 provide additional details on reactor use categories, multiple use and other tracked data.

B. Experiments Performed

1. Approved Experiments

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

- 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 these available experiments, six were used during the reporting period. Table IV.B.1 provides information related to the frequency of use and the general purpose of their 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 nine 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 4 changes to the reactor facility during this reporting period. For additional information regarding these changes, or copies of the changes, contact the OSTR Operations staff.

(1) *01-08, Evacuation Horn Removal*

(a) Description

The Radiation Center is served by 3 individual systems providing information and alarms capable of prompting facility evacuation during emergency conditions. These systems include the public address system (PA), the fire alarm system and a series of 12 volt automobile horns.

The car horn system was deemed to be substandard in its installation and less reliable, requiring high levels of maintenance. It was subsequently removed and replaced by the installation of an integrated circuit addition to the PA announcing system. A pre-recorder message can be actuated by evacuation switches located at the front of the Radiation Center and within the OSTR control room. Additional speakers and signal amplifiers were added as necessary to ensure the evacuation message is audible throughout the facility.

(b) Safety Evaluation

Both the PA and fire systems are powered from the inverter backed emergency power system and have demonstrated excellent reliability. Changes to this system

will not affect the need for actuation, but will increase reliability due to the PA system's frequency of use and standardization of message.

(2) *02-03, Installation of a Primary Tank Camera*

(a) Description

A standard color CCD camera, contained within a waterproof housing was mounted on the reactor tank liner to provide a clear view of the reactor core during all modes of operation. In addition to providing the operator with visual clues related to operation, the video signal provides the means for facility visitors to observe the core from the visitor's gallery.

(b) Safety Evaluation

Primary concerns related to the possible introduction of camera housing pieces during reactor operation were shown not to create unanalyzed damage.

(3) *02-04, Replacement of the Secondary Chemical Addition System*

(a) Description

The current non-functional secondary system conductivity based chemical addition system was replaced by a batch flow system based on cooling tower makeup flow. Additionally, chemical injection points were altered to increase mixing and reduce injection head requirements. Chemical addition and blowdown rates are adjusted based on periodic water chemistry analysis.

(b) Safety Analysis

Although a loss of coolant accident is considered to be the most pertinent event related to a failure of the secondary cooling system, the specifically addressed analysis of reactor damage associated while operating the reactor with only air cooling results in no cladding damage.

(4) *02-08, Insertion of a Bismuth Filter into Beam Port #3*

(a) Description

A bismuth filter was inserted into Beam Port #3 to reduce the photon content of the neutron beam produced during operation. This was necessary to further assess the suitability of the beam port for use as a neutron radiography source following initial neutron flux testing.

(b) Safety Analysis

The installed plug filter is passive and placed external to the reactor primary tank. No effect on reactor operation is expected.

2. 10 CFR 50.59 Changes to Reactor Procedures

Numerous changes to procedures related to reactor operation were prompted by facility changes and the periodic review of the Reactor Operations Committee (ROC).

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

(1) *02-07 and 03-01, Revisions to OSTROP 17, 26*

(a) Description

Changes to OSTROP 17, Reactor Room Ventilation System Procedures, were identified by the Operations Staff and subsequent review by the ROC in response to equipment changes.

Changes Made to OSTROP 26, Procedures for the Connection of External Monitoring and Recording Devices, resulted from an ROC audit and were mostly related to clerical corrections.

(b) Safety Evaluation

The intent of these OSTROPS will not be significantly altered. The changes simply clarify the original intent or make it consistent with the current regulations.

(2) *0 02-09 and 03-04, OSTROP 6*

(a) Description

OSTROP 6, Administrative and Personnel Procedures, was altered to include the ROC Charter as an integral part of the OSTROP. This change also increased the conservativeness of assistance to the Reactor Operator during at power operation by requiring the presence of a select list of individuals within the Radiation Center.

(b) Safety Evaluation

The intent of the OSTROP will not be significantly altered. The changes simply clarify the original intent or make it consistent with the current regulations.

(3) *02-10, OSTROP 18*

(a) Description

Changes made to this OSTROP, Procedures for the Approval and Use of Reactor Experiments, are meant to assist the experimenter to complete the necessary forms correctly and to comply with changes made internally to track and record reactor use data. Forms have been standardized and computerized allowing web access with streamlined instructions.

(b) Safety Analysis

The intent of the OSTROP will not be significantly altered.

(4) *03-02, OSTROP 11*

(a) Description

Grammatical and clerical errors in OSTROP 11, Fuel Element Handling Procedures, were identified by the ROC audit and corrected in this revision. Removed ambiguity in the form of "should" statements by replacement with "shall".

(b) Safety Analysis

The intent of the OSTROP will not be significantly altered. The changes simply clarify the original intent or make it consistent with the current regulations.

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 2002	Replaced Lazy Susan argon ventilation system HEPA filter. Replaced PB test switch on HV1 test circuit which seems to have eliminated spurious High Volts scrams.
August 2002	Replaced reactor bay air supply damper actuator diaphragm in D106. Replaced reactor bay ventilation steam supply diaphragm in D400.
September 2002	Painted reactor bay visitor's gallery (D300).

	Replaced the emergency power system inverter with a new upgraded unit. Unit has gel cells vs. lead acid batteries. Initial wiring error required the replacement of AC input switch.
	Replaced the emergency generator battery.
October 2002	Recovered and removed detached internal source from reactor top CAM.
December 2002	Fabricated 3 new polyethylene thermal column sample holding "pizza boards" for replacement of deteriorating ones.
	Inspected and load tested reactor bay crane.
January 2003	Drilled 2.5" hole in floor north of console for re-routing of wiring associated with console upgrade.
	Disassembled temporary Beam Port #3 shield blockhouse and returned internal assembly to original configuration.
February 2003	Upgraded reactor bay crane to operate using radio control vs. pendant. Changed oil in all gearboxes.
April 2003	Located new computer adjacent to console with internal data acquisitions system installed.

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 identified by shading are required by the OSTR Technical Specifications.

F. Reportable Occurrences

NRC notified of a "Self-Identified Violation of the OSTR Physical Security Plan". Details are restricted from general release.

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	July 1, 1992 Through June 30, 1993
Operating Hours (critical)	1205	1208	1172	1352	1170	1136	1094	1158	1180
Megawatt Hours	946	1042	993	1001	1025	1013	928	1002	1026
Megawatt Days	39.4	43.4	41.4	41.7	42.7	42.2	38.6	41.8	42.7
Grams ^{235}U Used	49.5	54.4	51.9	52.3	53.6	53.0	48.5	52.4	53.6
Hours at Full Power (1 MW)	904	1024	980	987	1021	1009	909	992	1000
Numbers of Fuel Elements Added or Removed (-)	0	0	0	-2	0	-1,+1	-1	0	0

Table IV.A.1 (Continued)

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	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, 2000 Through June 30, 2001	July 1, 2001 Through June 30, 2002
Operating Hours (critical)	1248	1262	1226	1124	1029	1241	949	983	1029
Megawatt Hours	1122	1117	1105	985	927	1115	852	896	917
Megawatt Days	46.7	46.6	46.0	41.0	38.6	46.5	35.5	37.3	38.2
Grams ^{235}U Used	58.6	58.4	57.8	51.5	48.5	58.3	44.6	46.8	47.7
Hours at Full Power (1 MW)	1109	1110	1101	980	921	1109	843	890	912
Numbers of Fuel Elements Added or Removed (-)	0	0	-1[5]	-1, +[7]	0	-1[5]	0	0	-1[5]
Number of Irradiation Requests	303	324	268	282	249	231	234	210	239

Table IV. A.1 (Continued)

OSTR Operating Statistics (Using the FLIP Fuel Core)

Operational Data for FLIP Core	July 1, 2002 Through June 30, 2003	July 1, 2003 Through June 30, 2004	July 1, 2004 Through June 30, 2005	July 1, 2005 Through June 30, 2006	July 1, 2006 Through June 30, 2007	July 1, 2007 Through June 30, 2008	July 1, 2008 Through June 30, 2009	July 1, 2009 Through June 30, 2010	July 1, 2010 Through June 30, 2011
Operating Hours (critical)	1100								
Megawatt Hours	1025								
Megawatt Days	42.7								
Grams ^{235}U Used	50.5								
Hours at Full Power (1 MW)	1023								
Numbers of Fuel Elements Added or Removed (-)	0								
Number of Irradiation Requests	215								

(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 use 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 (2002/2003)	Cumulative Values for FLIP Core
MWH of energy produced	1025	24,686
MWD of energy produced	42.7	1,028
Grams ^{235}U used	50.5	1,287.5
Number of fuel elements added fo (+) or removed from (-) the core	0	79 + 3 FFCR[(1)]
Number of pulses	10	1,377
Hours reactor critical	1100	24,343
Hours at full power (1 MW)	1023	24,266
Number of srtup and shutdown checks	250	6,817
Number of irradiation requests processed	215	8,768
Number of samples irradiated	2000	110,985

(1) Fuel Follower Control Rod. These numbers represent the core loading at the end of this 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]	28	13,176
OSU Research	505	9,372
Off-campus research	1,364	18,733
Forensic services	0	234[3]
Reactor preclude time	911	21,566
Facility time[3]	19	7,117
TOTAL REACTOR USE TIME	2,827	70,198

(1) See Tables III.A.2 and III.D.1 for teaching statistics (reactor tours are not logged as use).

(2) 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.

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

Table IV.A.5

OSTR Multiple Use Time(1)

Number of Users	Annual Values (hours)	Cumulative Values for FLIP Core (hours)
Two	479	4,933
Three	179	1,642
Four	17	576
Five	9	142
Six	0.5	59
Seven	0	12
TOTAL MULTIPLE USE TIME	684.5	7,364

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

Table IV.B.1

Use of OSTR Reactor Experiments

Experiment Number	Research	Teaching	Forensic	NRC License Requirement	Other	Total
A-1	0	0	0	4	8	12
B-3	143	20	0	0	16	179
B-12	12	0	0	0	0	12
B-23	0	0	0	0	3	3
B-31	7	0	0	0	0	7
B-32	2	0	0	0	0	2
Total	**164**	**20**	**0**	**1**	**27**	**215**

Table IV.C.1
Unplanned Reactor Shutdowns and Scrams

Type of Event	Number of Occurrences	Cause of Event
High Voltage 1 Scram	2	Scram occurs while shimming rods, acknowledging alarms and other seemingly unrelated events. HV1 PB test switch, internal spring was failing to keep contacts closed when external vibrations applied. Switch replaced.
Safety Power Scram	1	Operator error. Rod height balance allowed Safe channel power to exceed 106% during initial temperature rise at 1MW.
Period Scram	1	Scram occurs during rod withdrawl at very low power levels. No positively identified cause for what appears to be AC noise.
Manual Reactor Shutdown	1	Shutdown due to high activity on ARM#1. Cause determined to be clogged filter on outlet of Lazy Susan argon vent manifold. Low flow allowed argon concentration to accumulate in discharge header and raise local area background activity.
Manual Reactor Shutdown	2	Reactor shutdown from 15 watts and 1 MW to replace stack monitor particulate filter paper.
Manual Reactor Shutdown	1	Reactor shutdown due to activation of the Radiation Center Fire Alarm
Percent Power Scram	1	No positively identified cause for what appears to be AC noise.

Figure IV.E.1

Monthly Surveillance and Maintenance (Sample Form)

OSTROP 13 Rev. 8 **SURVEILLANCE & MAINTENANCE FOR THE MONTH OF ______________**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	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	BULK WATER TEMPERATURE ALARM	FUNCTIONAL					
3	ERP INVENTORY AND INSPECTIONS	ERP App. B					
4	PRIMARY WATER Ph MEASUREMENT	MIN: 5 MAX: 8.5					
5	BULK SHIELD TANK WATER Ph MEASUREMENT	MIN: 5 MAX: 8.5					
6	CHANGE LAZY SUSAN FILTER	FILTER CHANGED					
7	REACTOR TOP CAM OIL LEVEL CHECK	OSTROP 13.10	NEED OIL?_____				
8	PROPANE TANK LIQUID LEVEL CHECK	> 50%					
9	PRIMARY PUMP BEARINGS OIL LEVEL	OSTROP 13.13	NEED OIL?_____				
10	WATER MONITOR CHECK						

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

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

OSTROP 14 Rev. 6 **SURVEILLANCE & MAINTENANCE FOR THE 1st / 2ed / 3ed / 4th QUARTER OF 20__**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	REACTOR OPERATION COMMITTEE (ROC) AUDIT	QUARTERLY					
2	QUARTERLY ROC MEETING	QUARTERLY					
3	FUEL ELEMENT RADIATION LEVEL MEASUREMENTS IN WATER	≥ 23 R/hr @ 2' IN WATER					
4	ERP INSPECTIONS	QUARTERLY					
5	KEY INVENTORY	QUARTERLY					
6	ROTATING RACK CHECK FOR UNKNOWN SAMPLES	EMPTY					
7	WATER MONITOR ALARM CHECK	FUNCTIONAL					
8	STACK MONITOR CHECKS (OIL DRIVE MOTORS, H.V. READINGS)	MOTORS OILED PART: 1150 V GAS: 900 V ±50	 ____V ____V				
9	CHECK FILTER TAPE SPEED ON STACK MONITOR	1"/HR ± 0.2					
10	INCORPORATE 50.59 & ROCAS INTO DOCUMENTATION	QUARTERLY					
11	STACK MONITOR ALARM CIRCUIT CHECKS	ALARM ON					
12	ARM SYSTEM ALARM CHECKS	FUNCTIONAL					

ARM SYSTEM ALARM CHECKS (item 12):

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

* *Date not to be exceeded is only applicable to shaded 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 Rev. 6 (CONTINUED) **SURVEILLANCE & MAINTENANCE FOR THE 1st / 2nd / 3rd / 4th QUARTER OF 20___**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
13	OPERATOR LOG	a) ≥4 hours: at console (RO) or as Rx. Sup. (SRO) b) Complete Operating Exercise	a) TIME	b) OPERATING EXERCISE			

* Date not to be exceeded is only applicable to shaded items. It is equal to the date completed last quarter plus four months.

Figure IV.E.3

Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP 15 Rev. 9 **SEMI-ANNUAL SURVEILLANCE AND MAINTENANCE FOR 1st /2nd HALF 20____**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]						LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	FUNCTIONAL CHECKS OF REACTOR INTERLOCKS	NEUTRON SOURCE COUNT RATE INTERLOCK					NO WITHDRAW					
							5 cps					
		TRANSIENT ROD AIR INTERLOCK					NO PULSE					
		PULSE PROHIBIT ABOVE 1 kW					1 kW					
		TWO ROD WITHDRAWAL PROHIBIT					1 only					
		PULSE MODE ROD MOVEMENT INTERLOCK					NO MOVEMENT					
		MAXIMUM PULSE REACTIVITY INSERTION LIMIT					$2.50					
		PULSE INTERLOCK ON RANGE SWITCH					NO PULSE					
2	SAFETY	PERIOD SCRAM					[illegible] sec					
3	CONTROL ROD WITHDRAWAL INSERTION & SCRAM TIMES		TRANS	SAFE	SHIM	REG	2 sec					
		SCRAM										
		WITHDRAWAL					50 sec					
		INSERTION					50 sec					
4	TEST PULSE	PULSE ______ ______ MW ______ C					20% CHANGE	PULSE ______ ______ MW ______ C				
5	REACTOR BAY VENTILATION SYSTEM SHUTDOWN TEST						DAMPERS CLOSE IN [illegible] SECONDS	1 FLOOR ______ 4 FLOOR ______				
6	CALIBRATION OF THE FUEL ELEMENT TEMPERATURE CHANNEL						20C					
7	EMERGENCY RESPONSE PLAN INVENTORY						ERP App B					
8	CLEANING & LUBRICATION OF TRANSIENT ROD CARRIER INTERNAL BARREL											
9	LUBRICATION OF BALL NUT DRIVE ON TRANSIENT ROD CARRIER											

***Date not to be exceeded is only applicable to shaded items. It is equal to the date last time plus 7 ½ months.**

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

OSTROP 15 Rev. 9 (CONTINUED) **SEMI-ANNUAL SURVEILLANCE AND MAINTENANCE FOR 1st /2nd HALF 20____**

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
10	LUBRICATION OF THE ROTATING RACK BEARINGS		10W OIL					
11	CONSOLE CHECK LIST		OSTROP 15.XI					
12	INVERTER MAINTENANCE		See User Manual					
13	STANDARD CONTROL ROD MOTOR CHECKS		LO-17 Bodine Oil					
14	ION CHAMBER RESISTANCE MEASUREMENTS WITH MEGGAR INDUCED VOLTAGE	SAFETY CHANNEL	NONE (Info Only)					
		%POWER CHANNEL	NONE (Info Only)					
15	FISSION CHAMBER RESISTANCE CALCULATION $R = \frac{800V}{\Delta I}$	@ 100 V. I = ____________AMPS @ 900 V. I = ____________AMPS ΔI = ____________AMPS R = ____________Ω	NONE (Info Only)					
16	FUNCTIONAL CHECK OF HOLDUP TANK WATER LEVEL ALARMS		OSTROP 15.XVIII	HIGH_______ FULL_______ GREEN LIGHT_______				
17	INSPECTION OF THE PNEUMATIC TRANSFER SYSTEM	BRUSH INSPECTION						
		SOLENOID VALVE INSPECTION	FUNCTIONAL					
		SAMPLE INSERTION TIME CHECK	≤6 SECONDS					

*Date not to be exceeded is only applicable to shaded items. It is equal to the date last time plus 7 ½ months.

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

OSTROP 16.0 Rev. 7 | **Annual Surveillance and Maintenance for 20___**

	SURVEILLANCE AND MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	BIENNIAL INSPECTION OF CONTROL RODS	FFCRS	OSTROP 12.0					
		TRANS						
2	ANNUAL REPORT		NOV 1		OCT 1	NOV 1		
3	CONTROL ROD CALIBRATION	NORMAL	OSTROP 9.0					
		[illegible]						
		CLI/DUMMY						
4	REACTOR POWER CALIBRATION		OSTROP 8.0					
5	CALIBRATION OF REACTOR TANK WATER TEMP		OSTROP 16.5					
6	CONTINUOUS AIR MONITOR CALIBRATION	Particulate Monitor	RCHPP 18					
		Gas Monitor						
7	STACK MONITOR CALIBRATION	Particulate Monitor	RCHPP 18 & 26					
		Gas Monitor						
8	AREA RADIATION MONITOR CALIBRATION		RCHPP 18.0					
9	DECOMMISSIONING COST UPDATE		N/A	NA		AUGUST 1		
10	SNM PHYSICAL INVENTORY		N/A	NA		OCTOBER 1		
11	MATERIAL BALANCE REPORTS		N/A	NA		NOVEMBER		
12	STANDARD CONTROL ROD DRIVE INSPECTION		OSTROP 16.13					
13	HEU TO LEU CONVERSION REPORT		10 CFR 50.64		MAR 10	MAR 27		

** Date not to be exceeded is only applicable to shaded items. It is equal to the date completed last year plus 15 months. For biennial license requirements, it is equal to the date completed last time plus 2 ½ years.*

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

OSTROP 16.0 Rev. 7 (Continued) **Annual Surveillance and Maintenance for 20____**

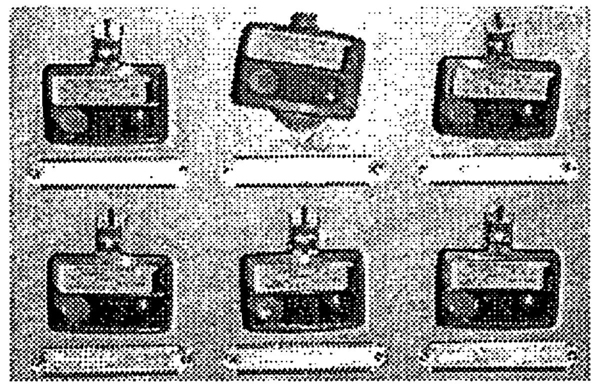
	SURVEILLANCE AND MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
14	EMERGENCY RESPONSE PLAN	GED TRAINING						
		GOOD SAM TRAINING						
		ERP REVIEW						
		ERP DRILL						
		FIRST AID FOR						
		FIRST AID FOR						
15	PHYSICAL SECURITY PLAN	OSP/DPS TRAINING						
		PSP REVIEW						
		PSP DRILL						
		LOCK/SAFE COMBO CHANGES						
		AUTHORIZATION LIST UPDATE						
16	REACTOR TANK AND CORE COMPONENT INSPECTION		NO POWDERY WHITE SPOTS					
17	EMERGENCY LIGHT LOAD TEST		RCHPP 18.0					
18	FUEL ELEMENT INSPECTION FOR SELECTED ELEMENTS (B1, B2, B3, B5, B6, C3, C5, D5, D6)		PASS GO/NO GO		Pulse #_____ Date________			
19	FUNCTIONAL TEST OF THE REACTOR WATER LOW LEVEL ALARM		~3 INCHES	__________INS __________ANN				

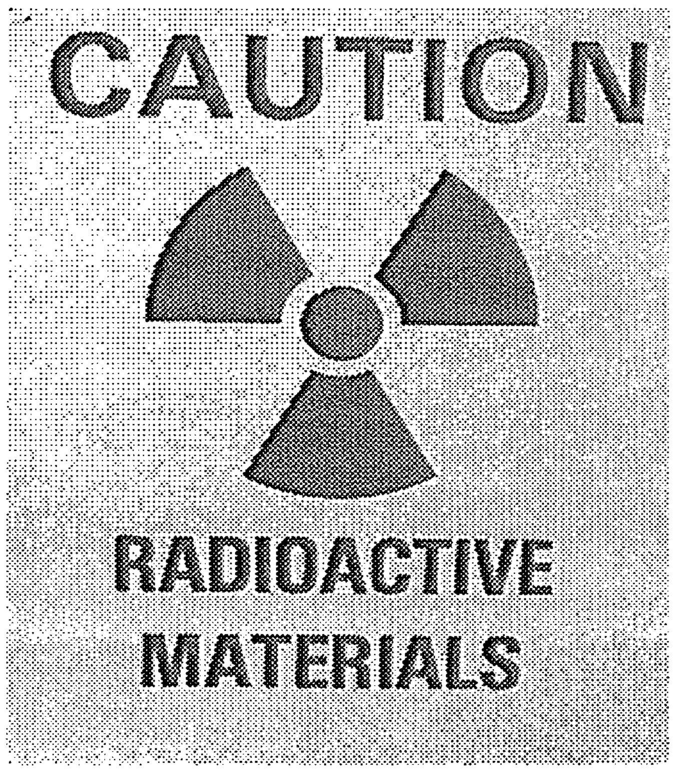
20	REACTOR OPERATOR LICENSE CONDITIONS	ANNUAL REQUALIFICATION				BIENNIAL MEDICAL		EVERY 6 YEARS LICENSE		
		WRITTEN EXAM		OPERATING TEST		DATE DUE	DATE COMPLETED	APPLICATION		EXPIRATION DATE
	OPERATOR NAME	DATE DUE	DATE PASSED	DATE DUE	DATE PASSED			DUE DATE	DATE MAILED	

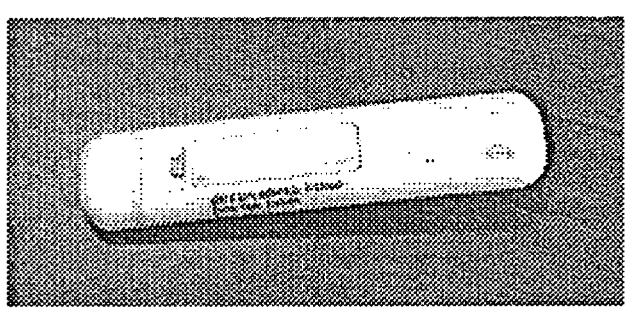
** Date not to be exceeded is only applicable to shaded items. It is equal to the date completed last year plus 15 months. For biennial license requirements, it is equal to the date completed last time plus 2 ½ years.*

Part V

Protection







Part V

PROTECTION

A. Introduction

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

The radiation protection program is implemented by a staff consisting of a Senior Health Physicist, a Health Physicist, 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.

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

B. Environmental Releases

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

1. Liquid Effluents Released

a. Liquid Effluents Released

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

b. Liquid Waste Generated and Transferred

Liquid waste generated from glassware and laboratory experiments is transferred by the campus Radiation Safety Office to its waste processing facility. 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, Thomas Gray Associates, 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 Xβ(γ) TLD badge and other dosimeters as appropriate for the work being performed.

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

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

OSU police and security personnel are issued a quarterly Xβ(γ) 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 4 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

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 taken during this reporting period is 86 (16 soil samples, 14 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 x 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)
April 2003	0	–	0	0	0	0	1696
Annual Total for Radiation Center	0	–	0	0	0	0	1696
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
TRIGA Reactor Facility	None	---	---	---
Radiation Center Laboratories	0.5	^{131}I	5.00×10^{-4}	10/25/02
TOTAL	0.5	^{131}I	5.00×10^{-4}	---

(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.

Table V.B.2

Monthly TRIGA Reactor Gaseous Waste Discharges and Analysis[(1)]

Month	Total Estimated Activity Released (Curies)	Total Estimated Quantity of Argon-41 Released[(2)] (Curies)	Estimated Atmospheric Diluted Concentration of Argon-41 at Point of Released (μCi/cc)	Fraction of the Technical Specification Annual Average Argon-41 Concentration Limit (%)
July	0.42	0.42	3.49E-08	0.87
August	0.37	0.37	3.09E-08	0.77
September	0.25	0.25	2.16E-09	0.54
October	0.39	0.39	3.27E-08	0.82
November	0.19	0.19	1.65E-08	0.41
December	0.19	0.19	1.63E-09	0.41
January	0.25	0.25	2.07E-08	0.52
February	0.16	0.16	1.51E-08	0.38
March	0.24	0.24	2.03E-08	0.51
April	0.18	0.18	1.56E-08	0.39
May	0.20	0.20	1.70E-08	0.43
June	0.37	0.37	3.26E-08	0.81
TOTAL ('02-'03)	3.21	3.21	2.28E-08	0.57

(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
TRIGA Reactor Facility	21.5	^{137}Cs, ^{46}Sc, ^{58}Co, ^{60}Co, ^{54}Mn, ^{75}Se ^{133}I, ^{152}Eu, ^{140}La	4.6×10^{-4}	10/25/02, 1/9/03, 5/23/03
Radiation Center Laboratories	13.75	^{14}C, ^{46}Sc, ^{47}Sc, ^{60}Co, ^{238}U, ^{86}Rb, ^{90}Sr, ^{232}Th	1.2×10^{-5}	10/25/02, 1/9/03, 5/23/03
TOTAL	35.25	See Above	4.7×10^{-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.

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	13	6	92	490	320	954
Key Facility Research Personnel	<1	3	18	96	29	295
Facilities Services Maintenance Personnel	0	N/A	0	N/A	0	N/A
Laboratory Class Students	<1	2	44	59	127	482
Campus Police and Security Personnel	1	N/A	19	N/A	58	N/A
Visitors	<1	N/A	8	N/A	81	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)	
		xβ(γ) (mrem)	Neutron (mrem)
MRCTNE	D104: North Badge East Wall	155	ND
MRCTSE	D104: South Badge East Wall	112	ND
MRCTSW	D104: South Badge West Wall	289	ND
MRCTNW	D104: North Badge West Wall	91	ND
MRCTWN	D104: West Badge North Wall	139	ND
MRCTEN	D104: East Badge North Wall	324	ND
MRCTES	D104: East Badge South Wall	916	ND
MRCTWS	D104: West Badge South Wall	283	ND
MRCTTOP	D104: Reactor Top Badge	343	ND
MRCTHXS	D104A: South Badge HX Room	375	ND
MRCTHXW	D104A: West Badge HX Room	153	ND
MRCD-302	D302: Reactor Control Room	196	ND
MRCD-302A	D302A: Reactor Supervisor's Office	48	N/A
MRCBP1	D104: Beam Port Number 1	101	ND
MRCBP2	D104: Beam Port Number 2	149	ND
MRCBP3	D104: Beam Port Number 3	609	ND
MRCBP4	D104: Beam Port Number 4	382	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]	
			xβ(γ) (mrem)	Neutron (mrem)
MRCA100	A100:	Receptionist's Office	ND	N/A
MRCBRF	A102H:	Front Personnel Dosimetry Storage Rack	38	N/A
MRCA120	A120:	Stock Room	44	N/A
MRCA120A	A120A:	NAA Temporary Storage	ND	N/A
MRCA126	A126:	Radioisotope Research Lab	120	N/A
MRCCO-60	A128:	^{60}Co Irradiator Room	251	N/A
MRCA130	A130:	Shielded Exposure Room	28	N/A
MRCA132	A132:	TLD Equipment Room	24	N/A
MRCA138	A138:	Health Physics Laboratory	ND	N/A
MRCA146	A146:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCB100	B100:	Gamma Analyzer Room (Storage Cave)	121	N/A
MRCB114	B114:	α Lab (^{226}Ra Storage Facility)	1,431	ND
MRCB119-1	B119:	Source Storage Room	250	N/A
MRCB119-2	B119:	Source Storage Room	834	N/A
MRCB119A	B119A:	Sealed Source Storage Room	4,020	1831
MRCB120	B120:	Instrument Calibration Facility	27	N/A
MRCB122-2	B122:	Radioisotope Storage Hood	40	N/A
MRCB122-3	B122:	Radioisotope Research Laboratory	40	N/A
MRCB124-1	B124:	Radioisotope Research Lab (Hood)	21	N/A
MRCB124-2	B124:	Radioisotope Research Laboratory	48	N/A
MRCB124-6	B124:	Radioisotope Research Laboratory	41	N/A
MRCB128	B128:	Instrument Repair Shop	24	N/A
MRCC100	C100:	Radiation Center Director's Office	19	N/A
MRCC106A	C106A:	Staff Lunch Room	12	N/A
MRCC106B	C106:	Solvent Storage Room	44	N/A
MRCC106-H	C106H:	East Loading Dock	43	N/A
MRCC118	C118:	Radiochemistry Laboratory	22	N/A
MRCC120	C120:	Student Counting Laboratory	17	N/A
MRCF100	F100:	APEX Facility	11	N/A

See footnotes following the table.

Table V.D.2 (continued)

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

Monitor I.D.	Radiation Center Facility Location (See Figure V.D.1)		Total Recorded Dose Equivalent[1]	
			$x\beta(\gamma)$ (mrem)	Neutron (mrem)
MRCF102	F102:	APEX Control Room	13	N/A
MRCB125N	B125:	Gamma Analyzer Room (Storage Cave)	ND	N/A
MRCB125S	B125:	Gamma Analyzer Room	34	N/A
MRCC124	C124:	Student Computer Laboratory	39	N/A
MRCC130-1	C130:	Radioisotope Laboratory (Hood)	10	N/A
MRCD100	D100:	Reactor Support Laboratory	164	N/A
MRCD102	D102:	Pneumatic Transfer Terminal Lab	247	ND
MRCD102-H	D102H:	1st Floor Corridor at D102	68	ND
MRCD106-H	D106H:	1st Floor Corridor at D106	138	N/A
MRCD200	D200:	Reactor Administrators's Office	181	ND
MRCD202	D202:	Senior Health Physicist's Office	180	ND
MRCBRR	D200H:	Rear Personnel Dosimetry Storage Rack	54	N/A
MRCD204	D204	Health Physicist Office	122	ND
MRCF104	F104:	ATHRL	44	ND
MRCD300	D300:	3rd Floor Conference Room	115	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/hr)		Contamination Levels[1] (dpm/cm²)	
	Average	Maximum	Average	Maximum
TRIGA Reactor Facility:				
Reactor Top (D104)	1	70	<500	1250
Reactor 2nd Deck Area (D104)	4	38	<500	1000
Reactor Bay SW (D104)	<1	3	<500	1000
Reactor Bay NW (D104)	<1	5	<500	3250
Reactor Bay NE (D104)	<1	6	<500	3800
Reactor Bay SE (D104)	<1	14	<500	2250
Class Experiments (D104, D302)	<1	<1	<500	<500
Demineralizer Tank--Outside Shielding (D104A)	<1	2	<500	<500
Particulate Filter--Outside Shielding (D104A)	<1	<1	<500	9800
Radiation Center:				
NAA Counting Rooms (A146, B100)	<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	2	<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	600
TRIGA Tube Wash Room (D100)	<1	<1	<500	<500

(1) <500 dpm/100 cm² = 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 μrem h^{-1} Dose Rate[3] (mrem)
MRCFE-1	93 ± 3	58 ± 6	69 ± 15
MRCFE-2	90 ± 2	52 ± 3	65 ± 13
MRCFE-3	83 ± 2	53 ± 3	62 ± 14
MRCFE-4	87 ± 2	55 ± 5	65 ± 14
MRCFE-5	81 ± 3	49 ± 3	61 ± 15
MRCFE-6	89 ± 1	54 ± 4	68 ± 16
MRCFE-7	85 ± 2	54 ± 4	64 ± 13
MRCFE-8	84 ± 2	51 ± 4	57 ± 13
MRCFE-9	81 ± 1	50 ± 6	63 ± 18

(1) Average Corvallis area natural background using ICN TLDs totals 74 ± 5 mrem for the same period.

(2) OSU fence totals include a measured natural background contribution of 55 ± 3 mrem.

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

Table V.E.2

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

Off-Site Radiation Monitoring Station[1] (See Figure V.E.2)	Total Recorded Dose Equivalent (Including Background) Based on ICN TLDs[2] (mrem)	Total Recorded Dose Equivalent (Including Background) Based on OSU TLDs[3][4] (mrem)	Total Calculated Dose Equivalent (Including Background) Based on the Annual Average μrem/h Exposure Rate[4] (mrem)
MRCTE-2L	---	51 ± 3	53 ± 11
MRCTE-3	88 ± 1	54 ± 5	69 ± 17
MRCTE-4	81 ± 1	59 ± 10	81 ± 16
MRCTE-5L	---	47 ± 12	59 ± 14
MRCTE-6	76 ± 1	46 ± 5	61 ± 9
MRCTE-7L	---	46 ± 6	72 ± 14
MRCTE-8	95 ± 1	57 ± 8	74 ± 14
MRCTE-9	88 ± 1	48 ± 6	69 ± 1
MRCTE-10	82 ± 1	53 ± 9	56 ± 17
MRCTE-12	89 ± 1	59 ± 7	61 ± 13
MRCTE-13L	---	53 ± 7	69 ± 9
MRCTE-14L	---	43 ± 6	49 ± 14
MRCTE-15	74 ± 3	47 ± 5	42 ± 10
MRCTE-16L	---	53 ± 10	66 ± 12
MRCTE-17	80 ± 1	57 ± 12	55 ± 11
MRCTE-18L	---	49 ± 5	56 ± 13
MRCTE-19	89 ± 1	56 ± 4	74 ± 10
MRCTE-20L	---	52 ± 7	60 ± 11
MRCTE-21	74 ± 2	49 ± 6	47 ± 13
MRCTE-22	79 ± 1	44 ± 4	52 ± 7

(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 74 ± 5 mrem for the same period.

(3) OSU off-site totals include a measured natural background contribution of 55 ± 3 mrem.

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

Table V.E.3

Annual Average Concentration of the Total Net Beta Radioactivity (Minus ^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	2.35E-07 ± 6.96E-07[2]	µCi ml^{-1}
4-W	Water	4.38E-08 ± 1.21E-08[2]	µCi ml^{-1}
11-W	Water	6.12E-08 ± 1.37E-09[2]	µCi ml^{-1}
19-RW	Water	6.47E-08 ± 1.43E-08[2]	µCi ml^{-1}
3-S	Soil	3.41E-05 ± 4.97E-05	µCi g^{-1} of dry soil
5-S	Soil	1.97E-05 ± 4.78E-06	µCi g^{-1} of dry soil
20-S	Soil	2.00E-05 ± 1.45E-05	µCi g^{-1} of dry soil
21-S	Soil	4.39E-05 ± 1.73E-05	µCi g^{-1} of dry soil
2-G	Grass	2.55E-04 ± 2.01E-04	µCi g^{-1} of dry ash
6-G	Grass	1.95E-04± 1.80E-04	µCi g^{-1} of dry ash
7-G	Grass	3.13E-04 ± 3.62E-05	µCi g^{-1} of dry ash
8-G	Grass	2.98E-04 ± 1.74E-04	µCi g^{-1} of dry ash
9-G	Grass	2.49E-04 ± 1.71E-04	µCi g^{-1} of dry ash
10-G	Grass	2.57E-04 ± 3.21E-04	µCi g^{-1} of dry ash
12-G	Grass	3.54E-04 ± 1.06E-04	µCi g^{-1} of dry ash
13-G	Grass	3.49E-04 ± 1.73E-04	µCi g^{-1} of dry ash
14-G	Grass	2.00E-04 ± 2.12E-04	µCi g^{-1} of dry ash
15-G	Grass	1.73E-04 ± 1.48E-04	µCi g^{-1} of dry ash
16-G	Grass	3.08E-04 ± 1.93E-04	µCi g^{-1} of dry ash
17-G	Grass	2.88E-04 ± 2.07E-04	µCi g^{-1} of dry ash
18-G	Grass	2.37E-04 ± 2.64E-04	µCi g^{-1} of dry ash
22-G	Grass	3.92E-04 ± 1.55E-04	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 Beta-Gamma LLD Concentration and Range of LLD Values for Soil, Water, and Vegetation Samples

Sample Type	Average LLD Value	Range of LLD Values	Reporting Units
Soil	1.25E-05	8.76E-06 *to* 1.77E-05	μCi g^{-1} of dry soil
Water	1.12E-07	5.97E-08 *to* 6.43E-07	μCi ml^{-1}
Vegetation	3.44E-05	1.14E-05 *to* 6.65E-05	μCi g 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
Berkeley Geochronology Center Berkeley, CA USA	8.83E-06	9	1	0	10
Cal State Fullerton Fullerton, CA USA	5.43E-07	1	0	0	1
California Institute of Technology Pasadena, CA USA	1.12E-05	1	0	0	1
Columbia University Palisades, NY USA	1.60E-06	2	0	0	2
General Dynamics Scottsdale, AZ USA	1.07E-06	1	0	0	1
Idaho State University Pocatello, ID USA	2.51E-05	0	4	0	4
Nu-Trek, Inc Poway, CA USA	8.55E-06	0	1	0	1
Oregon State University Corvallis, OR USA	1.51E-04	3	4	0	7
Plattsburgh State University Plattsburgh, NY USA	1.29E-06	2	0	0	2
Rutgers Piscataway, NJ USA	1.55E-06	1	0	0	1
Stanford University Stanford, CA USA	1.50E-06	3	0	0	3
Syracuse University Syracuse, NY USA	1.16E-06	2	0	0	2
Union College Schenectady, NY USA	3.20E-06	4	0	0	4
University of California at Berkeley Berkeley, CA USA	3.44E-06	2	0	0	2
University of California at Santa Barbara Santa Barbara, CA USA	2.75E-06	5	0	0	5

Table V.F.1 (continued)

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
University of Florida Gainesville, FL USA	5.82E-06	1	1	0	2
University of Southern California Los Angeles, CA USA	1.03E-06	2	0	0	2
University of Washington Seattle, WA USA	1.83E-06	3	0	0	3
University of Wisconsin-Madison Madison, WI USA	2.98E-05	1	3	0	4
Totals	2.61E-04	43	14	0	57

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
Lawrence Berkeley National Laboratory Berkeley, CA USA	5.00E-08	7	1	0	0	8
PGE Trojan Nuclear Plant Rainier, OR	1.60E-06	0	1	0	0	1
Totals	1.65E-06	7	2	0	0	9

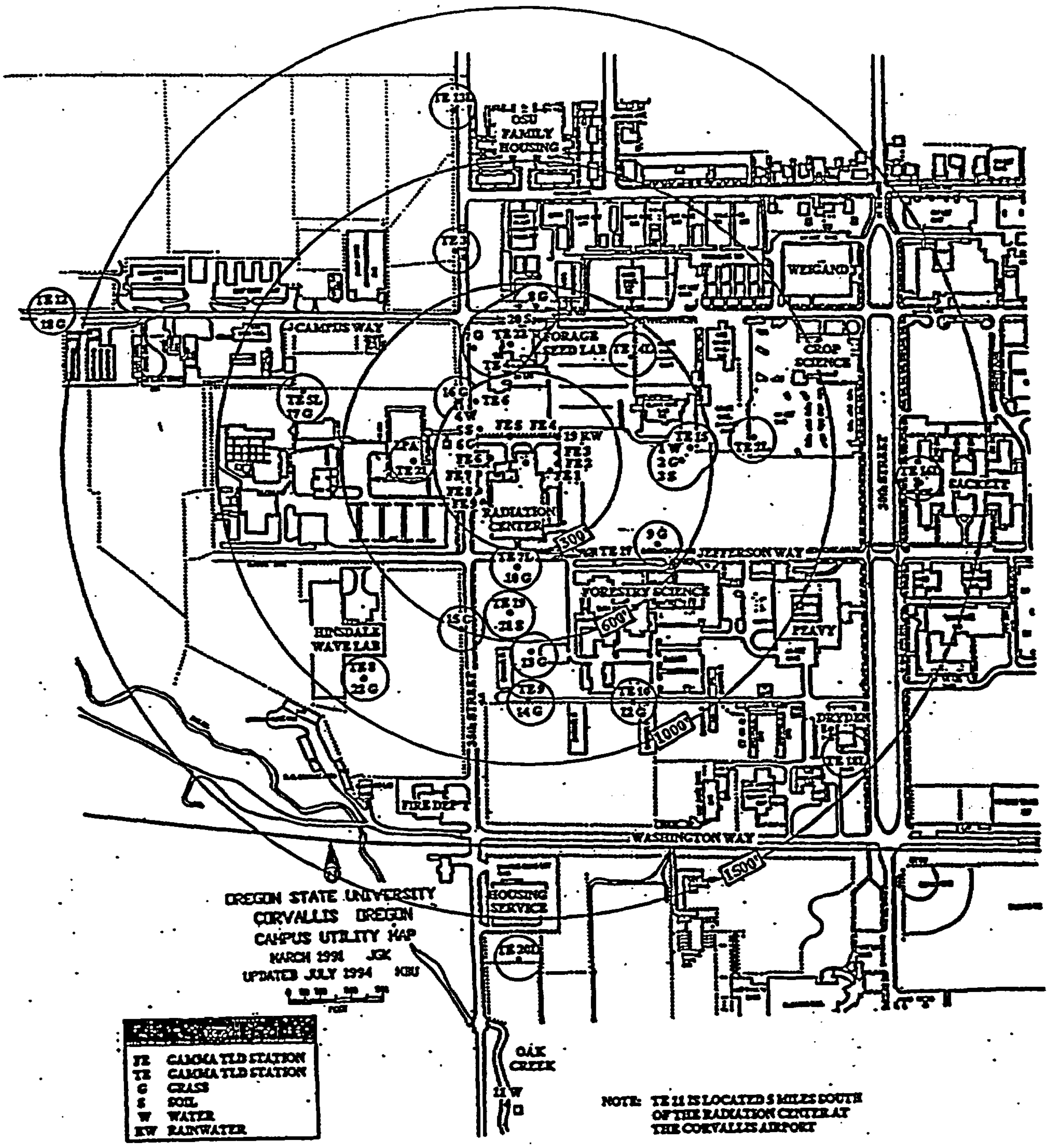
Table V.F.3

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
Geological Institute Copenhagen, DENMARK	4.87E-07	1	0	0	1
Polish Academy of Sciences Krakow, POLAND	7.77E-09	1	0	0	1
Ruhr-Universitat Bochum Bochum, GERMANY	3.26E-08	1	0	0	1
Scottish Universities Research and Reactor Centre East Kilbride, SCOTLAND	5.49E-07	1	0	0	1
Universita' Degli Studi di Bologna Bologna, ITALY	4.63E-07	1	0	0	1
Universitat Potsdam Postdam, GERMANY	5.06E-08	7	0	0	7
Universitat Tubingen Tubingen, GERMANY	6.01E-07	3	0	0	3
University of Geneva Geneva, SWITZERLAND	4.08E-07	1	0	0	1
University of Montpellier Montpellier, FRANCE	8.76E-07	2	0	0	2
University of Queensland Brisbane, Queensland AUSTRALIA	5.51E-06	0	3	0	3
Totals	8.99E-06	18	3	0	21

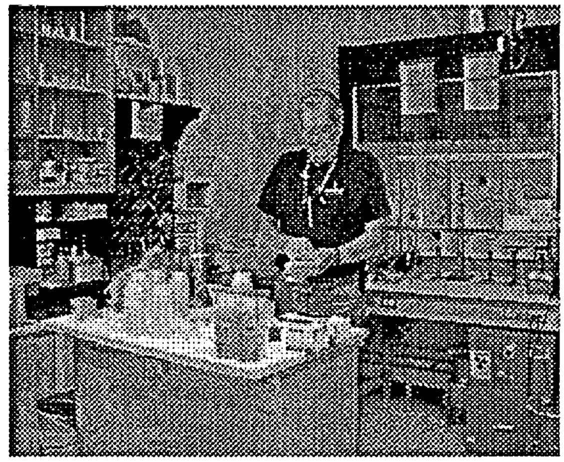
Figure V. D. 1

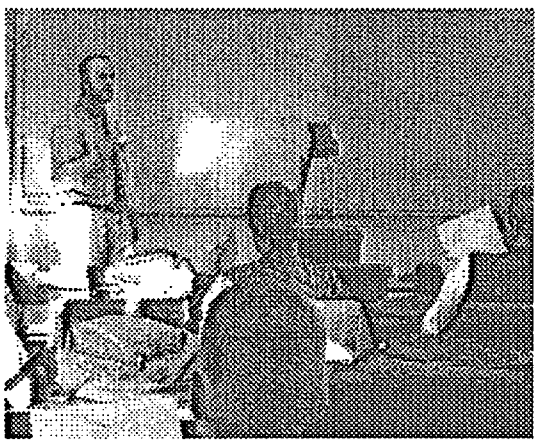
Monitoring Stations for the OSU TRIGA Reactor



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 74 academic classes involving a number of different academic departments from OSU and other Oregon universities. The OSU teaching programs (not including research) utilized 28 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's presence. Computerized data reduction of the gamma ray spectra then yields the concentrations of the various elements in samples being studied. With sequential instrumental NAA it is possible to measure quantitatively about 35 elements in small samples (5 to 100 mg), and for activable elements the lower limit of detection is on the order of parts per million or parts per billion, depending on the element.

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

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

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

2. Forensic Studies

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

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

3. Irradiations

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

4. Radiological Emergency Response Services

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

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

5. Training and Instruction

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

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

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

6. Radiation Protection Services

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

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

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

7. Radiological Instrument Repair and Calibration

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

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

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

Table VI.C.4 is a summary of the instruments which were calibrated in support of the Radiation Center's instructional and research programs and the OSTR Emergency Plan, while Table VI.C.5 shows instruments calibrated for other OSU departments and non-OSU agencies.

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 99 scheduled tours including 1,287 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

Institution	Number of Projects[3]	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*Oregon State University[1] Corvallis, OR USA	20	21	3	97[2]
*Oregon State University - Educational Tours Corvallis, OR USA	15	13	0	52
AVI Bio Pharma Corvallis, OR USA	1	0	0	4
Corvallis Clinic Corvallis, OR USA	1	0	0	1
*Crescent Valley High School Corvallis, OR USA	1	1	0	1
*Linn Benton Community College Albany, OR USA	1	0	0	6
*Marist High School Eugene, OR USA	1	0	0	1
*McKay High School Salem, OR USA	1	0	0	1
*National Council of Stream and Air Improvement Corvallis, OR USA	1	1	0	4
*Non-Educational Tours Corvallis, OR USA	1	0	0	29
*University of Oregon Eugene, OR USA	3	3	0	4
*York Engineering Corvallis, OR USA	1	1	0	2
*Douglas High School Roseburg, OR USA	1	1	0	1
Hemcon, Inc. Tigard, OR USA	1	0	0	2
*Madison High School Portland, OR USA	1	1	0	1
*Neahkahnie High School Rockaway Beach, OR USA	1	1	0	1

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects[3]	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*Providence Medical Center Portland, OR USA	1	1	0	1
Providence St. Vincent Hospital Portland, OR USA	1	0	0	19
Rogue Community College Grants Pass, OR USA	1	0	0	1
*Thurston High School Springfield, OR USA	1	1	0	1
*Idaho State University Pocatello, ID USA	1	1	0	2
*University of Washington Seattle, WA USA	2	2	0	4
*Berkeley Geochronology Center Berkeley, CA USA	1	0	4	16
*Cal State Fullerton Fullerton, CA USA	1	1	2	1
*Nu-Trek, Inc Poway, CA USA	1	0	0	2
* Stanford University Stanford, CA USA	2	2	0	3
*University of California at Berkeley Berkeley, CA USA	2	2	0	2
*University of California at Santa Barbara Santa Barbara, CA USA	2	3	5	3
*University of Southern California Los Angeles, CA USA	1	1	0	2
* General Dynamics Scottsdale, AZ USA	1	0	0	1
*Geovic Ltd. Grand Junction, CO USA	1	0	0	16
*University of Wisconsin Madison, WI USA	2	2	5	8
*Columbia University Palisades, NY USSA	1	1		2

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects[3]	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*George Washington University Washington, DC USA	1	1	0	1
*North Carolina State University Raleigh, NC USA	1	0	0	1
*Plattsburgh State University Plattsburgh, NY USA	2	2	0	2
*Syracuse University Syracuse, NY USA	1	1	3	1
*Union College Schenectady, NY USA	3	3	0	4
*Rutgers Piscataway, NJ USA	1	1	1	4
*University of Florida Gainesville, FL USA	1	1	0	3
Vectron International Norwalk Inc. Norwalk, CT USA	1	0	0	1
*Scottish Universities Research and Reactor Centre East Kilbride, SCOTLAND	1	0	0	3
*University of Montpellier Montpellier, FRANCE	1	0	0	3
*GeoForschungsZentrum Potsdam Potsdam, GERMANY	1	1	0	3
*Geological Institute Copenhagen, DENMARK	1	0	0	1
*Polish Academy of Sciences Krakow, POLAND	1	0	0	1
*Ruhr-Universitat Bochum Bochum, GERMANY	2	2	0	3
*Universita' Degli Studi di Bologna Bologna, ITALY	1	2	0	1
*Unversitat Potsdam Potsdam, GERMANY	1	0	0	4
*University of Tuebingen Tuebingen, GERMANY	1	1	3	3

Table VI.C.1 (continued)

Institutions and Agencies Which Utilized the Radiation Center

Institution	Number of Projects[3]	Number of Faculty Involved	Number of Students Involved	Number of Uses of Center Facilities
*University of Queensland Brisbane, Queensland AUSTRALIA	1	1	0	3
Total	95	77	41	333

* 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.

(3) This does not include projects pertaining to instrument calibrations.

Table VI.C.2

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Albert-Ludwigs-Universitaet					
Link, Katharina	PhD	Mineralogy	Rahn	1595	Fission track dating of Mid-European Rhine graben shoulder uplift
Berkeley Geochronology Center					
Culler, Timothy	PhD	Earth and Planetary Science	Alvarez	920	Lunar Impact History from Analysis of Impact Melt Spherules
Knight, Kimberly	MA	Earth and Planetary Science	Renne	920	Geochemical and Isotopic Insights into Continental Flood Basalts
Kyoungwon, Min	MA	Earth and Planetary Science	Renne	920	Reduction of Systematic Errors in 40Ar/39Ar Geochronology
Zhou, Zhensheng	MA	Earth and Planetary Science	Renne	920	Rates and Tempo of Permian-Triassic Boundary Events.
Cal State Fullerton					
Irwin, Christine	MS	Geological Sciences	Armstrong	1625	Uplift of the Puente Hills using fission track data
Oregon State University					
Huang, Zhongliang	PhD	Chemistry	Loveland	1598	
Sinton, Christopher	PhD	Oceanography	Duncan	444	Age and Composition of Two Large Igneous Provinces: The North Atlantic Volcanic Rifted Margin and the Caribbean Plateau
Rutgers					
Young, Amy	PhD	UCLA Geology	Turrin	1423	Petrology and geochemical evolution of the Damavand trachyandesite volcano in northern Iran.

Table VI.C.2 (continued)

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
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
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

Table VI.C.2 (continued)

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
Steele, G.	PhD	Aberdeen University	Pringle	1073	Cerro Rico Silver
White, R.	PhD	Leicester University	Pringle	1073	Caribean Crustal Growth
Syracuse University					
Kline, Simon	MS	Earth Sciences	Fitzgerald	1555	Uplift of the Transantarctic Mountains in the Reedy Glacier area
Monteleone, Brian	PhD	Earth Sciences	Fitzgerald	1555	Papua New Guinea Woodlark Basin Project
Schwabe, Erika	PhD	Earth Sciences	Fitzgerald	1555	Exhumation in the western Pyrenees
Universitat Tubingen					
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.
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

Table VI.C.2 (continued)

Graduate Student Research Which Utilized the Radiation Center

Student's Name	Degree	Academic Department	Faculty Advisor	Project	Thesis Topic
University of Manchester					
Flude, Stephanie	PhD	Earth Sciences	Burgess	1592	Rhyolite volcanism in Iceland: timing and timescales of eruption
University of Wisconsin					
Barquero-Molina, Miriam	PhD	Geology and Geophysics	Singer	1612	
Harper, Melissa	MS	Geology and Geophysics	Singer	1612	
Jicha, Brian	MS	Geology and Geosciences	Singer	1465	
Jicha, Brian	MS	Geology and Geophysics	Singer	1612	
Relle, Monica	MS	Geology and Geophysics	Singer	1465	
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
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	Instrument calibration.	Oregon Health Sciences University
488	Farmer	Oregon State University	Instrument Calibration	Instrument calibration.	OSU Radiation Center
519	Martin	US Environmental Protection Agency	Instrument Calibration	Instrument calibration.	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	Instrument calibration.	USEPA, Cincinnati, OH
664	Reese	Oregon State University	Good Samaritan Hospital Instrument Calibration	Instrument calibration.	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 Geological & Environmental Sci

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Table VI.C.3 (continued)

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
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	Instrument calibration.	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	Markos	Army Corps of Engineers	Instrument Calibration	Instrument calibration.	U.S. Army Engineer District, Portland.
1073	Pringle	Scottish Universities Research and Reactor Centre	Argon 40/39 Dating of Rock Minerals	Age dating of various materials using the Ar-40/Ar-39 ratio method.	Scottish Universities Research and Reactor Centre
1074	Wijbrans	Vrije Universiteit	40Ar-39 Ar Dating of Rocks and Minerals	40Ar-39Ar dating of rocks and minerals.	Vrije Universiteit, Amsterdam
1075	Teaching and Tours	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.	US Geological Survey

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Table VI.C.3 (continued)

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
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
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
1354	Wright	Radiation Protection Services	Radiological Instrument Calibration	Instrument calibration.	Oregon Health Division

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Table VI.C.3 (continued)

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
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
1366	Quidelleur	Universite Paris-Sud	Ar-Ar Geochronology	Determination of geological samples via Ar-Ar radiometric dating.	Universite Paris-Sud
1397	Teach	Providence St. Vincent Hospital	Sterilization of various biological materials	Sterilization of various biological materials for St. Vincents Hospital, Portland	Oregon Medical Laser Institute
1406	Pate	Tracerco	Production of Argon-41	Production of Argon-41 for various field uses	Tracerco
1415	McGinness	ESCO Corporation	Calibration of Instruments	Instrument calibration	ESCO Corporation
1423	Turrin	Rutgers	40Ar/39Ar Analysis	Petrology and geochemical evolution of the Damavand trachyandesite volcano in Northern Iran.	Department of Geological Sciences
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.	OSU Microbiology Department
1431	Patterson	AVI Bio Pharma	Instrument Calibrations	Instrument calibration	AVI Bio Pharma
1464	Slavens	USDOE Albany Research Center	Instrument Calibration	Instrument calibration.	USDOE Albany Research Center

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Table VI.C.3 (continued)

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
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
1467	Kirner	Kirner Consulting, Inc	Instrument Calibration	Instrument calibration.	Kirner Consulting
1468	Nitsche	University of California at Berkeley	Chemistry 146 Experiment	Sample irradiations for Chemistry 146 class	University of California at Berkeley
1470	Bolken	SIGA Technologies, Inc.	Instrument Calibration	Instrument calibration.	Siga Pharmaceuticals
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
1486	Hockmuth	General Dynamics	Irradiation of Electronic Components	Study radiation effects on electronic components for the Nuclear and Space Radiation Effects Group	Motorola
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
1492	Stiger	Federal Aviation Administration	Instrument Calibration	Instrument calibration	Federal Aviation Administration

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Table VI.C.3 (continued)

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
1502	Teaching and Tours	Portland Community College	Portland Community College Tours/Experiments	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1503	Teaching and Tours	Non-Educational Tours	Non-Educational Tours	Tours for guests, university functions, student recruitment.	OSU Radiation Center
1504	Teaching and Tours	Oregon State University - Educational Tours	OSU Nuclear Engineering & Radiation Health Physics Department	OSTR tour and reactor lab.	USDOE Reactor Sharing
1505	Teaching and Tours	Oregon State University - Educational Tours	OSU Chemistry Department	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1506	Teaching and Tours	Oregon State University - Educational Tours	OSU Geosciences Department	OSTR tour.	USDOE Reactor Sharing
1507	Teaching and Tours	Oregon State University - Educational Tours	OSU Physics Department	OSTR tour.	USDOE Reactor Sharing
1508	Teaching and Tours	Oregon State University - Educational Tours	Adventures in Learning Class	OSTR tour.	USDOE Reactor Sharing
1509	Teaching and Tours	Oregon State University - Educational Tours	HAZMAT course tours	First responder training tours.	Oregon Office of Energy
1510	Teaching and Tours	Oregon State University - Educational Tours	Science and Mathematics Investigative Learning Experience	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1511	Teaching and Tours	Oregon State University - Educational Tours	Reactor Staff Use	Reactor operation required for conduct of operations testing, operator training, calibration runs, encapsulation tests and other.	OSU Radiation Center

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Table VI.C.3 (continued)

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
1512	Teaching and Tours	Linn Benton Community College	Linn Benton Community College Tours/Experiments	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1514	Sobel	Universitat Potsdam	Apatite Fission Track Analysis	Age determination of apatites by fission track analysis.	Universitat Potsdam
1519	Dunkl	Universitat Tubingen	Fission Track Analysis of Apatites	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	Western Oregon University	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1522	Control Room	Oregon State University	General Reactor Operation	Reactor operation when no other project is involved.	OSU Radiation Center
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	Life Gate High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1526	Crawford	Hot Cell Services	Instrument calibration	Instrument calibration.	Hot Cell Services
1527	Teaching and Tours	Oregon State University - Educational Tours	Odyssey Orientation Class	OSTR tour.	USDOE Reactor Sharing
1528	Teaching and Tours	Oregon State University - Educational Tours	Upward Bound	OSTR tour.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

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
1529	Teaching and Tours	Oregon State University - Educational Tours	OSU Connect	OSTR tour.	USDOE Reactor Sharing
1530	Teaching and Tours	Newport School District	Newport School District	OSTR tour.	USDOE Reactor Sharing
1531	Teaching and Tours	Central Oregon Community College	Central Oregon Community College Engineering	OSTR tour.	USDOE Reactor Sharing
1535	Teaching and Tours	Corvallis School District	Corvallis School District	OSTR tour.	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 - Educational Tours	Naval Science Department	OSTR tour.	USDOE Reactor Sharing
1538	Teaching and Tours	Oregon State University - Educational Tours	OSU Speech Department	OSTR tour.	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	McKay High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1542	Teaching and Tours	Oregon State University - Educational Tours	Engineering Sciences Classes	OSTR tour.	USDOE Reactor Sharing
1543	Bailey	Veterinary Diagnostic Imaging & Cytopathology	Instrument Calibration	Instrument calibration.	Veterinary Diagnostic Imaging & Cytopathology

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Table VI.C.3 (continued)

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
1544	Teaching and Tours	West Albany High School	West Albany High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1545	Teaching and Tours	Oregon State University - Educational Tours	OSU Educational Tours	OSTR tour.	USDOE Reactor Sharing
1548	Teaching and Tours	Willamette Valley Community School	Willamette Valley Community School	OSTR tour.	USDOE Reactor Sharing
1554	Fleischer	Union College	Fission Track Irradiations	Use of fission track to determine age dating in apatites	USDOE Reactor Sharing
1555	Fitzgerald	Syracuse University	Fission track thermochronology	Irradiation to induce U-235 fission for fission track thermal history dating, especially for hydrocarbon exploration. The main thrust is towards tectonics, in particular the uplift and formation of mountain ranges.	Syracuse University
1558	Binney	Oregon State University	Measurement of cross sections for medical radionuclides	Irradiations to measure neutron cross sections for medically important radionuclides.	USDOE
1564	Krane	Oregon State University	Measurement of neutron capture cross sections	Measurement of neutron capture cross sections.	USDOE Reactor Sharing
1567	Johnson	University of Houston	Compositions of apatites from magnetite-rich segregation deposits in the Cornucopia stock, NE Oregon	Study of chemical composition of apatites from magnetite deposits in Cornucopia stock to determine processes responsible for their genesis.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

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
1571	Hansen	Geological Institute	Fission track analysis	Study of East Greenland contionental margin to determine thermotectonic evolution as an aid in understanding rifting and opening of a continental volcanic margin with formation of a new ocean.	Geological Institute
1573	Baxter	California Institute of Technology	Ar partitioning experiments	Measurement of the partitioning of noble gases between crystals and grain boundaries.	California Institute of Technology
1578	Monie	University of Montpellier	Fission Track Analysis of U-235	Use of fission tracks from U-235 to determine the uranium content in minerals.	University of Montpellier
1579	Leisy	Oregon State University	Evaluation of Bacillus spores as an immunogen in rainbow trout	Fish will be immunized with Bacillus subtilis spores and challenged with virulent infectious hematopoietic necrosis virus (IHNV) to test for immunization against IHNV. All experiments will be conducted at the OSU Salmon Disease Laboratory.	OSU Microbiology Department
1583	Teaching and Tours	Neahkahnie High School	Neahkahnie High School	OSTR tour.	USDOE Reactor Sharing
1584	Teaching and Tours	Reed College	Reed College Staff & Trainees	OSTR tour.	USDOE Reactor Sharing
1592	Burgess	University of Manchester	Ar-Ar dating of Icelandic rhyolites	Nuclear irradiation of rock chips in cadmium-lined irradiation facility for Ar-Ar dating studies of Icelandic rhyolites.	University of Manchester
1594	Teaching and Tours	Jefferson High School	Jefferson High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

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
1595	Rahn	Albert-Ludwigs-Universitaet	Fission Track Dating of the Mid-European Rhine Graben Shoulder	Dating of the shoulder uplift along the Mid-European Rhine graben shoulders by the fission track technique.	German Science Foundation
1597	Reese	Oregon State University	Neutron Radiography	Neutron radiography of airplane components and related material.	Precision Castparts Corp.
1598	Loveland	Oregon State University	QSAR of organically bound metals	Measurement of octanol/water partition coefficients for a series of chemically related organically bound metals.	OSU Chemistry Department
1601	Crutchley	Josephine County	Instrument Calibrations	Instrument calibration.	Josephine County Public Works
1602	Teaching and Tours	Crescent Valley High School	Crescent Valley High School AP Physics Class	This project supports the advanced placement physics class at Cresent Valley High School. It will utilize the reactor for an investigation of arsenic concentrations in soils and bedrock of the Sweet Home area.	USDOE Reactor Sharing
1603	Teaching and Tours	Thurston High School	Thurston High School Chemistry	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1604	Buckovic	Geovic Ltd.	Support of Cobalt-Nickel Laterite Analyses	Analysis of Co/Ni in soil samples from Africa.	Geovic, Ltd.

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Table VI.C.3 (continued)

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
1607	Struzik	Polish Academy of Sciences	Timing of uplift and exhumation of Polish Western Carpathians	Determination of timing of uplift and exhumation of Polish Western Carpathians (Tatra Mts. and Podhale Flysch) using AFT methods to verify paleotemperature, which are determined by illite-smectite methods. Reconstruction of thermal history.	Polish Academy of Sciences
1609	Loveland	Oregon State University	Time-Resolved Laser Spectroscopy	Photophysic determination of olgomeric components of DNA; use of luminescence spectroscopy to investigate the speciation of uranyl ions in aqueous systems.	OSU Chemistry Department
1611	Teaching and Tours	Grants Pass High School	Grants Pass High School	OSTR tour.	USDOE Reactor Sharing
1612	Singer	University of Wisconsin	Determination of age of Eocene and Quaternary volcanic rocks	Determination of age of Eocene and Quaternary volcanic rocks by production of Ar-39 from K-39.	USDOE Reactor Sharing
1613	Teaching and Tours	Silver Falls School District	Silver Falls School District	OSTR tour.	USDOE Reactor Sharing
1614	Teaching and Tours	Marist High School	Marist High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1615	Teaching and Tours	Liberty Christian High School	Liberty Christian High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1616	Doyle	Evanite Fiber Corporation	Instrument Calibration	Instrument calibration.	Evanite Fiber Corporation
1618	Teaching and Tours	Fall City High School	Fall City High School	OSTR tour and half life experiment.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

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
1619	Teaching and Tours	Sheridan High School	Sheridan High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1620	Teaching and Tours	Eddyville High School	Eddyville High School	OSTR tour.	USDOE Reactor Sharing
1621	Foster	University of Florida	Irradiation for Ar/Ar Analysis	Ar/Ar analysis of geological samples.	University of Florida
1622	Reese	Oregon State University	Flux Measurements of OSTR	Measurement of neutron flux in various irradiation facilities.	OSU Radiation Center
1623	Blythe	University of Southern California	Fission Track Analysis		University of Southern California
1624	Porter	Oregon State University	Irradiation of MacCema Buttons	Testing of MacCema memory buttons for failure in high radiation (gamma only) environments.	OSU Industrial & Manufacturing Engineering
1625	Armstrong	Cal State Fullerton	Fission Track Irradiations	Measurement of fission track ages to determine erosion amounts and timing.	USDOE Reactor Sharing
1626	Eastburn	Corvallis Clinic	Radiation Survey	Release survey of a laboratory formerly using I-125 and Co-58.	Corvallis Clinic

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Table VI.C.3 (continued)

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
1627	Fleischer	Union College	Fission Track Irradiations	The primary project is the use of tracks to study the leaching out of imbedded radionuclides from alpha-activity in materials. The radionuclide could be a decay product of U-238 or Th-232 in studying the geochemistry of natural materials, or of Rn-222 in dealing with environmental materials that are used to assess radon exposures. Here we will use an analogue case -- the embedding in the laboratory of U-235 recoils from the alpha activity of Pu-239.	USDOE Reactor Sharing
1628	Garver	Union College	Fission Track Irradiations	Use of fission track to determine age dating of apatites.	USDOE Reactor Sharing
1629	Rauch	Nu-Trek, Inc	GaAs 1 MeV Equivalent Damage Evaluation	Neutron damage to GaAs to reduce carrier lifetime to make flash x-ray photoconductive detectors	Nu-Trek, Inc.
1631	Sivaramakrishnan	Oregon State University	Radiation Damage to GaAs	Neutron damage to GaAs for use in semiconductors	USDOE Reactor Sharing
1633	Goles	University of Oregon	Evolution and lateral growth of active continental margins	Selected terranes of the New Zealand basement contain metasediments that are ideal for testing the model and learning about the evolution of this part of the ancient Gondwana active margin; clasts of terrane conglmerates will be characterized by INAA.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

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
1634	Tollo	George Washington University	REE Geochemistry of Meta-Igneous Rocks using INAA (TBC)	NAA of apatite samples to determine metal composition in ingneous rocks.	USDOE Reactor Sharing
1635	Fodor	North Carolina State University	Determination of REE's in Ultramafic Rocks by NAA.	To be edited when samples are received.	USDOE Reactor Sharing
1637	Johnson	University of Houston	Geochemistry of gold bearing horblendite vains	The purpose of this project is to provide geochemical analysis of golde hornblendite veins that are gold mineralized and part of a larger porphyry copper stock.	USDOE Reactor Sharing
1638	Lee	University of Oregon	Geochemistry of lithological matter to determine provenance	Relationships bewteen regional geologic features can be contraint by the geochemical analysis of rocks in formations.	USDOE Reactor Sharing
1640	Gans	University of California at Santa Barbara	Age dating of Neogene volcanism	Age dating of rock samples from Sierra Nevada, Sonora, Mexico, and Chilean Andes	USDOE Reactor Sharing
1641	Hughes	Idaho State University	Independent Study of NAA	Development of NAA for Thesis Research	USDOE Reactor Sharing
1643	York	York Engineering	INAA of Paint Scrapings	The purpose of this experiment is to determine the chemical composition of paint scrapings from marine vessels as a potential identification technique.	York Engineering
1645	Gustafson	Oregon State University	Pulmonic and Vascular Repair with Biomaterial Patch, Phase 1: Acute studies	I am using a biomaterial to repair an induced lung injury in rabbits.	OSU Veterinary Medicine
1647	Graefe	GeoForschungsZentrum Potsdam	Fission Track Irradiations	Use of fission track to study zircon.	GeoForschungsZentrum Potsdam

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Table VI.C.3 (continued)

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
1648	Stewart	University of Washington	Fission-track Dating of Zircon	Fission-track Dating of Zircon from the Exhumation of Avaloatz Mountians in California	University of Washington
1653	Teaching and Tours	Madison High School	Madison High School Senior Science Class	OSTR tour.	USDOE Reactor Sharing
1655	Teaching and Tours	Future Farmers of America	OSTR Tour	OSTR tour	USDOE Reactor Sharing
1656	Mourich	AVI Bio Pharma	Avasive anitcancer vaccine mechanism of immuno-protein	Using a mouse model for cancer. Tumor cells are irradiated and then coated with anitbodies produced by the vaccine. This complex is use to vaccinate mice to determine if subsequent anti-tumor specific immune responses are generated.	AVI Bio Pharma
1657	Teaching and Tours	Richland High School	Richland High School	OSTR tour.	USDOE Reactor Sharing
1658	Hensel	Hemcon, Inc.	Sterilization of Bandages	Sterilization of Army bandages used for hemorrhage control.	Hemcon Inc.
1660	Reese	Oregon State University	Industrial Isotope Production Testing	Testing of containers and source material to produce various industrial radiography and tracer sources	
1661	Wroblewski	Vectron International Norwalk Inc.	Gamma Irradiation of Parts	Gamma irradiation of parts.	Vectron International
1662	Retallack	University of Oregon	Geochemistry of Soil from Eugene Hills	Determination of the trace element chemistry of soils.	USDOE Reactor Sharing

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Table VI.C.3 (continued)

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
1664	Ciarella	Providence Medical Center	Determination of Gadolinium in Spinal Cord Fluid	Neutron Activation Analysis of spinal cord fluid and Omniscan RX (gadodiamine) for gadolinium after radiochemical separation of sodium on HAP.	Providence Medical Center
1665	LaFleur	National Council of Stream and Air Improvement	Preparation of Hog Fuel Standard Reference Material	The purpose of this project is to prepare a NAA standard of composite wood waste material as a reference material for laboratory analyses.	National Council for Air & Stream Improvement
1666	Teaching and Tours	Douglas High School	Douglas High School AP Physics Class	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1668	Meigs	Oregon State University	Fission Track Dating	Use of fission tracks from U-235 to determine the locationand concentration of U238 in apatite/zircon crystals for age dating	USDOE Reactor Sharing
1669	Hamby	Oregon State University	Activation of Black Beans	Activation of black beans used as a natural tracer in laboratory animal nutrition studies	USDOE Reactor Sharing
1670	Teaching and Tours	Toledo High School	Toledo High School	OSTR tour and half-life experiment.	USDOE Reactor Sharing
1671	Roden-Tice	Plattsburgh State University	Fission Track Dating	Use of fission tracks to determine location of U-235 and Th232 in natural rocks and minerals	USDOE Reactor Sharing
1672	Brix	Ruhr-Universitat Bochum	Fission track analysis of apatites and zircon.	Fission track analysis of apatites and zircon.	Ruhr-Universitat Bochum
1673	Teaching and Tours	Heal College	Heal College Physics Department	OSTR tour.	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	2
GM Detectors	28
Ion Chambers	12
Micro-R Meters	2
Personal Dosimeters	31
TOTAL	75

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	1
Biochemistry/Biophysics	9
Botany and Plant Pathology	7
Chemistry	1
Civil, Construction and Environmental Engineering	1
Crop Science	3
E.M.T.	6
Fisheries and Wildlife	2
Forest Science	3
Horticulture	3
Linus Pauling Institute	4
Microbiology	8
Oceanic and Atmospheric Sciences	3
Pharmacy	5
Physics	5
Radiation Safety Office	15
Veterinary Medicine	7
Zoology	3
OSU Departments Total	86
Non-OSU Agencies	
ESCO Corporation	1
Evanite Fiber Corp	1
Federal Aviation Administration	5
Good Samaritan Hospital	7
Hot Cell Services	4
Kimer Consulting	1
Oregon Office of Energy	35
Oregon Department of Transportation	4
Oregon Health Sciences University	23
Oregon Public Utilities Commission	5
Oregon State Health Division	39
USDA Agricultural Research Service	2
U.S. Environmental Protection Agency	3
Valley Landfills, Inc.	2
Veterinary Diagnostic Imaging Cytopathology	3
Non-OSU Agencies Total	136

Table VI.F.1

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
7/12/2002	10	Adventures in Learning
7/15/2002	8	START group
7/17/2002	3	Summer Experience in Science and Engineering for Youth
7/17/2002	10	Adventures in Learning
7/18/2002	8	WINS- Wondering Individual Networks
7/25/2002	1	Keith Kaufman- Morse Bros.
8/1/2002	4	FBI tour
8/1/2002	3	FBI tour and Lt. Martz
8/9/2002	6	Francis Marshall
8/26/2002	20	OSU CH 123
8/26/2002	19	OSU CH 123
8/27/2002	19	OSU CH 123
9/5/2002	3	Terry Brock, Paul Stansbury, Dan Stromm
9/9/2002	2	John and Miriam Rauch from Nu-Trek
9/20/2002	3	Mr. and Mrs. Bob Nelson, Art Johnson
9/27/2002	10	Graduate Orientation
10/7/2002	2	Barry Klein and Wade Richards
10/7/2002	3	XRI Testing: Kirk Tams, Glen McGillvery and Hank Rowe
10/8/2002	15	WNSA Advisory Committee
10/9/2002	20	NE/RHP 114
10/13/2002	4	ABET
10/26/2002	81	Dad's Weekend
10/28/2002	2	Odyssey Class

Table VI.F.1 (continued)

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
10/29/2002	2	Alex Cheyne and Keith Kirk
10/31/2002	15	LBCC Science, Technology and Society
10/31/2002	15	LBCC Science, Technology and Society
11/5/2002	25	Engineering students from ENGR 111
11/5/2002	25	Engineering students from ENGR 111
11/5/2002	25	Engineering students from ENGR 111
11/5/2002	25	Engineering students from ENGR 111
11/6/2002	2	Gene Schrekece and Ward Wicker
11/7/2002	25	Engineering students from ENGR 111
11/7/2002	20	Odyssey Class
11/7/2002	25	Engineering students from ENGR 111
11/7/2002	25	Engineering students from ENGR 111
11/15/2002	15	LBCC Science, Technology and Society
12/5/2002	1	Seungjin Kim
12/9/2002	1	Brian Woods
12/9/2002	2	Jenepher Woods and Tracy Klein
12/16/2002	1	Francisco Moraga
12/26/2002	2	Jacob Litis - OSU student & Amanda Free - high school student
12/27/2002	12	Boy Scouts of America Troop 8
1/7/2003	2	Seminar Speakers
1/9/2003	7	OSU CH 462
1/10/2003	20	Madison High School Seniors

Table VI.F.1 (continued)

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
1/13/2003	8	Nuclear Engineering and Radiation Health Physics 115
1/16/2003	7	OSU CH 462
1/17/2003	1	A.J. Hodson
1/21/2003	1	Phillip Williams
1/31/2003	1	Wesley Frey
2/4/2003	12	Good Samaratin Hospital Emergency Room Nursing Staff
2/4/2003	1	Alena Paulenova
2/10/2003	1	Doug Henderson
2/21/2003	4	Mr. and Mrs. Shuette & Melanie Marshall
2/25/2003	25	OSU CH 225H
2/25/2003	25	McKay HS
2/26/2003	25	LBCC General Science 154
2/27/2003	23	OSU CH 225H
2/28/2003	1	Prospective UG - Richard Wingfield
3/4/2003	25	OSU CH 205
3/4/2003	25	OSU CH 205
3/5/2003	25	OSU CH 205
3/5/2003	25	OSU CH 205
3/5/2003	25	Thurston High School Students
3/6/2003	25	OSU CH 205
3/6/2003	25	OSU CH 205
3/11/2003	25	OSU CH 205
3/11/2003	1	Eric Henry

Table VI.F.1 (continued)

Summary of Visitors to the Radiation Center

Date	No. of Visitors	Name of Group
3/12/2003	25	OSU CH 205
3/13/2003	25	OSU CH 205
4/8/2003	20	SMILE students
4/22/2003	24	Physics Class
4/22/2003	1	John Henshaw
4/25/2003	20	LBCC
5/2/2003	15	OSU Mom's Club
5/3/2003	30	Mom's Weekend
5/7/2003	1	Robert A. Fjeld
5/8/2003	12	Science & Math Educators
5/8/2003	2	EPA guests
5/8/2003	1	Prospective Graduate Student - Joshua Axelrod
5/9/2003	1	Prospective Graduate Student - Alex Misner
5/12/2003	7	Douglas High School, Roseburg, OR
5/14/2003	15	Yamhill Carlton High School
5/14/2003	14	Marist High School
5/14/2003	14	Marist High School
5/16/2003	10	Physics Class
5/16/2003	4	4 Mechanical Engr students
5/16/2003	15	Physics Class
5/17/2003	10	Physics Class
5/20/2003	35	Richland High School, Washington
5/21/2003	12	Physics Class

Table VI.F.1 (continued)

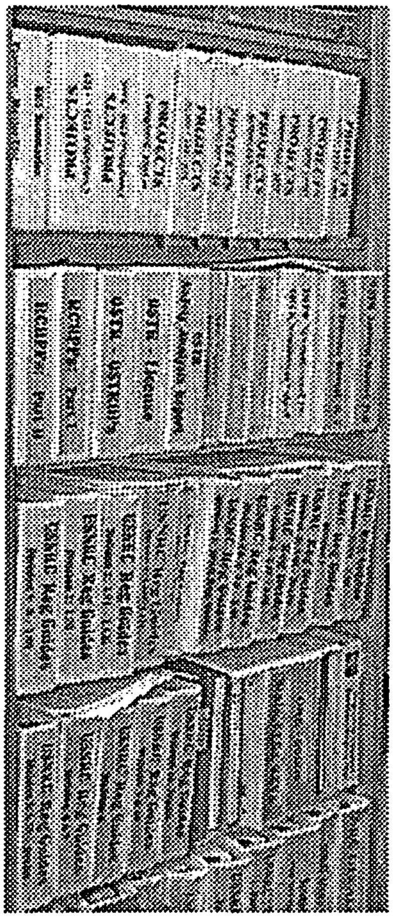
Summary of Visitors to the Radiation Center

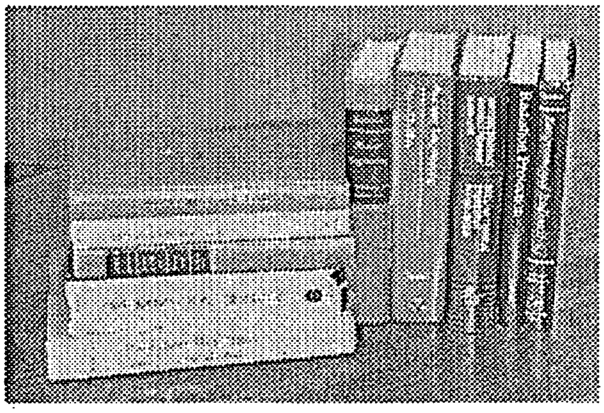
Date	No. of Visitors	Name of Group
5/23/2003	37	GS 152
6/5/2003	2	Kay Altman
6/5/2003	20	Toledo High School - SMILE Progrm
6/13/2003	2	Perspective Students
6/24/2003	4	Mike Stringham's family
6/26/2003	20	High School Educators (Physics, Science)
6/26/2003	2	Mr. & Mrs. John Hightower
6/26/2003	3	Corvallis Fire Department

Total Tours: 99 **Total Visitors: 1287**

Part VII

Words





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B. Documents Submitted for Publication

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