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Radiation Center
Oregon State University, 100 Radiation Center, Corvallis, Oregon 97331-5903
T 541-737-2341 | F 541-737-0480 | http://ne.oregonstate.edu/facilities/radiation_center

October 23, 2014

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 6.7.1 of the OSTR Technical Specifications, we are hereby submitting the Oregon State University Radiation Center and OSTR Annual Report for the period July 1, 2013 through June 30, 2014.

The Annual Report continues the pattern established over many years by including information about the entire Radiation Center rather than concentrating primarily on the reactor. Because this 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.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on: 10/23/14

Sincerely,

Steven R. Reese
Director

Cc: William Schuster, USNRC
Craig Bassett, USNRC
Ken Niles, ODOE
Dr. Ron Adams, OSU
Dr. Rich Holdren, OSU
Dr. Andy Klein, OSU

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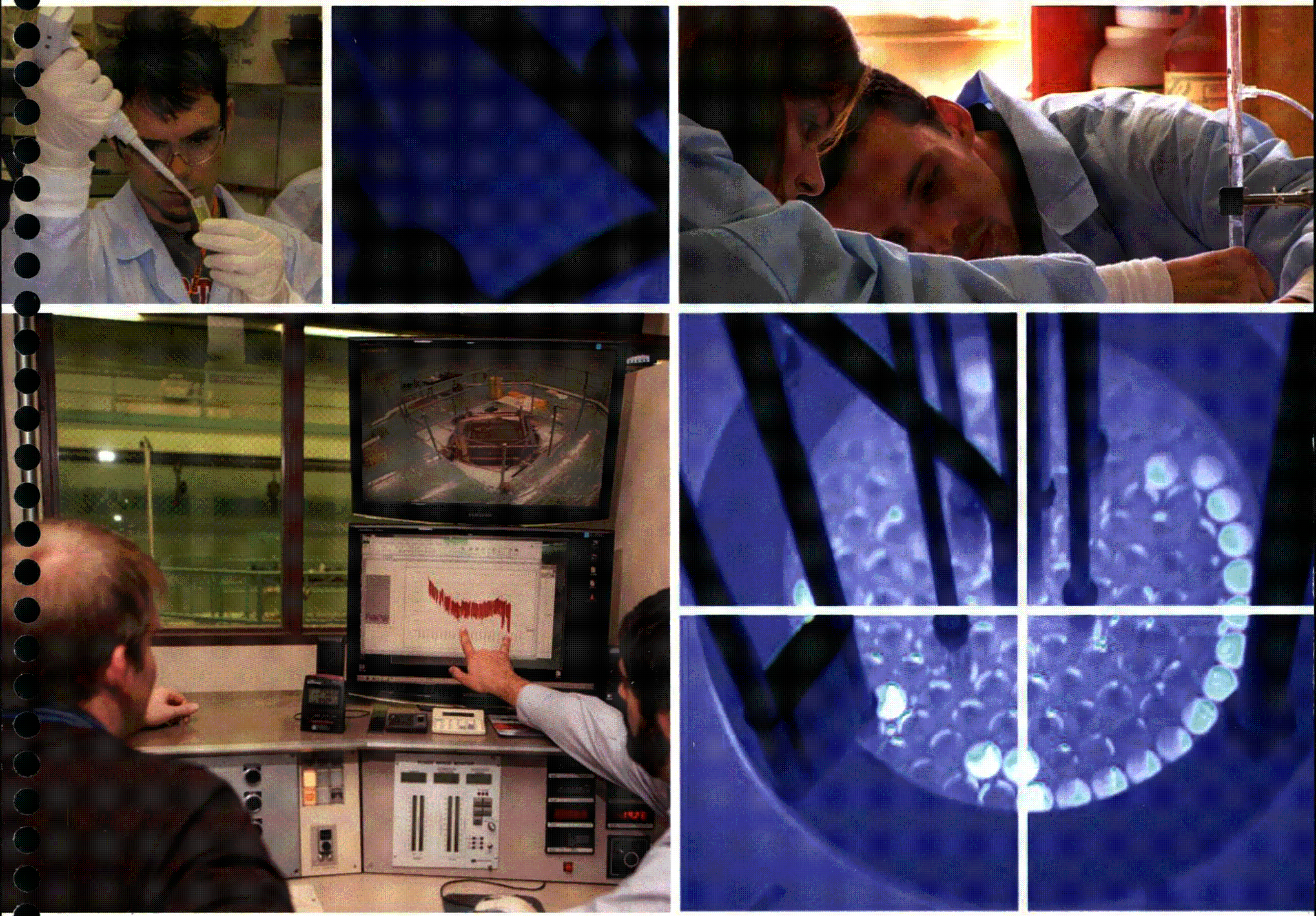
Radiation Center and TRIGA Report

Annual Report

July 1, 2013—June 30, 2014



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Submitted by:
Steve R. Reese, Director

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

To satisy the requirements of :

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

B. Battelle Energy Alliance, LLC; Subcontract Award No. 00074510.

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

Contents

Tables

Figures

Overview

Executive Summary

The data from this reporting year shows that the use of the Radiation Center and the Oregon State TRIGA reactor (OSTR) has continued to grow in many areas.

The Radiation Center supported 60 different courses this year, mostly in the Department of Nuclear Engineering and Radiation Health Physics. About 35% of these courses involved the OSTR. The number of OSTR hours used for academic courses and training was 17, while 2,255 hours were used for research projects. Sixty-one percent (61%) of the OSTR research hours were in support of off-campus research projects, reflecting the use of the OSTR nationally and internationally. Radiation Center users published or submitted 64 articles this year, and made 42 presentations on work that involved the OSTR or Radiation Center. The number of samples irradiated in the reactor during this reporting period was 3,554. Funded OSTR use hours comprised 82% of the research use.

Personnel at the Radiation Center conducted 81 tours of the facility, accommodating 1,077 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.

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 155. Reactor related projects comprised 73% of all projects. The total research dollars in some way supported by the Radiation Center, as reported by our researchers, was $9.8 million. The actual total is likely considerably higher. This year the Radiation Center provided service to 46 different organizations/institutions, 37% of which were from other states and 43% 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.

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://radiationcenter.oregonstate.edu.

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 covers the period from July 1, 2013 through June 30, 2014. Cumulative reactor operating data in this report relates only to the LEU fueled core. This covers the period beginning July 1, 2008 to the present date. For a summary of data on the reactor's two other cores, the reader is referred to previous annual reports.

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 Department of Energy. Because of this, the report is divided into several distinct parts so that the reader may easily find the sections of interest.

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 and Radiation Health Physics, the OSU Institute of Nuclear Science and Engineering, and for the OSU nuclear chemistry, radiation chemistry, geochemistry and radiochemistry 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 many 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 and AP1000 reactor designs. The AP600 and AP1000 are next-generation nuclear reactor designs which incorporate 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 and AP1000 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 (ATHRL), which is used for state-of-the-art two-phase flow experiments.

The Multi-Application Light Water Reactor (MASLWR) is a nuclear power plant test facility that is instrumental in the development of next generation commercial nuclear reactors currently seeking NRC certification. The Test Facility is constructed of all stainless steel components and is capable of operation at full system pressure (1500 psia), and full system temperature (600F).

All components are 1/3 scale height and 1/254.7 volume scale. The current testing program is examining methods for natural circulation startup, helical steam generator heat transfer performance, and a wide range of design basis, and beyond design basis, accident conditions. In addition, the MASLWR Test Facility is currently the focus of an international collaborative standard problem exploring the operation and safety of advanced natural circulations reactor concepts. Over 7 international organizations are involved in this standard problem at OSU.

The Advanced Nuclear Systems Engineering Laboratory (ANSEL) is the home to two major thermal-hydraulic test facilities—the High Temperature Test Facility (HTTF) and the Hydro-mechanical Fuel Test Facility (HMFTF). The HTTF is a 1/4 scale model of the Modular High Temperature Gas Reactor. The vessel has a ceramic lined upper head and shroud capable of operation at 850oC (well mixed helium). The design will allow for a maximum operating pressure of 1.0MPa and a maximum core ceramic temperature of 1600°C. The nominal working fluid will be helium with a core power of approximately 600 kW (note that electrical heaters are used to simulate the core power). The test facility also includes a scaled reactor cavity cooling system, a circulator and a heat sink in order to complete the cycle. The HTTF can be used to simulate a wide range of accident scenarios in gas reactors to include the depressurized conduction cooldown and pressurized conduction cooldown events. The HMFTF is a testing facility which will be used to produce a database of hydro-mechanical information to supplement the qualification of the prototypic ultrahigh density U-Mo Low Enriched Uranium fuel which will be implemented into the U.S. High Performance Research Reactors upon their conversion to low enriched fuel. This data in turn will be used to verify current theoretical hydro- and thermo-mechanical codes being used during safety analyses. The maximum operational pressure of the HMFTF is 600 psig with a maximum operational temperature of 450°F.

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.

People

This section 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.

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

Radiation Center Staff

Steve Reese, Director

Dina Pope, Office Manager

Shaun Bromagem, Business Manager

Brittany Combs, Receptionist

S. Todd Keller, Reactor Administrator

Gary Wachs, Reactor Supervisor, Senior Reactor Operator

Robert Schickler, Senior Reactor Operator

Wade Marcum, Reactor Operator

Scott Menn, Senior Health Physicist

Jim Darrough, Health Physicist

Leah Minc, Neutron Activation Analysis Manager

Steve Smith, Scientific Instrument Technician, Senior Reactor Operator

Erin Cimbri, Custodian

Jarvis Caffrey, Reactor Operator (Student)

Trevor Howard, Reactor Operator (Student)

Topher Matthews, Reactor Operator (Student)

Jacob Owen, Reactor Operator (Student)

Kyle Combs, Health Physics Monitor (Student)

Joey DeShields, Health Physics Monitor (Student)

David Robson, Health Physics Monitor (Student)

Reactor Operations Committee

Andrew Klein, Chair
OSU Nuclear Engineering and Radiation Health Physics

Rainier Farmer
OSU Radiation Safety

Abi Tavakoli Farsoni
OSU Nuclear Engineering and Radiation Health Physics

S. Todd Keller
OSU Radiation Center

Scott Menn
OSU Radiation Center

Steve Reese *(not voting)*
OSU Radiation Center

Mark Trump
Penn State University

Gary Wachs *(not voting)*
OSU Radiation Center

Bill Warnes
OSU Mechanical Engineering

Professional and Research Faculty

Daniels, Malcolm
Professor Emeritus, Chemistry

Farsoni, Abi
Associate Professor, Nuclear Engineering & Radiation Health Physics

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

Hart, Lucas P.
Faculty Research Associate, Chemistry

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

****Keller, S. Todd***
Reactor Administrator, Radiation Center

Klein, Andrew C.
Professor, Nuclear Engineering and Radiation Health Physics

****Krane, Kenneth S.***
Professor Emeritus, Physics

****Loveland, Walter D.***
Professor, Chemistry

Marcum, Wade
Assistant Professor Nuclear Engineering and Radiation Health Physics

****Menn, Scott A.***
Senior Health Physicist, Radiation Center

****Minc, Leah***
Associate Professor, Anthropology

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

****Paulenova, Alena***
Associate Professor, Nuclear Engineering and Radiation Health Physics

Pope, Dina
Office Manager, Radiation Center

****Reese, Steven R.***
Director, Radiation Center

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

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

****Schmitt, Roman A.***
Professor Emeritus, Chemistry

Tack, Krystina
Assistant Professor, Medical Physics Program Director

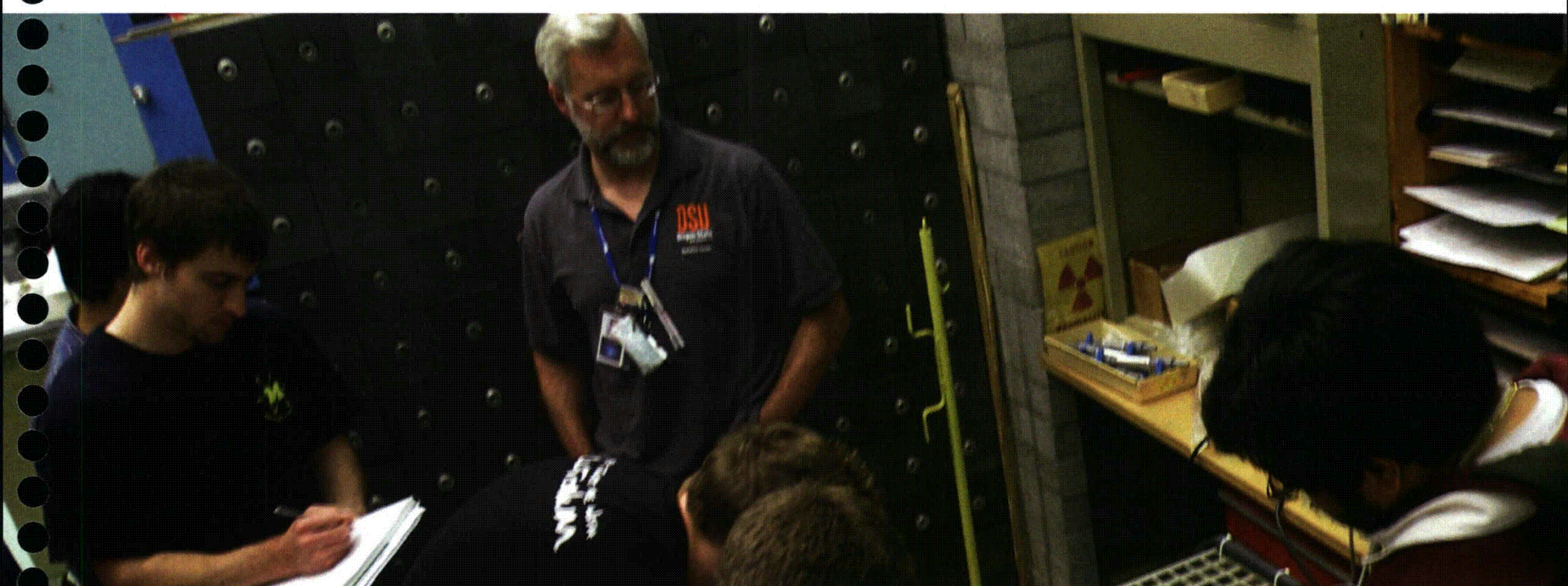
****Wachs, Gary***
Reactor Supervisor, Radiation Center

Woods, Brian
Professor, Nuclear Engineering and Radiation Health Physics

Wu, Qiao
Professor, Nuclear Engineer and Radiation Health Physics

Yang, Haori
Assistant Professor, Nuclear Engineering and Radiation Health Physics

**OSTR users for research and/or teaching*



Facilities

Research Reactor

The Oregon State University TRIGA Reactor (OSTR) is a water-cooled, swimming pool type 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 **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. The neutron radiography facility utilized the tangential beam port (beam port #3) to produce ASTM E545 category I radiography capability. The other beam ports are available for a variety of experiments.

If samples 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.

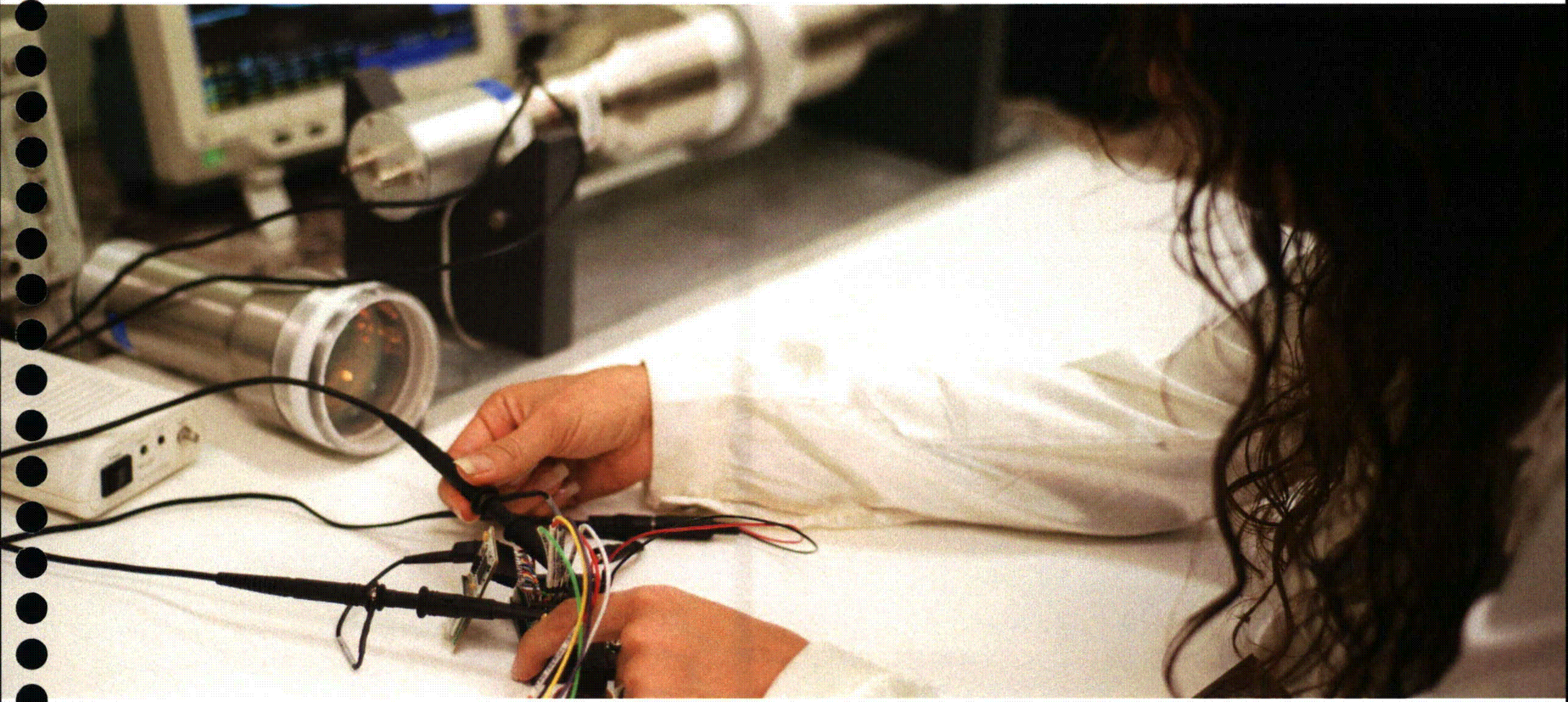
The **cadmium-lined in-core irradiation tube (CLICIT)** enables samples to be irradiated in a high flux region near the center of the core. The cadmium lining in the facility eliminates thermal neutrons and thus permits sample exposure to higher energy neutrons only. The cadmium-lined end of this air-filled 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.

The two main uses of the OSTR are instruction and research.

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 educating 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 of this report.



During this reporting period the OSTR accommodated a number of different OSU academic classes and other academic programs. In addition, portions of classes from other Oregon universities were also supported by the OSTR.

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.

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.

Analytical Equipment

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. Additional equipment for classroom use and an extensive inventory of portable radiation detection instrumentation are also available.

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.

Radioisotope Irradiation Sources

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.

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.1 provides use data for the Gammacell 220 irradiator.

Laboratories and Classrooms

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 two student computer rooms.

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. In addition, there are two smaller conference rooms and a library 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.

All of the laboratories and classrooms are used extensively during the academic year. A listing of courses accommodated at the Radiation Center during this reporting period along with their enrollments is given in Table III.2.

Instrument Repair & Calibration Facility

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 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 Department of Energy, the Oregon Public Utilities Commission, the Oregon Health and Sciences University, the Army Corps of Engineers, and the U. S. Environmental Protection Agency.

Library

The Radiation Center has a library containing a 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 of a number 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 reproduced, recorded, and edited by Radiation Center staff, using the Center's videotape equipment and the facilities of the OSU Communication Media Center.

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.1
Gammacell 220 ^{60}Co Irradiator Use

Purpose of Irradiation	Samples	Dose Range (rads)	Number of Irradiations	Use Time (hours)
Sterilization	wood, shale, polymers	$1.3x10^6$ to $4.0x10^6$	21	2936
Material Evaluation	silicon polymers, polymers, shield	$1.0x10^2$ to $2.5x10^5$	28	410
Botanical Studies	wheat seeds, wheat pollen, seeds, barley	$1.0x10^3$ to $6.0x10^4$	13	7
Biological Studies	fibronectic	$1.5x10^5$ to $1.5x10^5$	1	6
Totals			63	3359

Table III.2

Student Enrollment in Courses Which are Taught or Partially Taught at the Radiation Center

Course #	CREDIT	COURSE TITLE	Number of Students			
			Summer 2012	Fall 2012	Winter 2013	Spring 2013
NE/RHP 114*	2	Introduction to Nuclear Engineering and Radiation Health Physics		66		
NE/RHP 115	2	Introduction to Nuclear Engineering and Radiation Health Physics			70	
NE/RHP 116**	2	Introduction to Nuclear Engineering and Radiation Health Physics				58
NE/ RHP 234	4	Nuclear and Radiation Physics I		71		
NE/ RHP 235	4	Nuclear and Radiation Physics II			58	
NE/ RHP 236*	4	Nuclear Radiation Detection & Instrumentation				53
NE 311	4	Intro to Thermal Fluids	7	19	7	
NE 312	4	Thermodynamics			15	16
NE 319	3	Societal Aspects of Nuclear technology			68	
NE 331	4	Intro to Fluid Mechanics			21	8
NE 332	4	Heat Transfer	12	3		20
NE/RHP 333	3	Mathematical methods for NE/RHP			31	
NE/RHP/MP 401/501/601	1-16	Research	6	28	23	19
NE/RHP/MP 405/505/605	1-16	Reading and Conference	2	1		5
NE/RHP/MP 406/506/606	1-16	Projects	2			2
NE/RHP/MP 407/507/607	1	Nuclear Engineering Seminar		70	68	31
NE/ RHP/MP 410/510/610	1-12	Internship	1	1		
NE/ RHP 415/515	2	Nuclear Rules and Regulations		48		
NE 451/551	4	Neutronic Analysis		45		
NE 452/552	4	Neutronic Analysis			46	
NE 455/555**	3	Reactor Operator Training I				15
NE 456/556**	3	Reactor Operator Training II	5			
NE 457/557**	3	Neuclear Reactor Lab				35
NE 467/567	4	Nuclear Reactor Thermal Hydraulics		39		
NE 667	4	Nuclear Reactor Thermal Hydraulics				7
NE/RHP 435/535	3	External Dosimetry & Radiation Shielding				67
NE 565	3	Applied Thermal Hydraulics			7	
NE 474/574	4	Nuclear System Design I			38	

Table III.2 (continued)

Student Enrollment in Courses Which are Taught or Partially Taught at the Radiation Center

Course #	CREDIT	COURSE TITLE	Number of Students			
			Summer 2012	Fall 2012	Winter 2013	Spring 2013
NE 475/575	4	Nuclear System Design II				41
NE/RHP 479*	1-4	Individual Design Project				
NE/RHP 481*	4	Radiation Protection		42		
NE/RHP 582*	4	Applied Radiation Safety			9	
RHP 483/583	4	Radiation Biology			12	
RHP 488/588*	3	Radioecology		14		
NE/RHP 590	4	Internal Dosimetry			6	
NE/RHP/MP 503/603*	1	Thesis	18	38	35	56
NE/ RHP 516*	4	Radiochemistry			1	
NE 526	3	Numerical Methods for Engineering Analysis		11		
NE/RHP/MP 531	3	Nuclear Physics for Engineers and Scientists		14		
NE/RHP/MP 536*	3	Advanced Radiation Detection & Measurement			18	
NE/RHP 537	3	Digital Spectrometer Design				5
MP 541	3	Diagnostic Imaging Physics				
NE 550	3	Nuclear Medicine				
NE 553	3	Advanced Nuclear Reactor Physics				12
MP 563	4	Applied Medical Physics		3		
NE 468/568	3	Nuclear Reactor Safety			19	
NE/RHP/MP 599		Special Topics	6		13	18
MP 610		Internship/Work Experience			2	

Course From Other OSU Departments

CH 233*	5	General Chemistry	100			
CH 233H*	5	Honors General Chemistry				44
CH 462*	3	Experimental Chemistry II Laboratory			17	
ENGR 111*	3	Engineering Orientation		214		
ENGR 212H*	3	Honors Engineering				15

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

Operating Status

During the operating period between July 1, 2013 and June 30, 2014, the reactor produced 769 MWH of thermal power during its 814 critical hours.

Experiments Performed

During the current reporting period there were nine approved reactor experiments available for use in reactor-related programs. They are:

- 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-33 Irradiation of Combustible Liquids in Rotating Rack.
- B-34 Irradiation of enriched uranium in the Neutron Radiography Facility.
- B-35 Irradiation of enriched uranium in the PGNAA Facility.

Of these available experiments, three were used during the reporting period. Table IV.4 provides information related to the frequency of use and the general purpose of their use.

Inactive Experiments

Presently 33 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 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.

B-32 Argon Production Facility

C-1 PuO_2 Transient Experiment.

Unplanned Shutdowns

There were six unplanned reactor shutdowns during the current reporting period. Table IV.5 details these events.

Changes Pursuant to10 CFR 50-59

No safety evaluations were performed during this year.

There were nine new screens performed in support of the reactor this year. They were:

13-05, Replacement of the annular reflector assembly

Description

A leaking annular reflector surrounding the reactor was replaced with a new reflector built to the same specifications as the original. Configuration changes were outlined.

13-06, Repair of tank welds and seams

Description

To seal potential leakage sites in the reactor tank, a recommended epoxy sealant was used to coat suspected welds and seams on the inside of the tank.

13-07, OSTROP 24 changes

Description

These changes to the Physical Security System Functional Checks and Control Room Exit Procedures reflect the screening procedure for changes in OSTROPS. Security related equipment is not discussed in the FSAR.

13-08, OSTROP 6 changes

Description

Electronic versions of updated OSTROPs provide only one set of hard copy procedures which are maintained by the Reactor Supervisor in the control room.

13-09, Reactor Top and Stack Cam changes. Water monitor changes.

Description

Evaluates the upgrade of electronics associated with the Reactor Top and Stack CAMs and water monitor. Moving filter assembles and scintillation detectors are expected to improve the accuracy and reliability of these systems.

13-10, Transient Rod and Rotating Rack control changes

Description

Modifies the rotating rack directional control switch to prevent damage due to rapid reversing of the drive motor. Allows operation of the reactor with the maximum pulse addition limiting bracket removed from the Transient rod. Removal of this bracket initiates an interlock to prevent transient mode operation.

13-11, Changes to OSTROPs 2, 3,4,5,13,14 and 15

Description

These changes were evaluated as a result of the Reactor Operations Committee audits of assigned procedures and best practices input from operating staff.

14-01, Changes to OSTROPs 2, 5, 13 and 16

Description

Grammatical or formatting changes based on recommendations to clarify language or intent.

14-02, Changes to RCHPP 18

Description

Grammatical or formatting changes based on recommendations to clarify language or intent.

14-03, Changes to OSTROPs 6, 7, 8,9,11 and 22

Description

Grammatical or formatting changes based on recommendations to clarify language or intent.

Surveillance and Maintenance

Non-Routine Maintenance

July 2013

- Replaced bearings on cooling tower fans and hood exhaust fan for B-121.
- Disassembled cooling tower spray manifolds and riser tubes to rod out rust chips and other debris blocking flow. Cleaned tower basin.
- Facility Services repaired cracks in reactor bay roof tar surface around the new cooling tower piping penetrations.

August 2013

- Scrapped rust and other debris from the inside of beam port 4.
- Rotary rack, fuel, graphite elements, and bellows removed for reflector replacement project.

September 2013

- Cleaned inside surfaces of Beam Ports 1, 2 and 4 and prepped for painting. Applied several coats of epoxy.
- Primary tank ultrasonically inspected.

November 2013

- New bellows, annulor reflector, core barrel and stand all replaced and installed.
- Rotary rack, fuel, graphite elements reinstalled as part of the annular reflector replacement project.

April 2014

- Replaced the bearings for the reactor roof meteorological WindBird unit.
- ARM #1 detector replaced due to failing ion chamber.
- A new roof access ladder has been fabricated and installed on the reactor roof.
- The Stack monitor air flow indicator failed and was replaced.

May 2014

- Changed out the RONAN annunciator alarm panels which are on at night (failed on) which were darkening due to phosphor burn out with amber sets. These are expected to last much longer.
- Safe channel ion chamber wiring connections under the reactor top grate appear to have developed some corrosion and were replaced.
- Primary resin bed replaced.

June 2014

- Facility Services replaced a low temperature shutdown switch on the EDG.

Table IV.1
Present OSTR Operating Statistics

Operational Data For LEU Core	Annual Values (2013/2014)	Cumulative Values
MWH of energy produced	769	7,259
MWD of energy produced	32	2,93.8
Grams ^{235}U used	44	416
Number of fuel elements added to (+) or removed(-) from the core	0	90
Number of pulses	24	202
Hours reactor critical	814	7,835
Hours at full power (1 MW)	766	7,232
Number of startup and shutdown checks	242	1,183
Number of irradiation requests processed	205	1,357
Number of samples irradiated	3,554	10,798

Table IV.2
OSTR Use Time in Terms of Specific Use Categories

OSTR Use Category	Annual Values (hours)	Cumulative Values (hours)
Teaching (departmental and others)	17	13,636
OSU research	875	18,370
Off campus research	1,380	42,896
Demonstrations	0	38
Reactor preclude time	1,378	32,308
Facility time	25	7,222
Total Reactor Use Time	3,675	114,470

Table IV.3
OSTR Multiple Use Time

Number of Users	Annual Values (hours)	Cumulative Values (hours)
Two	261	8,889
Three	210	4,660
Four	164	2,588
Five	53	926
Six	19	241
Seven	2	69
Eight	0	3
Total Multiple Use Time	709	17,376

Table IV.4
Use of OSTR Reactor Experiments

Experiment Number	Research	Teaching	Other	Total
A-1	2	0	0	2
B-3	181	11	0	192
B-31	11	0	0	11
Total	194	11	0	205

Table IV.5
Unplanned Reactor Shutdowns and Scrams

Type of Event	Number of Occurrences	Cause of Event
Safe channel high power	1	Excessive operator rod withdrawal rate
Period	1	Aggressive rod callibration curve development
Manual	3	Loss of off-site power
Manual	1	Operator error on pulse initiation

Figure IV.1

Monthly Surveillance and Maintenance (Sample Form)

OSTROP 13, Rev. LEU-4 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	REACTOR TANK HIGH AND LOW WATER LEVEL ALARMS	MAXIMUM MOVEMENT ± 3 INCHES	UP:________INCHES DN:________INCHES ANN:________				
2	BULK WATER TEMPERATURE ALARM CHECK	FUNCTIONAL	Tested @______				
3	CHANNEL TEST OF REACTOR TOP CAM AND STACK CAM	3600±100 cpm	Rx Top_______ Stack _______			—	—
4.A	MEASUREMENT OF REACTOR PRIMARY WATER CONDUCTIVITY	<5 μmho\cm					
4.B	PRIMARY WATER Ph MEASUREMENT	MIN: 5 MAX: 8.5			N/A		
5	BULK SHIELD TANK WATER Ph MEASUREMENT	MIN: 5 MAX: 8.5			N/A		
6	CHANGE LAZY SUSAN FILTER	FILTER CHANGED			N/A		
7	REACTOR TOP CAM OIL LEVEL CHECK	OSTROP 13.10	NEED OIL?______		N/A		
8	EMERGENCY DIESEL GENERATOR CHECKS	> 50% Total hours			N/A		
9	PRIMARY PUMP BEARINGS OIL LEVEL CHECK	OSTROP 13.13	NEED OIL?______		N/A		
10	WATER MONITOR CHECK				N/A		
11	RABBIT SYSTEM RUN TIME	Total hours			N/A		
12	OIL TRANS ROD BRONZE BEARING	WD 40			N/A		

* 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.2

Quarterly Surveillance and Maintenance (Sample Form)

OSTROP 14, Rev. LEU-2 — 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
1	REACTOR OPERATION COMMITTEE (ROC) AUDIT	QUARTERLY					
2	QUARTERLY ROC MEETING	QUARTERLY					
3	NOT CURRENTLY USED	N/A					N/A
4	ERP INSPECTIONS	QUARTERLY					
5	NOT CURRENTLY USED	N/A					N/A
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 ± 50	_____V				
		GAS: 900 V ± 50	_____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 CONTACT					

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

OSTROP 14, Rev. LEU-2 — 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
12	ARM SYSTEM ALARM CHECKS	FUNCTIONAL					

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

		LIMITS					
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 be exceeded only applies to shaded items. It is equal to the date completed last quarter plus four months.

Figure IV.3

Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP 15, Rev. LEU-2 — Surveillance & Maintenance for the 1st / 2nd Half of 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	≤ $2.25					
		PULSE INTERLOCK ON RANGE SWITCH	NO PULSE					
2	SAFETY CIRCUIT TEST	PERIOD SCRAM	≥3 sec					
3	NOT CURENTLY USED		N/A					N/A
4	TEST PULSE	PULSE # ________ $________ ________MW ________°C	≤20% CHANGE	PULSE # ______ $________ ________MW ________°C				
5	NOT CURRENTLY USED		N/A					N/A
6	NOT CURRENTLY USED		N/A					N/A
7	NOT CURRENTLY USED		N/A					N/A

*Date not to be exceeded is only applicable to shaded items. It is equal to the date last time plus 7 1/2 months.

Figure IV.3 (continued)

Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP 15, Rev. LEU-2 — Surveillance & Maintenance for the 1st / 2nd Half of 20______

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
8	CLEANING & LUBRICATION OF TRANSIENT ROD CARRIER INTERNAL BARREL							
9	LUBRICATION OF BALL-NUT DRIVE ON TRANSIENT ROD CARRIER							
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 $R = \frac{800\ V}{\Delta I}$	@ 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______				
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 1/2 months.

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

OSTROP 16, Rev. LEU-2 — 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					
		CLICIT						
		ICIT/DUMMY						
4	REACTOR POWER CALIBRATION		OSTROP 8.0					
5	CALIBRATION OF REACTOR TANK WATER TEMP TEMPERATURE METERS		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	N/A		AUGUST 1		

* Date not 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 1/2 years.

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

OSTROP 16, Rev. LEU-2 — 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
10	SNM PHYSICAL INVENTORY		N/A	N/A	OCTOBER 1			
11	MATERIAL BALANCE REPORTS		N/A	N/A	NOVEMBER			
12	STANDARD CONTROL ROD DRIVE INSPECTION		OSTROP 16.13					
13	CORE EXCESS		$\leq \$7.55$	NORMAL ___ ICIT___ CLICIT ___				
14	EMERGENCY RESPONSE PLAN	CFD TRAINING						
		GOOD SAM TRAINING						
		ERP REVIEW						
		ERP DRILL						
		FIRST AID FOR:						
		FIRST AID FOR:						
		EVACUATION DRILL						
		AUTO EVAC ANNOUNCEMENT TEST						
		ERP EQUIPMENT INVENTORY						
		BIENNIAL SUPPORT AGREEMENTS						
15	PHYSICAL SECURITY PLAN	OSP/DPS TRAINING						
		PSP REVIEW						
		PSP DRILL						
		LOCK/SAFE COMBO CHANGES						
		AUTHORIZATION LIST UPDATE						
		SPOOF MEASUREMENTS						

* Date not 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 1/2 years.

Figure IV.4 (continued)

Annual Surveillance and Maintenance (Sample Form)

OSTROP 16, Rev. LEU-2 — 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
16	KEY INVENTORY	ANNUAL					
17	CONTROL ROD WITHDRAWAL INSERTION & SCRAM TIMES (TRANS / SAFE / SHIM / REG): SCRAM	≤2 sec					
	W/D	<50 sec					
	INSERT	≤50 sec					
18	REACTOR BAY VENTILLATION SYSTEM SHUTDOWN TEST	DAMPERS CLOSE IN ≤5 SECONDS	1st Floor ___ 2nd Floor___	_____			
19	CALIBRATION OF THE FUEL ELEMENT TEMPERATURE CHANNEL	Per Checksheet					
20	FUEL ELEMENT INSPECTION FOR SELECTED ELEMENTS	≥ 20 FE's inspected No damage, deteriora.tion or swell. At least one FE from each ring inspected. 100% of irradiated FE's inspected after 5 years.					
21	REACTOR TANK AND CORE COMPONENT INSPECTION	NO WHITE SPOTS					
22	EMERGENCY LIGHT LOAD TEST	RCHPP 18.0					

	REACTOR OPERATOR LICENSE CONDITIONS	ANNUAL REQUALIFICATION				BIENNIAL MEDICAL		EVERY 6 YEARS LICENSE		
		WRITTEN EXAM		OPERATING TEST				APPLICATION		EXPIRATION DATE
	OPERATOR NAME	DATE DUE	DATE PASSED	DATE DUE	DATE PASSED	DATE DUE	DATE COMPLETED	DUE DATE	DATE MAILED	
23										
24	NEUTRON RADIOGRAPHY FACILITY INTERLOCKS									

* Date not 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 1/2 years.

Introduction

The purpose of the radiation protection 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 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.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). 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 Department of Energy Rule No. 345-30-010, which requires an annual report of environmental effects due to research reactor operations.

Within the scope of 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).

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.

Liquid Effluents Released

Liquid Effluents

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. Liquid effluent are analyzed for radioactivity content at the time it is released to the collection point. For this reporting period, the Radiation Center and reactor made seven liquid effluent releases to the sanitary sewer. All Radiation Center and reactor facility liquid effluent data pertaining to this release are contained in Table V.2.

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.3.

Airborne Effluents Released

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

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.4.

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

Particulate Effluents

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.

Solid Waste Released

Data for the radioactive material in the solid waste generated and transferred during this reporting period are summarized in Table V.5 for both the reactor facility and the Radiation Center. Solid radioactive waste is routinely transferred to OSU Radiation Safety. 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 OSU Radiation Safety by transfer to the University's radioactive waste disposal vendor.

Personnel Dose

The OSTR annual reporting requirements specify that the licensee shall present a summary of the radiation exposure received by facility personnel and visitors. 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, pocket ion chambers, electronic dosimetry.

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 Xß(γ) TLD badge and other dosimeters as appropriate for the work being performed.

Students attending laboratory classes are issued quarterly Xß(γ) 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 lab 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 Xß(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 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.6. There were no personnel radiation exposures in excess of the limits in 10 CFR 20 or State of Oregon regulations during the reporting period.

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.

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.7 and the total dose equivalent recorded on the Radiation Center area dosimeters is listed in Table V.8. Generally, the characters following the Monitor Radiation Center (MRC) designator show the room number or location.

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.9.

Environmental Survey Data

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

Gamma Radiation Monitoring

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 and nine environmental monitoring stations.

During this reporting period, each fence environmental station utilized an LiF TLD monitoring packet supplied and processed by Mirion Technologies, Inc., Irvine, California. Each GDS packet contained three LiF TLDs and was exchanged quarterly for a total of 108 samples during the reporting period (9 stations x 3 TLDs per station x 4 quarters). The total number of GDS TLD samples for the reporting period was 108. A summary of the GDS TLD data is also shown in Table V.10.

From Table V.10 it is concluded that the doses recorded by the dosimeters on the TRIGA facility fence can be attributed to natural back-ground radiation, which is about 110 mrem per year for Oregon (Refs. 1, 2).

Off-site Monitoring

The off-site gamma environmental radiation monitoring program consists of twenty monitoring stations surrounding the Radiation Center (see Figure V.1) and six stations located within a 5 mile radius of the Radiation Center.

Each monitoring station is located 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). The total number of GDS TLD samples for the reporting period was 240. A summary of GDS TLD data for the off-site monitoring stations is given in Table V.11.

After a review of the data in Table V.11, 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).

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 annual basis. The program monitors highly unlikely radioactive material releases from either the TRIGA reactor facility or the OSU Radiation Center, and also helps indicate the general trend of the radioactivity concentration in each of the various substances sampled. See Figure V.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.1.

There are a total of 22 sampling locations: four soil locations, four water locations (when water is available), and fourteen vegetation locations.

The annual 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.12. Calculation of the total net beta disintegration rate incorporates subtraction of only the counting system back-ground from the gross beta counting rate, followed by application of an appropriate counting system efficiency.

The annual 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.13 gives the concentration and the range of 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.12 it can be seen that the levels of radioactivity detected were consistent with naturally occurring radioactivity and comparable to values reported in previous years.

Radioactive Materials Shipments

A summary of the radioactive material shipments originating from the TRIGA reactor facility, NRC license R-106, is shown in Table V.14. A similar summary for shipments originating from the Radiation Center's State of Oregon radioactive materials license ORE 90005 is shown in Table V.15. A summary of radioactive material shipments exported under Nuclear Regulatory Commission general license 10 CFR 110.23 is shown in Table V.16.

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.1

Radiation Protection Program Requirements and Frequencies

Frequency	Radiation Protection Requirement
Daily/Weekly/Monthly	Perform Routing area radiation/contamination monitoring
Monthly	Collect and analyze TRIGA primary, secondary, and make-up water. Exchange personnel dosimeters and inside area monitoring dosimeters, and review exposure reports. Inspect laboratories. 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. Conduct orientations for classes using radioactive materials. Collect and analyze samples 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.
Annual	Calibrate portable radiation monitoring instruments and personnel pocket ion chambers. Calibrate reactor stack effluent monitor, continuous air monitors, remote area radiation monitors, 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. Update decommissioning logbook. Collect and process environmental soil, water, and vegetation samples.

Table V.2

Monthly Summary of Liquid Effluent Release to the Sanitary Sewer[1]

Date of Discharge (Month and Year)	Total Quantity of Radioactivity Released (Curies)	Detectable Radionuclide in the Waste	Specific Activity for Each Detectable Radionuclide in the Waste, Where the Release Concentration Was>1 x 10^{-7} (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 (%)[2]	Total Volume of Liquid Effluent Released Including Diluent (gal)
July 2013	1.03×10^{-1}	H-3 Cr-51 Co-58 Co-60	H-3, 9.43×10^{-5}	H-3, 1.03×10^{-1} Cr-51, 1.06×10^{-6} Co-58, 4.11×10^{-7} Co-60, 9.07×10^{-7}	H-3, 9.43×10^{-5} Cr-51, 9.75×10^{-10} Co-58, 3.78×10^{-10} Co-60, 8.33×10^{-10}	H-3, 0.94 Cr-51, 0.00002 Co-58, 0.0002 Co-60, 0.003	287,947
August 2013	1.69×10^{-1}	H-3 Mn-54 Cr-51 Co-58 Co-60	H-3, 3.24×10^{-4}	H-3, 1.69×10^{-1} Mn-54, 5.44×10^{-7} Cr-51, 2.48×10^{-6} Co-58, 1.94×10^{-7} Co-60, 3.89×10^{-6}	H-3, 3.24×10^{-4} Mn-54, 1.04×10^{-9} Cr-51, 4.74×10^{-9} Co-58, 3.72×10^{-10} Co-60, 7.42×10^{-9}	H-3, 3.24 Mn-54, 0.0003 Cr-51, 0.00009 Co-58, 0.0002 Co-60, 0.02	138,161
September 2013	2.73×10^{-1}	H-3 Sc-46 Cr-51 Mn-54 Co-58 Co-60 Rb-89 Sb-124 Eu-154	H-3, 8.69×10^{-4}	H-3, 2.73×10^{-1} Sc-46, 9.04×10^{-7} Cr-51, 1.45×10^{-5} Mn-54, 3.54×10^{-6} Co-58, 5.85×10^{-7} Co-60, 3.83×10^{-5} Rb-89, 4.14×10^{-6} Sb-124, 7.38×10^{-7} Eu-154, 4.11×10^{-7}	H-3, 8.69×10^{-4} Sc-46, 2.88×10^{-8} Cr-51, 4.62×10^{-8} Mn-54, 1.13×10^{-8} Co-58, 1.86×10^{-9} Co-60, 1.22×10^{-7} Rb-89, 1.32×10^{-8} Sb-124, 2.35×10^{-9} Eu-154, 1.31×10^{-9}	H-3, 8.69 Sc-46, 0.003 Cr-51, 0.0009 Mn-54, 0.004 Co-58, 0.0009 Co-60, 0.4 Rb-89, 0.0001 Sb-124, 0.003 Eu-154, 0.002	82,950
February 2014	1.07×10^{-2}	H-3 Co-60	H-3, 4.81×10^{-5}	H-3, 1.07×10^{-4} Co-60, 2.56×10^{-6}	H-3, 4.81×10^{-5} Co-60, 1.15×10^{-18}	H-3, 0.48 Co-60, 0.04	58,646
June 2014	1.06×10^{-3}	H-3 Co-60	H-3, 1.41×10^{-6}	H-3, 1.06×10^{-3} Co-60, 2.29×10^{-6}	H-3, 1.41×10^{-6} Co-60, 3.05×10^{-19}	H-3, 0.014 Co-60, 0.01	198,129
Annual Total for Radiation Center	8.3×10^{-1}	H-3, Sc-46, Cr-51, Mn-54, Co-58, Co-60, Rb-89, Sb-124, Eu-154	1.34×10^{-3}	H-3, 0.55	1.34×10^{-3}	13.85	765,833

(1) The OSU operational policy is to subtract only detector background from the water analysis data and not background radioactivity in the Corvallis city water.
(2) Based on values listed in 10 CFR 20, Appendix B to 20.1001 – 10.2401, Table 3, which are applicable to sewer disposal.

Table V.3

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	0		0	
Radiation Center Laboratories	1.59	U-238	1.71×10^{-5}	8/29/14
TOTAL	**1.59**	**See above**	$\mathbf{1.71 \times 10^{-5}}$	

(1) OSTR 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.4

Monthly TRIGA Reactor Gaseous Waste Discharges and Analysis

Month	Total Estimated Activity Released (Curies)	Total Estimated Quantity of Argon-41 Released[1] (Curies)	Estimated Atmospheric Diluted Concentration of Argon-41 at Point of Release (μCi/cc)	Fraction of the Technical Specification Annual Average Argon-41 Concentration Limit (%)
July	0.00	0.00	0.00×10^{0}	0.00
August	0.00	0.00	0.00×10^{0}	0.00
September	0.00	0.00	0.00×10^{0}	0.00
October	0.00	0.00	0.00×10^{0}	0.00
November	0.00	0.00	0.00×10^{0}	0.00
December	0.00	0.00	0.00×10^{0}	0.00
January	1.49	1.49	1.19×10^{-7}	2.97
February	1.44	1.44	1.28×10^{-7}	3.19
March	1.70	1.70	1.36×10^{-7}	3.39
April	1.97	1.97	1.63×10^{-7}	4.06
May	1.75	1.75	1.40×10^{-7}	3.51
June	1.82	1.82	1.50×10^{-7}	3.75
TOTAL ('13-'14)	**10.17**	**10.17**	6.96×10^{-8} [2]	**1.74**[2]

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

Table V.5

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	38	Sc-46, Cr-51, Mn-54, Co-58, Co-60, Zn-65, As-74, Hf-181, Ag-110m, Sb-124, Eu-152, Eu-154, Se-75, Fe-59, H-3, Cs-134, Na-24	1.25×10^{-4}	8/29/13 11/20/13 2/17/14 5/17/14
Radiation Center Laboratories	32.25	Cs-134, Cs-137, Co-60, Am-241, H-3, Sr-85, U-238, Sr-90, Ag-110m, Cd-109, Co-109, Co-57. Cr-51, Sn-113, Y-88, Te-123m	1.25×10^{-5}	8/29/13 11/20/13 2/17/14 5/17/14
TOTAL	70.25	See Above	1.38×10^{-4}	

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

Table V.6

Annual Summary of Personnel Radiation Doses Received

	Average Annual Dose[1]		Greatest Individual Dose[1]		Total Person-mrem for the Group[1]	
Personnel Group	**Whole Body (mrem)**	**Extremities (mrem)**	**Whole Body (mrem)**	**Extremities (mrem)**	**Whole Body (mrem)**	**Extremities (mrem)**
Facility Operating Personnel	381.43	502.57	639	914	2,229	3,518
Key Facility Research Personnel	4.23	12.44	37	46	55	112
Facilities Services Maintenance Personnel	0	N/A	0	N/A	0	N/A
Laboratory Class Students	4.31	0.61	58	48	880	115
Campus Police and Security Personnel	ND	N/A	ND	N/A	ND	N/A
Visitors	<1	N/A	20.9	N/A	127.49	N/A
Contractors	818.93	136.33	683	773	1,334	2,045

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

Table V.7

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

Monitor I.D.	TRIGA Reactor Facility Location (See Figure V.1)	Total Recorded	Dose Equivalent[(1)(2)]
		Xß(γ) (mrem)	Neutron (mrem)
MRCTNE	D104: North Badge East Wall	214	ND
MRCTSE	D104: South Badge East Wall	93	ND
MRCTSW	D104: South Badge West Wall	1292	ND
MRCTNW	D104: North Badge West Wall	244	ND
MRCTWN	D104: West Badge North Wall	751	ND
MRCTEN	D104: East Badge North Wall	286	ND
MRCTES	D104: East Badge South Wall	1359	ND
MRCTWS	D104: West Badge South Wall	386	ND
MRCTTOP	D104: Reactor Top Badge	750	ND
MRCTHXS	D104A: South Badge HX Room	612	ND
MRCTHXW	D104A: West Badge HX Room	362	ND
MRCD-302	D302: Reactor Control Room	342	ND
MRCD-302A	D302A: Reactor Supervisor's Office	74	N/A
MRCBP1	D104: Beam Port Number 1	600	ND
MRCBP2	D104: Beam Port Number 2	229	ND
MRCBP3	D104: Beam Port Number 3	698	ND
MRCBP4	D104: Beam Port Number 4	715	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.8

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

Monitor I.D.	Radiation Center Facility Location (See Figure V.1)	Total Recorded Dose Equivalent[1]	
		Xß(γ) (mrem)	Neutron (mrem)
MRCA100	A100: Receptionist's Office	30	N/A
MRCBRF	A102H: Front Personnel Dosimetry Storage Rack	28	N/A
MRCA120	A120: Stock Room	32	N/A
MRCA120A	A120A: NAA Temporary Storage	0	N/A
MRCA126	A126: Radioisotope Research Lab	349	N/A
MRCCO-60	A128: ^{60}Co Irradiator Room	180	N/A
MRCA130	A130: Shielded Exposure Room	80	N/A
MRCA132	A132: TLD Equipment Room	856	N/A
MRCA138	A138: Health Physics Laboratory	188	N/A
MRCA146	A146: Gamma Analyzer Room (Storage Cave)	147	N/A
MRCB100	B100: Gamma Analyzer Room (Storage Cave)	167	N/A
MRCB114	B114: Lab (^{226}Ra Storage Facility)	1530	N/A
MRCB119-1	B119: Source Storage Room	363	N/A
MRCB119-2	B119: Source Storage Room	686	N/A
MRCB119A	B119A: Sealed Source Storage Room	5,442	2,878
MRCB120	B120: Instrument Calibration Facility	45	N/A
MRCB122-2	B122: Radioisotope Hood	223	N/A
MRCB122-3	B122: Radioisotope Research Laboratory	33	N/A
MRCB124-1	B124: Radioisotope Research Lab (Hood)	33	N/A
MRCB124-2	B124: Radioisotope Research Laboratory	30	N/A
MRCB124-6	B124: Radioisotope Research Laboratory	28	N/A
MRCB128	B128: Instrument Repair Shop	32	N/A
MRCB136	B136 Gamma Analyzer Room	19	N/A
MRCC100	C100: Radiation Center Director's Office	22	N/A

(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.

Table V.8 (continued)

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

Monitor I.D.	Radiation Center Facility Location (See Figure V.1)	Total Recorded Dose Equivalent[1]	
		Xß(γ) (mrem)	Neutron (mrem)
MRCC106A	C106A: Office	28	N/A
MRCC106B	C106B: Custodian Supply Storage	19	N/A
MRCC106-H	C106H: East Loading Dock	13	N/A
MRCC118	C118: Radiochemistry Laboratory	0	N/A
MRCC120	C120: Student Counting Laboratory	43	N/A
MRCF100	F100: APEX Facility	17	N/A
MRCF102	F102: APEX Control Room	10	N/A
MRCB125N	B125: Gamma Analyzer Room (Storage Cave)	10	N/A
MRCN125S	B125: Gamma Analyzer Room	0	N/A
MRCC124	C124: Classroom	31	N/A
MRCC130	C130: Radioisotope Laboratory (Hood)	35	N/A
MRCD100	D100: Reactor Support Laboratory	49	N/A
MRCD102	D102: Pneumatic Transfer Terminal Lab`	163	ND
MRCD102-H	D102H: 1st Floor Corridor at D102	66	ND
MRCD106-H	D106H: 1st Floor Corridor at D106	193	N/A
MRCD200	D200: Reactor Administrator's Office	120	ND
MRCD202	D202: Senior Health Physicist's Office	167	ND
MRCBRR	D200H: Rear Personnel Dosimetry Storage Rack	38	N/A
MRCD204	D204: Health Physicist Office	383	ND
MRCATHRL	F104: ATHRL	12	N/A
MRCD300	D300: 3rd Floor Conference Room	146	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.

Table V.9

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

Accessible Location (See Figure V.1)	Whole Body Radiation Levels (mrem/hr)		Contamination Levels(1) (dpm/cm^2)	
	Average	Maximum	Average	Maximum
TRIGA Reactor Facility:				
Reactor Top (D104)	1.0	880	<500	20625
Reactor 2nd Deck Area (D104)	4.1	38	<500	2097
Reactor Bay SW (D104)	<1	60	<500	9821
Reactor Bay NW (D104)	<1	28	1221	80484
Reactor Bay NE (D104)	<1	25	673	138548
Reactor Bay SE (D104)	<1	4	<500	4355
Class Experiments (D104, D302)	<1	<1	<500	<500
Demineralizer Tank & Make Up Water System (D104A)	<1	12	<500	2258
Particulate Filter--Outside Shielding (D104A)	<1	4	<500	968
Radiation Center:				
NAA Counting Rooms (A146, B100)	<1	15	<500	<500
Health Physics Laboratory (A138)	<1	<1	<500	<500
^{60}Co Irradiator Room and Calibration Rooms (A128, B120, A130)	<1	20	<500	<500
Radiation Research Labs (A126, A136) (B108, B114, B122, B124, C126, C130, A144)	<1	10	<500	<500
Radioactive Source Storage (B119, B119A, A120A, A132A)	<1	17	<500	<500
Student Chemistry Laboratory (C118)	<1	<1	<500	<500
Student Counting Laboratory (C120)	<1	<1	<500	<500
Operations Counting Room (B136, B125)	<1	<1	<500	<500
Pneumatic Transfer Laboratory (D102)	<1	16	<500	62292
RX support 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.10

Total Dose Equivalent at the TRIGA Reactor Facility Fence

Fence Environmental Monitoring Station (See Figure V.1)	Total Recorded Dose Equivalent (Including Background) Based on Mirion TLDs[1,2] (mrem)
MRCFE-1	98 +/- 6
MRCFE-2	93 +/- 6
MRCFE-3	86 +/- 7
MRCFE-4	98 +/- 7
MRCFE-5	100 +/- 6
MRCFE-6	96 +/- 6
MRCFE-7	155 +/- 21
MRCFE-8	97 +/- 6
MRCFE-9	94 +/- 6

(1) Average Corvallis area natural background using Mirion TLDs totals 87 ± 15 mrem for the same period.

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

Table V.11

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

Off-Site Radiation Monitoring Station (See Figure V.1)	Total Recorded Dose Equivalent (Including Background) Based on Mirion TLDs[1,2] (mrem)
MRCTE-2	94 ± 5
MRCTE-3	90 ± 7
MRCTE-4	91 ± 7
MRCTE-5	101 ± 8
MRCTE-6	89 ± 6
MRCTE-7	95 ± 5
MRCTE-8	104 ± 6
MRCTE-9	99 ± 7
MRCTE-10	87 ± 6
MRCTE-12	103 ± 7
MRCTE-13	93 ± 5
MRCTE-14	94 ± 6
MRCTE-15	89 ± 7
MRCTE-16	99 ± 6
MRCTE-17	90 ± 7
MRCTE-18	93 ± 6
MRCTE-19	98 ± 9
MRCTE-20	91 ± 5
MRCTE-21	83 ± 6
MRCTE-22	87 ± 8

(1) Average Corvallis area natural background using Mirion TLDs totals 87 ± 15 mrem for the same period.
(2) ± values represent the standard deviation of the total value at the 95% confidence level.

Table V.12

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

Sample Location (See Fig. V.1)	Sample Type	Annual Average Concentration Of the Total Net Beta (Minus ^3H) Radioactivity(1)	Reporting Units
1-W	Water	$4.97x10^{-6}$(2)	$\mu Ci\ ml^{-1}$
4-W	Water	$4.97x10^{-6}$(2)	$\mu Ci\ ml^{-1}$
11-W	Water	$4.97x10^{-6}$(2)	$\mu Ci\ ml^{-1}$
19-RW	Water	$4.97x10^{-6}$(2)	$\mu Ci\ ml^{-1}$
3-S	Soil	$1.19x10^{-4} \pm 1.22x10^{-5}$	$\mu Ci\ g^{-1}$ of dry soil
5-S	Soil	$9.18x10^{-5} \pm 1.08x10^{-5}$	$\mu Ci\ g^{-1}$ of dry soil
20-S	Soil	$7.01x10^{-5} \pm 8.26x10^{-6}$	$\mu Ci\ g^{-1}$ of dry soil
21-S	Soil	$8.91x10^{-5} \pm 9.57x10^{-6}$	$\mu Ci\ g^{-1}$ of dry soil
2-G	Grass	$6.75x10^{-4} \pm 3.94x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
6-G	Grass	$6.18x10^{-4} \pm 5.01x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
7-G	Grass	$3.44x10^{-4} \pm 2.73x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
8-G	Grass	$3.93x10^{-4} \pm 3.23x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
9-G	Grass	$1.02x10^{-3} \pm 7.36x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
10-G	Grass	$4.65x10^{-4} \pm 3.41x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
12-G	Grass	$3.56x10^{-4} \pm 2.87x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
13-G	Grass	$3.95x10^{-4} \pm 3.22x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
14-G	Grass	$2.78x10^{-4} \pm 2.19x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
15-G	Grass	$3.92x10^{-4} \pm 3.66x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
16-G	Grass	$5.11x10^{-4} \pm 3.83x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
17-G	Grass	$3.74x10^{-4} \pm 3.07x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
18-G	Grass	$4.36x10^{-4} \pm 4.36x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
22-G	Grass	$3.47x10^{-4} \pm 2.54x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash

(1) ± values represent the standard deviation of the value at the 95% confidence level.
(2) Less than lower limit of detection value shown.

Table V.13

Beta-Gamma Concentration and Range of LLD Values for Soil, Water, and Vegetation Samples

Sample Type	Average Value	Range of Values	Reporting Units
Soil	$1.65x10^{-5}$	$1.37x10^{-5}$ to $1.92x10^{-5}$	µCi g^{-1} of dry soil
Water	$4.97x10^{-6}$ (1)	$4.97x10^{-6}$ (1)	µCi ml^{-1}
Vegetation	$5.08x10^{-5}$	$3.03x10^{-5}$ to $9.74x10^{-5}$	µCi g^{-1} of dry ash

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

Table V.14

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				
		Exempt	Limited Quantity	Yellow II	Yellow III	Total
Arizona State University Tucson, AZ USA	1.06×10^{-7}	1	1	0	0	2
Berkeley Geochronology Center Berkeley, CA USA	1.05×10^{-7}	4	0	0	0	4
Materion Coperation Elmore, OH USA	2.87×10^{-2}	0	0	0	3	3
Materion Natural Resources Delta, UT USA	9.54×10^{-2}	0	0	0	20	20
Oregon State University Corvallis, OR USA	2.92×10^{-6}	0	0	3	0	3
Syracuse University Syracuse, NY USA	3.80×10^{-8}	1	0	0	0	1
University of Arizona Tucson, AZ USA	2.63×10^{-7}	4	0	0	0	4
University of California at Berkeley Berkeley, CA USA	8.38×10^{-7}	2	0	1	0	3
University of California at Santa Barbara Santa Barbara, CA USA	3.90×10^{-7}	0	0	1	0	1
University of Cincinnati Cincinnati, OH USA	5.30×10^{-9}	2	0	0	0	2
University of Wisconsin-Madison Madison, WI USA	1.02×10^{-5}	1	0	3	0	4
Totals	**1.27×10^{-1}**	**15**	**1**	**8**	**23**	**47**

Table V.15

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				
		Exempt	Limited Quantity	White I	Yellow II	Total
Lawrence Livermore National Laboratory Berkeley, CA USA	6.25×10^{-11}	1	0	0	0	1
Los Alamos National Lab Los Alamos, NM USA	2.36×10^{-6}	5	8	0	0	13
Materials and Chemistry Lab, Inc. Oak Ridge, TN USA	7.33×10^{-7}	0	2	0	0	2
Totals	**3.09×10^{-6}**	**6**	**10**	**0**	**0**	**16**

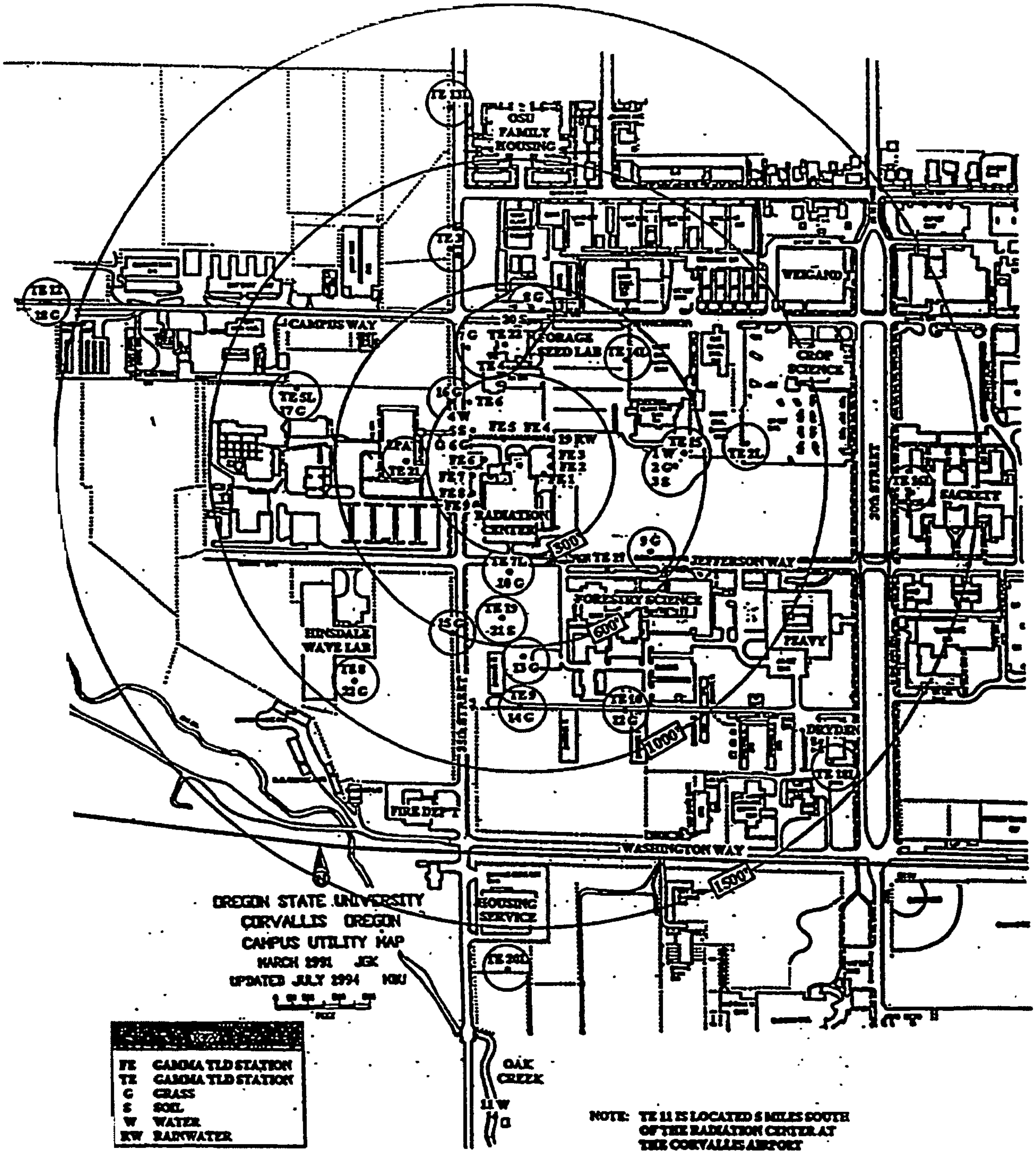
Table V.16

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

Shipped To	Total Activity (TBq)	Number of Shipments			
		Exempt	Limited Quantity	Yellow II	Total
Dalhousie University Halifax, Nova Scotia CANADA	$4.96x10^{-9}$	1	0	0	1
Glasgow University Glasgow SCOTLAND	$1.27x10^{-8}$	1	0	0	1
Lanzhou University Lanzhou, Gansu CHINA	$9.05x10^{-9}$	1	0	0	1
Lund University Lund, SWEDEN	$8.16x10^{-7}$	3	0	0	3
Nanjing University Nanjing CHINA	$1.04x10^{-8}$	1	0	0	1
Polish Academy of Sciences Krakow, POLAND	$1.68x10^{-9}$	1	0	0	1
Scottish Universities Research & Reactor Centre East Kilbride, SCOTLAND	$1.81x10^{-6}$	1	2	0	3
Universidade de Brasilia Brasilia, BRAZIL	$1.07x10^{-7}$	3	0	0	3
Universidade de Sao Paulo San Paulo, BRAZIL	$3.10x10^{-7}$	0	1	0	1
Universitat Potsdam Postdam, GERMANY	$3.89x10^{-8}$	2	0	0	2
University of Geneva Geneva, SWITZERLAND	$1.08x10^{-7}$	2	0	0	2
University of Manitoba Winnipeg, CANADA	$1.16x10^{-6}$	0	1	0	1
University of Melbourne Parkville, Victoria AUSTRALIA	$5.21x10^{-7}$	1	1	0	2
University of Padova Padova, ITALY	$7.89x10^{-9}$	2	0	0	2
University of Queensland Brisbane, Queensland AUSTRALIA	$1.87x10^{-6}$	0	1	1	2
University of Waikato Hamilton, NEW ZEALAND	$3.91x10^{-8}$	2	0	0	2
University of Zurich Zurich, SWITZERLAND	$5.68x10^{-9}$	2	0	0	2
Victoria University of Wellington Wellington, NEW ZELAND	$1.45x10^{-8}$	1	0	0	1
Vrijc Universiteit Amsterdam, THE NETHERLANDS	$4.25x10^{-7}$	0	1	0	1
Zhejiang University Hangzhou, CHINA	$4.36x10^{-9}$	1	0	0	1
Totals	**$7.28x10^{-6}$**	**25**	**7**	**1**	**33**

Figure V.1

Monitoring Stations for the OSU TRIGA Reactor



Work

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 section is to summarize the teaching, research, and service efforts carried out during the current reporting period.

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. Table III.2 plus the "Training and Instuction" section (see next page) provide detailed information on the use of the Radiation Center and reactor for instruction and training.

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.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.

The major table in this section is Table VI.2. 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 the following text.

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.

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 are included in Part III as well as in the "Research & Service" text of this section.

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 Department 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 in Corvallis.

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.

Training and Instruction

In addition to the academic laboratory classes and courses discussed in Parts III and VI, 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 the People Section.

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 Oregon State University.

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 Part VI), 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 State of Oregon Radiation Protection Services (RPS) 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 RPS radiological response field teams. As part of the ongoing preparation for this emergency support, the Radiation Center participates in inter-institution drills.

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.3 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.4 shows instruments calibrated for other OSU departments and non-OSU agencies.

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.

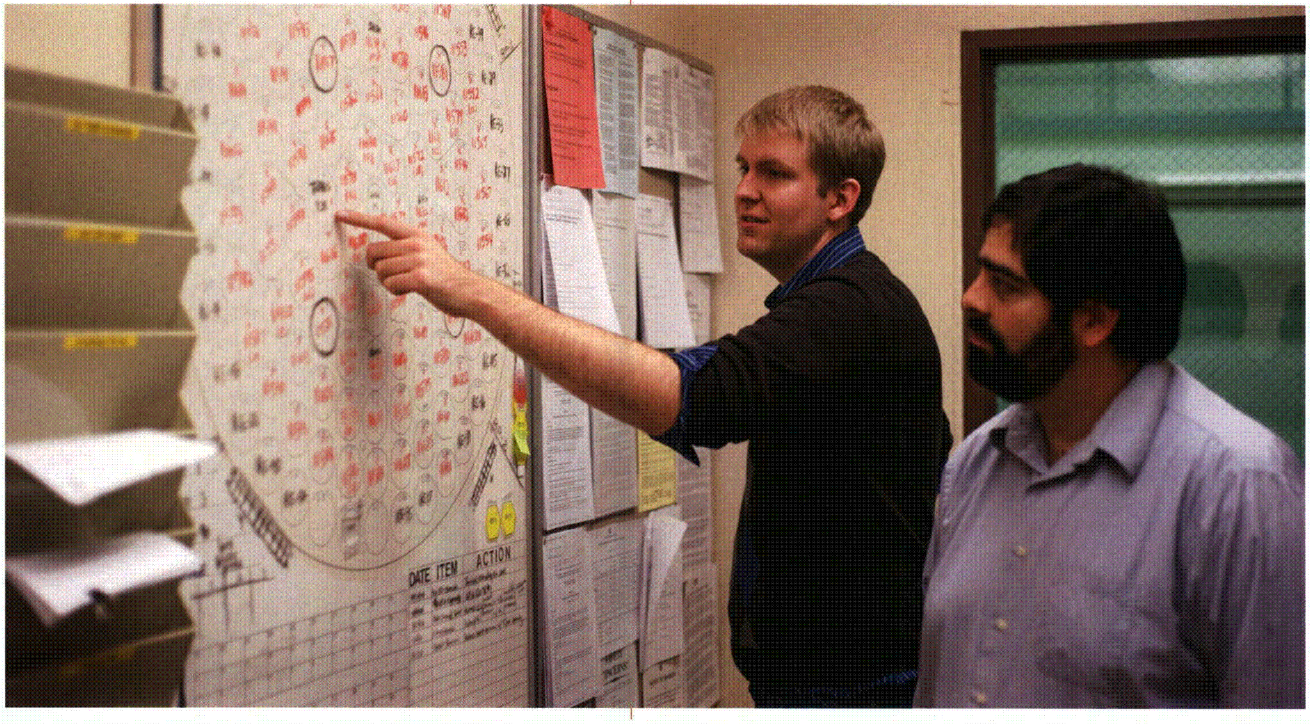


Table VI.1
Institutions, Agencies and Groups Which Utilized the Radiation Center

Intuitions, Agencies and Groups	Number of Projects	Number of Times of Faculty Involvement	Number of Uses of Center Facilities
Akron Biotach Boca Raton, FL USA	1	0	1
Alternative Nutrition LLC Casa Grande, AZ USA	1	1	1
*Benjamin Mutin Cambridge, MA USA	1	4	10
*Berkeley Geochronology Center Berkeley, CA USA	1	0	6
Branch Engineering Salem, OR USA	1	0	1
Chemical Bilogical &Environmental Engineering Corvallis, OR USA	1	1	1
*Dalhousie University Halifax, Novia Scotia CANADA	1	2	1
*Eth Zurich Zurich, SWITZERLAND	1	1	2
*Field Museum Chicago, IL USA	1	2	13
Kinetic Force, Inc. Medford, OR USA	2	0	13
*Lanzhou University Lanzhou, CHINA	1	0	1
*Lund University Lund, SWEDEN	1	0	3
*Materion Brush, Inc. Elmore, OH USA	1	0	1
*Materion Natural Resources Delta, UT USA	1	0	11
New Earth Klamath Falls, OR USA	1	0	11
*Oregon State University(1) Corvallis, OR USA	15	52	97 (2)

Table VI.1 (continued)
Institutions, Agencies and Groups Which Utilized the Radiation Center

Intuitions, Agencies and Groups	Number of Projects	Number of Times of Faculty Involvement	Number of Uses of Center Facilities
*Oregon State University - Educational Tours Corvallis, OR USA	2	1	12
*Polish Academy of Sciences Krakow POLAND	1	0	1
*Quaternary Dating Laboratory Roskilde, DENMARK	1	0	2
Radiation Protection Services Portland, OR USA	1	0	1
Rainier Farmer Albany, OR USA	1	0	1
*Scottish Universities Enfironmental Research Centre East Kilbride UK	1	0	6
The Land Institute Salina, KS USA	2	0	6
*The University of Waikato Hamilton NEW ZEALAND	1	1	4
*Universidad de Granada Granada SPAIN	1	0	5
*Universita' Degli Studi di Padova Padova ITALIA	1	2	1
*Universitat Potsdam Postdam GERMANY	2	0	2
*University of Arizona Tucson, AZ USA	3	3	4
*University of California at Berkeley Berkeley, CA USA	2	0	3
*University of California at Santa Barbara Santa Barbara, CA USA	1	1	1
*University of Cambridge Cambridge UK	1	1	8
*University of Chicago Chicago, IL USA	1	4	4

Table VI.1 (continued)
Institutions, Agencies and Groups Which Utilized the Radiation Center

Intuitions, Agencies and Groups	Number of Projects	Number of Times of Faculty Involvement	Number of Uses of Center Facilities
*University of Cincinnati Cincinnati, OH USA	1	1	2
*University of Geneva Geneva SWITZERLAND	1	1	5
*University of Glasgow Glasgow SCOTLAND	1	1	1
*University of Melbourne Melbourne, Victoria AUSTRALIA	1	1	3
*University of Michigan Ann Arbor, MI USA	2	9	8
*University of Queensland Brisbane, Queensland AUSTRALIA	1	1	3
*University of Sao Paulo Sao Paulo BRAZIL	1	0	1
*University of Washington Seattle, WA USA	1	3	6
*University of Wisconsin Madison, WI USA	1	1	5
US National Parks Service Crater Lake, OR USA	1	0	4
*Victoria University of Wellington Wellington, NEW ZEALAND	1	0	3
*Vrije Universiteit Amsterdam THE NETHERLANDS	1	1	1
*Zhejiang University Xihu District, Hangzhou City CHINA	1	0	2
Totals	**67**	**95**	**180**

* 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 on going projects being performed by residents of the Radiation Center such as the APEX project, others in the Department of Nuclear Engineering and Radiation Health Physics or Department of Chemistry or projects conducted by Dr. Walt Loveland, which involve daily use of the Radiation Center facilities.

Table VI.2
Listing of Major Research and Service Projects Preformed 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 - various departments
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
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
1074	Wijbrans	Vrije Universiteit	Ar/Ar Dating of Rocks and Minerals	Ar/Ar dating of rocks and minerals.	Vrije Universiteit, Amsterdam
1177	Garver	Union College	Fission Track Analysis of Rock Ages	Use of thermal column irradiations to perform fission track analysis to determine rock ages.	Union College, NY
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
1353	Kamp	The University of Waikato	Fission Track Thermochronology of New Zealand	Determination of history and timing of denudation of basement terranes in New Zealand and thermal history of late Cretaceous-Cenozoic sedimentary basins.	University of Waikato

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1354	Lindsay	Radiation Protection Services	Radiological Instrument Calibration	Instrument calibration.	State of Oregon Radiation Protection Services
1366	Quidelleur	Universite Paris-Sud	Ar-Ar Geochronology	Determination of geological samples via Ar-Ar radiometric dating.	Universite Paris-Sud
1404	Riera-Lizarau	Oregon State University	Evaluation of wheat DNA	Gamma irradiation of wheat seeds.	OSU Crop and Soil Science
1415	McGinness	ESCO Corporation	Calibration of Instruments	Instrument calibration.	ESCO Corporation
1419	Krane	Oregon State University	Nuclear Structure of N=90 Isotones	Study of N=90 isotone structure (Sm-152, Gd-154, Dy-156) from decays of Eu-152, Eu-152m, Eu-154, Tb-154, and Ho-156. Samples will be counted at LBNL.	OSU Physics Department
1464	Slavens	USDOE Albany Research Center	Instrument Calibration	Instrument calibration.	USDOE Albany Research Center
1465	Singer	University of Wisconsin	Ar-40/Ar-39 Dating of Young Geologic Materials	Irradiation of geological materials such as volcanic rocks from sea floor, etc. for Ar-40/Ar-39 dating.	University of Wisconsin
1470	Shatswell	SIGA Technologies, Inc.	Instrument Calibration	Instrument calibration.	Siga Pharmaceuticals
1492	Stiger	Federal Aviation Administration	Instrument Calibration	Instrument calibration.	Federal Aviation Administration
1503	Teaching and Tours	Non-Educational Tours	Non-Educational Tours	Tours for guests, university functions, student recruitment.	NA
1504	Teaching and Tours	Oregon State University - Educational Tours	OSU Nuclear Engineering & Radiation Health Physics Department	OSTR tour and reactor lab.	NA
1505	Teaching and Tours	Oregon State University - Educational Tours	OSU Chemistry Department	OSTR tour, teaching labs, and/or half-life experiment.	NA
1506	Teaching and Tours	Oregon State University - Educational Tours	OSU Geosciences Department	OSTR tour.	NA
1507	Teaching and Tours	Oregon State University - Educational Tours	OSU Physics Department	OSTR tour.	NA

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1509	Teaching and Tours	Oregon State University - Educational Tours	HAZMAT course tours	First responder training tours.	NA
1510	Teaching and Tours	Oregon State University - Educational Tours	Science and Mathematics Investigative Learning Experience	OSTR tour and half-life experiment.	NA
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.	NA
1512	Teaching and Tours	Linn Benton Community College	Linn Benton Community College Tours/Experiments	OSTR tour and half-life experiment.	NA
1514	Sobel	Universitat Potsdam	Apatite Fission Track Analysis	Age determination of apatites by fission track analysis.	Universitat Potsdam
1519	Dunkl	University of Goettingen	Fission Track Analysis of Apatites	Fission track dating method on apatites: use of fission tracks from decay of U-238 and U-235 to deterimine the coling age of apatites.	University of Tuebingen
1523	Zattin	Universita' Degli Studi di Padova	Fission track analysis of Apatites	Fission track dating method on apatites by fission track analysis.	NA
1527	Teaching and Tours	Oregon State University - Educational Tours	Odyssey Orientation Class	OSTR tour.	NA
1528	Teaching and Tours	Oregon State University - Educational Tours	Upward Bound	OSTR tour.	NA
1529	Teaching and Tours	Oregon State University - Educational Tours	OSU Connect	OSTR tour.	NA
1535	Teaching and Tours	Corvallis School District	Corvallis School District	OSTR tour.	NA
1537	Teaching and Tours	Oregon State University - Educational Tours	Naval Science Department	OSTR tour.	NA
1542	Teaching and Tours	Oregon State University - Educational Tours	Engineering Sciences Classes	OSTR tour.	NA

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1543	Bailey	Veterinary Diagnostic Imaging & Cytopathology	Instrument Calibration	Instrument calibration.	Veterinary Diagnostic Imaging & Cytopathology
1544	Teaching and Tours	West Albany High School	West Albany High School	OSTR tour and half-life experiment.	NA
1545	Teaching and Tours	Oregon State University - Educational Tours	OSU Educational Tours	OSTR tour.	NA
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
1584	Teaching and Tours	Reed College	Reed College Staff & Trainees	OSTR tour for Reed College Staff & Trainees.	NA
1611	Teaching and Tours	Grants Pass High School	Grants Pass High School	OSTR tour.	NA
1614	Teaching and Tours	Marist High School	Marist High School	OSTR tour and half-life experiment.	NA
1617	Spikings	University of Geneva	Ar-Ar geochronology and Fission Track dating	Argon dating of Chilean granites.	University of Geneva
1621	Foster	University of Florida	Irradiation for Ar/Ar Analysis	Ar/Ar analysis of geological samples.	University of Florida
1623	Blythe	Occidental College	Fission Track Analysis	Fission track Thermochronology of geological samples	Occidental College
1660	Reactor Operations Staff	Oregon State University	Operations support of the reactor and facilities testing	Operations use of the reactor in support of reactor and facilities testing.	NA
1674	Niles	Oregon Department of Energy	Radiological Emergency Support	Radiological emergency support ot OOE related to instrument calibration, radiological and RAM transport consulting, and maintenance of radiological analysis laboratory at the Radiation Center.	Oregon Department of Energy
1677	Zuffa	Universita' di Bologna	Fission Track Dating	Use of fission track from U-235 to determine uranium content in rock.	Universita' di Bologna

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1692	Estell	Lonza	Screening Tests of Wood Decay	This is to build up basic knowledge on the efficacy of a copper based preservative in preventing decay of wood inhabiting basidiomycetes.	Lonza
1717	Baldwin	Syracuse University	Ar/Ar Dating	Ar/Ar Dating.	Syracuse University
1718	Armstrong	California State University at Fullerton	Fission Track Dating	Fission track age dating of apatite grains.	Department of Geological Sciences
1720	Teaching and Tours	Saturday Academy	OSTR Tour	OSTR Tour.	NA
1726	Teaching and Tours	Oregon State University - Educational Tours	Academic Learning Services	Cohort Class 199.	NA
1745	Girdner	US National Parks Service	C14 Measurements	LSC analysis of samples for C14 measurements.	US National Parks Service
1747	Teaching and Tours	East Linn Christian Academy	Reactor Tour	Reactor Tour for Chemistry Class.	NA
1758	Teaching and Tours	Oregon State University - Educational Tours	Kids Spirit	OSTR tour.	NA
1765	Beaver	Weyerhaeuser	Instrument Calibration	Calibration of radiological instruments.	Weyerhaeuser Foster
1768	Bringman	Brush-Wellman	Antimony Source Production	Production of Sb-124 sources.	Brush-Wellman
1771	Otjen	Oregon State Fire Marshal	Instrument calibration	Calibration of radiological response kits	Oregon State Fire Marshall
1777	Storey	Quaternary Dating Laboratory	Quaternary Dating	Production of Ar-39 from K-39 to determine radiometric ages of geological materials.	Quaternary Dating Laboratory
1790	Teaching and Tours	Oregon State University - Educational Tours	OSTR Tour	OSTR Tour.	NA
1794	O'Kain	Knife River	Instrument Calibration	Instrument calibration.	Tangent Construction
1796	Hardy	CH2M Hill, Inc.	Instrument Calibration	Instrument calibration.	CH2M Hill, Inc.
1816	Kounov	Geologisch-Palaontologisches Institut	Fission Track Analysis	Geochronology analysis using fission track dating.	Geologisch-Palaontologisches Institut

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1818	Sabey	Brush Wellman	Antimony source production (Utah)		Brush-Wellman
1819	Vetter	University of California at Berkeley	NE-104A INAA source	Stainless Steel disk source for INAA lab.	University of California at Berkeley
1820	Jolivet	Universite Montpellier II	Fission Track Analysis	Use of fission track analysis for geochronology.	University of Montpellier II
1823	Harper	Oregon State University	Evaluation of Au nanoparticle uptake	INAA of gold concentrations in zebrafish embryos to evaluate nanoparticle uptake.	OSU Environmental Health Sciences Center
1826	Teaching and Tours	North Eugene High School	OSTR Tour	OSTR Tour and half-life experiment.	NA
1831	Thomson	University of Arizona	Fission Track	Fission track thermochronometry of the Patagonian Andes and the Northern Apennines, Italy.	Yale University
1840	Burgess	University of Manchester	Ar/Ar Dating	Production of Ar-39 from K-39 for Ar-40/Ar-39 dating of geological samples.	University of Manchester
1841	Swindle	University of Arizona	Ar/Ar dating of ordinary chondritic meterorites	Ar/Ar dating of ordinary chondritic meterorites.	University of Arizona
1847	Higley	Oregon State University	Ultra-trace uptake studies for allometric studies	NAA of ultra-trace elements in plant samples for application in allometric studies	NERHP CRESP Grant
1852	McGuire	Oregon State University	Antimicrobial activity of silanized silica microspheres with covalently attached PEO-PPO-PEO	co-polymer and nisin association. The project is aimed at finding effective methods for coating surfaces to enhance protein repellant activity and antimicrobial activity using nisin.	Chemical,Biological & Env Engineering
1853	Ivestor	Grande Ronde Hospital	Instrument Calibration	Instrument calibration.	Grande Ronde Hospital
1855	Anczkiewicz	Polish Academy of Sciences	Fission Track Services	Verification of AFT data for illite-mechte data.	Polish Academy of Sciences
1858	Arbogast	Gene Tools, LLC	Instrument Calibration	Calibration of instruments.	Gene Tools, LLC
1861	Page	Lund University	Lund University Geochronology	Ar/Ar Geochronology.	Lund University
1864	Gans	University of California at Santa Barbara	Ar-40/Ar-39 Sample Dating	Production of Ar-39 from K-40 to determine radiometric ages of geologic samples.	University of California at Santa Barbara
1865	Carrapa	University of Wyoming	Fission Track Irradiations	Apatite fission track to reveal the exhumation history of rocks from the ID-WY-UY postion of the Sevier fold and thrust belt, Nepal, and Argentina.	University of Wyoming

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1875	Hosmer	102nd Oregon Civil Support Unit	Instrument Calibration	Calibration of instruments.	102nd Oregon Civil Support Unit
1878	Roden-Tice	Plattsburgh State University	Fission-track research	Use of fission tracks to detrmine location of 235U, 232Th in natural rocks and minerals.	Plattsburgh State University
1880	Merrill	Oregon State University	Selenium, Thioredoxin Reductase and Cancer	Determine whether deletion of the geme encoding thioredoxin reductase in liver 1)increases or decreases the rate of liver cancer, 2)impacts the cancer-preventive activity of dietary selenium, 3)effects the pathways by wich cells protect themselves from oxicative stress and cancer.	OSU Biochemistry & Biophysics
1883	Wright	University of Michigan	The Uruk Expansion	INAA of ceramics from Uruk-period sites in Mesopotamia and adjacent areas.	OSU Radiation Center
1886	Coutand	Dalhousie University	Fission Track Irradiation	Fission track irradiations of apatite samples.	Dahousie University
1887	Farsoni	Oregon State University	Xenon Gas Production	Production of xenon gas.	OSU NERHP
1894	Greene	University of Chicago	INAA of Late Bronze-Age Ceramics, Armenia	Trace-element analyses of ceramics from Tsaghkahovit, Armenia, to determine provenance.	University of Chicago
1895	Filip	Academy of Sciences of the Czech Republic	Bojemian Massif	Fission-track dating.	Academy of Sciences of the Czech Republic
1898	Fayon	University of Minnesota	Fission Track Services	Use of fission tracks to determine location of 235U, 232Th in natural rocks and minerals.	University of Minnesota
1905	Fellin	ETH Zurich	Fission Track Analysis	Use of fission tracks to determine location of 235U, 232Th in natural rocks and minerals.	Geologisches Institut, ETH Zurich
1907	Tanguay	Oregon State University	Nanoparticle Uptake in Zebrafish Embryos	INAA to determine the uptake by zebrafish embryos of various metals in nanoparticle form.	OSU Environmental and Molecular Toxicology
1911	Alden	University of Michigan	INAA of Ancient Iranian Ceramics	Trace-element analysis of ceramic from ancient Iran to monitor trade.	National Science Foundation
1913	Reese	Oregon State University	Fission Yield Determination Using Gamma Spectroscopy	Use of neutron activation to determine fission yields for various fissile and fertile materials using gamma spectroscopy.	NA
1914	Barfod	Scottish Universities Environmental Research Centre	Ar/Ar Age Dating	Ar/Ar age dating.	Scottish Universities Research and Reactor Centre
1916	Shusterman	University of California at Berkeley	UC Berkeley Chemistry/NAA	Introduction of NAA by activation of human hair to detect trace impurities.	UC Berkeley

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1927	Seward	Victoria University of Wellington	Fission Track Dating	Fission track dating of apatite samples.	Vitoria University of Wellington
1929	Farsoni	Oregon State University	Source Activation	Irradiation of different materials to make sources for detection experiments.	NA
1931	Emori	Nunhems USA, Inc.	Pollen Sterilization	Irradiation by gamma radiation will make sterile pollen which can be used on female flowers to produce fruit with haploid embryos in some of the seed.	Nunhems USA Inc.
1933	Loveland	Oregon State University	Pt radiochemistry	Production of tracer for testing chemical separation of Pt from Pb.	
1939	Wang	Lanzhou University	Lanzhou University Fission Track	Fission Track dating.	Lanzhou University
1941	Wright	University of Michigan	INAA of ceramics from ancient Jebel Aruda, Syria	Trace-element analyses of ceramics from the site of Jebel Aruda, Syria to investigate interregional exchange.	OSU Radiation Center, Minc
1944	Jander	Oregon State University	Neutron Effects on Magnetic Tunneling Junction	Neutron Effects on Magnetic Tunneling Junction.	
1949	Reichel	Royal Ontario Museum	INAA of Ceramics from Godin Tepe, Iran	Trace-element analyses of ancient ceramics from Iran using INAA.	NSF Collaborative Research Project
1953	Idleman	Lehigh University	Lehigh University Ar/Ar Dating	Lehigh has a geochronology lab for dating rock and mineral samples using the 40Ar/39Ar method, which has been in operation since about 1990. Fast neutron irradiation of these samples produces 40Ar from 40K and is an essential step in the 40Ar/39Ar dating	Lehigh University
1954	Iwaniec	Oregon State University	The Role of Leptin in Inflammation-driven Bone Loss	Inflammation contributes to the etiology of several common metabolic bone diseases, including arthritis, periodontal disease, and postmenopausal and senile osteoporosis. The proposed research will test the novel hypothesis that leptin by functioning as an immune system modulator, plays a crucial but previously unsuspected role in amplifying inflammation-driven bone loss.	Department of Nutrition and Exercise Sciences
1956	Jaqua	Portland State University	Instrument Calibration	Instrument Calibration.	Portland State University
1957	Phillips	University of Melbourne	Radiometric age dating of geologic samples	Ar/Ar age dating.	University of Melbourne
1958	Minc	Oregon State University	INAA of Oaxaca Ceramics	Trace-element analyses of prehistoric ceramics from Oaxaca, Mexico, to determine provenance.	NSF Collaborative Research Project
1959	Mutin	Benjamin Mutin	Tepe Yahya	INAA of archaeological ceramics from Tepe Yahya, Iran.	NSF Collaborative Research Project
1960	Minc	Oregon State University	Nineveh	INAA of archaeological ceramics from the British Museum's collection from ancient Nineveh.	NSF Collaborative Research Project

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1961	Cohen	NASA	Geochronology of Terrestrial and Extraterrestrial Samples	Age dating of Earth-based, lunar and meteorite samples.	University of Alabama at Huntsville
1965	Webb	University of Vermont	Ar/Ar age dating	Irradiation with fast neutrons to produce Ar-39 from K-39 for Ar/Ar geochronology.	University of Vermont
1968	Santos	Institito de Geociencias	Radiometric ages of geological material	Production of Ar39 from K40 to determine age.	Univerisdade de Brasilia
1969	Wilkes	James Wilkes	Radiation Contamination of Salmon	Determine if salmon is contaminated with Cs134/137.	
1970	Holbert	Arizona State University	Battery Dosimetry	Determination of isotope content of various batteries to determine the neutron flux.	Arizona State University
1971	Shaik	New Earth	Testing Blue Green Algae	Testing of blue green algae to determine if it is contaminated with radioactive material.	New Earth
1972	Danisik	University of Waikato	Fission Track dating	Fission track dating of apatite samples from China in order to investigate exhumation history of ultra high pressure rocks in Dabie-Shan region.	University of Waikato
1973	Khatchadourian	Cornell University	INAA of ceramics from Armenia	Trace-element analyses of ancient pottery from Armenia.	Cornell University
1975	McDonald	University of Glasgow	Samuel Jaanne	Use of fissin tracks to determine last heating event of apatites.	School of Geographical and Earth Science
1976	Wang	The Land Institute	Perennial wheat	Wheatgrass chromosome 4E carries a major gene for perenniality. By treating chromosome 4E addition line, we intend to induce different length of deletions on this chromosome and map the gene.	The Land
1979	Paulenova	Oregon State University	Mixed Matrix Extraction Testing	Multi-element, transition metal salt production for mixed matrix extraction testing.	
1980	Carpenter	Radiation Protection Services	Sample counting	Sample counting.	State of Oregon
1981	Walsh	University of Oregon	INAA of Korean Ceramics	Trace-element analysis of Neolithic and Bronze Age ceramics from SW Korea.	
1983	Minc	Oregon State University	INAA of Archaeological Ceramics from Yaasuchi, Oaxaca	Trace-element analyses of ancient ceramics and clays from Yaasuchi, Oaxaca to examine ceramic technology and trade.	NSF Collaborative Research Project
1984	Baxter	Silverton Hospital	Instrument Calibration	Instrument calibration.	Silverton Hospital
1985	Faulseit	Southern Illinois University	INAA of Classic Zapotec Ceramics	Trace-element analyses of Classic period ceramics from Macuilxochitl, Oaxaca.	NSF Collaborative Research Project
1986	Feinman	Field Museum	INAA of Archaelogical Ceramics from El Palmillo, Oacaca	Trace-element analyses of Classic-period ceramics from the site of El Palmillo, Oaxaca.	NSF Collaborative Research Project

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
1987	Alden	University of Michigan	Kunji Cave	Trace-element determination via INAA of ceramic from Kunji Cave, Iran.	NSF Collaborative Research Project
1988	Petrie	University of Cambridge	Mamasani	Trace-element analyses via INAA of archaeological ceramics from Mamasani.	NSF Collaborative Research Project
1989	Minc	Oregon State University	Tell Hadidi, Syria	INAA of Late Uruk ceramic containers.	NSF Collaborative Research Project
1990	Townsend	Oregon State University	Hop irradiation	The induction of genetic mutations in hop (Humulus lupulus L.) will be attempted using radiation treatment. Generated stable mutations may lead to new hop varieties and assist with genetic research.	OSU Crop and Soil Science
1991	Enjelmann	University of Cincinnati	Fission Track Dating	Apatite fission track dating, study of Yukon and southeastern Alaska geological evolution.	University of Cincinnati
1992	Castonguay	University of Oregon	Structure of Amargosa Chaos	INAA of samples from mineralized fault zone, Virgin Spring Phase of the Amargosa Chaos, Southern Death Valley, California.	
1993	Goldfinger	Oregon State University	Sedementary deposits relted to earthquake hazards	Trace-element analysis of sedimentary deposits left by 2004 Sumatra-Andaman earthquake to determine details about the earthqueake rupture.	OSU COAS
1994	Zhu	Najing University	Apatite Fission Track	Apatite Fission track for Durango samples.	Nanjing University
1995	Camacho	University of Manitoba	Ar/Ar dating	Production of Ar-39 from K-39 to determine radiometric ages of geological materials.	University of Manitoba
1996	Pahle	Kinetic Force Inc	Shielding Evaluation	Material shielding evaluation.	
1999	Wishart	Oregon State University	Shale and Flowback Ambient Pressure/ Temperature Microcosm Incubations	This project is studying the interactions between microorganisms that inhabit flowback fluid from hydraulic fracturing and Marcellus shale samples obtained from the subsurface. The shale samples are being irradiated to remove microbial contamination without altering the chemical or mineralogical composition of the shale.	
2000	Kaspar	Alternative Nutrition LLC	Contamination detection in Taurine	Look for contamination in Taurine that was shipped from Japan.	
2001	Derrick	Branch Engineering	Densitometer Leak Test	Wip counts for leak test of densitometer sources.	Branch Engineering
2002	Sosa	Universidad de Granada	Iridium in Soil Samples	Epithermal INAA to determine Ir content in soils at the K-T boundary.	

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
2003	Paul	Oregon State University	Effect of gamma irratiation on mass transport and mech prop of polyacrylonitrile copolymer membrane	The membrane (polyacrylonitrile or PAN) which I am going to irradiate is used in kidney dialyzer. At present Medical agencies use ETO to sterilize the membrane. The other technique to sterilize is by using gamma irradiation. Recently some researchers used low dosage of gamma irradiation to cross link this membrane with other organic compound which makes membrane biocompatible and repel protein to make it more effective in blood purification. So our research question is whether we can both sterilize and graft the organic compound I n the membrane at the same time? Therefore I would be test the membrane for its mass transfer and mechanical properties for our research objective.	OSU Industrial & Manufacturing Engineering
2004	Sudo	University of Postdam	Ar/Ar Geochronological Studies	Ar/Ar dating of natural rocks and minerals for geological studies.	
2005	Stewart-Smith		Radon Daugheter Detection	Determination of radon concentration from daughter products from samples collected around Oregon.	
2006	Van Tassel	The Land Institute	Silphium mutagenesis	Silphium integrifolium is a native, perennial prairie plant with potential as a new source of vegetable oil. We have begun making selections using natural variation, but would also like to induce mutations in this species as a sourve new genetic variation such as dwarfing, early flowering, reduced seed dormancy, reduced seed shattering, reduced branching, etc.	The Land
2007	Wartho	Arizona State University	Argon-Argon Geochronology	Fast neutron irradiation of mineral and rock samples for 40 Ar/39Ar dating purposes.	Arizona State University
2008	Pahle	Kinetic Force Inc	Shiled Testing	Material evaluation for use in shielding different types radioactive elements.	Kinetic Force
2009	Chen	Zhejiang University	Durango apatite fission track	Fission track apatite irradiation.	Zhejiang University
2010	Helena Hollanda	University of Sao Paulo	Ar/Ar Geological Dating	Ar/Ar geologic dating of materials.	University of Sao Paulo
2011	Minc	Oregon State University	INAA of Archaeological Ceramics from Jalieza, Oaxaca	Trace-element analyses of ancient ceramics and clays from Jalieza, Oaxaca to examine ceramic techology and trade.	N/A
2012	Berg	University of Washington	Debromination during Organic Matter Degradation in the Deep Biosphere	INAA of deep sea organic samples to determing Br content.	University of Washington
2013	Farmer	Rainier Farmer	Decommissioning Surveys	Detector use for decommissioning surveys.	Rainier Farmer

Table VI.2 (continued)
Listing of Major Research and Service Projects Preformed or in Progress at the Radiation Center and Their Funding Agencies

Project	Users	Organization Name	Project Title	Description	Funding
2014	Leonard	Oregon State University	Barley Irradiation	Barley irradiation to determine growth potential.	OSU Crop and Soil Science
2015	Matosevic	Akron Biotech	Investigation of irradiation on biological activity of human plasma-derived fibronectin.	A solution of purified fibronectin in PBS and lyophilized powder sampe of fibronectin will be irradiated and the activity tested.	Akron Biotech
2016	Schilke	Chemical, Biological & Environmental Engineering	TCVS Silanization for EGAP coating	Si02 surfaces were silanized (vapor deposition) with TCVS to create double bonds on surface. The surface is incubated in Polyethylene triblocks, once gamma irradiated it will bind the triblocks to the surface.	OSU Chemical Engineering
2018	Kent	Oregon State University	Gamma Irradiation of Zebra Fish	Gamma irradiation of zebra fish to induce specific growth.	

Figure VI.1
Summary of the Types of Radiological Instrumentation Calibrated to Support the OSU TRIGA Reactor and Radiation Center

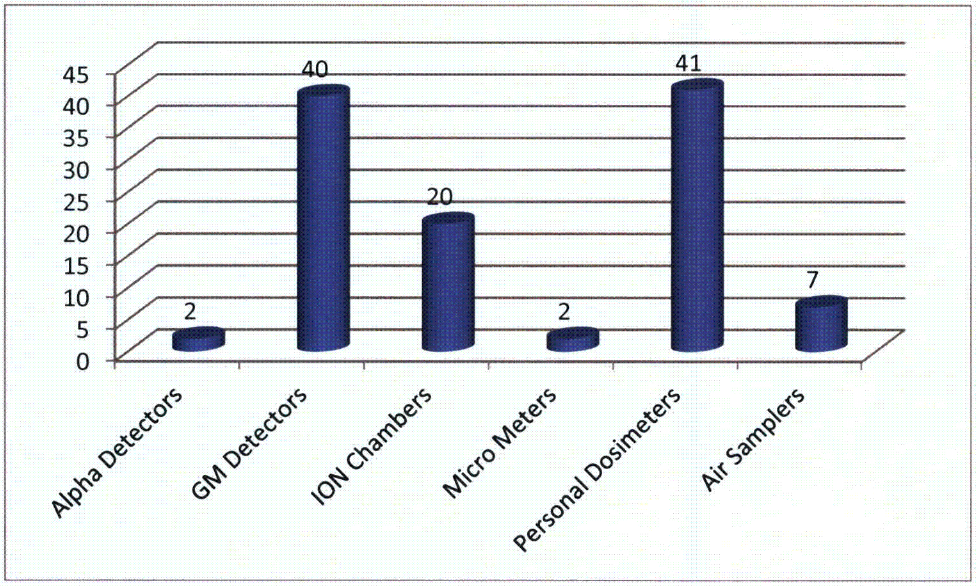


Table VI.3
Summary of Radiological Instrumentation Calibrated to Support OSU Departments

OSUDepartment	Number of Calibrations
Animal Science	2
Biochem/Biophysics	2
Botany	5
Chemistry	1
Civil and Construction Engineering	2
COAS	2
Environmental & Molecular Toxicology	3
Environmental Engineering	1
Linus Pauling Institute	2
Microbiology	2
Nutrition & Exercise Science	3
Pharmacy	2
Physics	5
Radiation Safety Office	34
Veterinary Medicine	9
Total	**75**

Table VI.4
Summary of Radiological Instrumentation Calibrated to Support Other Agencies

Agency	Number of Calibrations
Branch Engineering	1
CH2MHill	2
Doug Evans, DVM	2
ESCO Corporation	4
Fire Marshall/Hazmat	58
Gene Tools	3
Grand Ronde Hospital	5
Health Division	119
Hollingsworth & Vose	1
Knife River	2
Newport Fire	2
Occupational Health Lab	7
ODOE	4
ODOT	11
Oregon Health and Sciences University	33
PSU	16
Samaritan Health	43
Siga Technologies	1
Silverton Hospital	5
USDOT/FAA	3
Weyerhaeuser	1
Total	**323**

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Staff, R A., T. Nakagawa, G. Schlolaut, M.H. Marshall, A. Brauer, H.F. Lamb, C.B. Ramsey, C.L. Bryant, Fiona Brock, H. Kitagawa, J. Van der Plicht, R.L. Payne, V.C. Smith, D.F. Mark, A. MacLeod, S.P.E. Blockley, J.L. Schwenninger, P.E. Tarasov, T. Haraguchi, K. Gotanda, H. Yonenobu and Y. Yokoyama. "The Multiple Chronological Techniques Applied to the Lake Suigetsu SG06 Sediment Core, Central Japan." Boreas (2013): 10.1111/j.1502-3885.2012.00278.x.

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Tate G. W., N. McQuarrie, D.J.J. Hinsbergen, R.R. Bakker, R. Harris, S. Willett, P.W. Reiners, M.G. Fellin, M. Ganerød and J.W. Zachariasse. "Resolving Spatial Heterogeneities in Exhumation and Surface Uplift in Timor-Leste: Constraints on Deformation Processes in Young Orogens." Tectonics, 33 (2014): 1089–1112, doi:10.1002/2013TC003436.

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Presentations

Alden, John. "People, Potters, or Pots: the Transmission of Stylistically Similar Ceramics in the Late Uruk." 79th Annual Meeting of the Society for American Archaeology (SAA), Austin, Texas, April 27, 2014.

Algaze, Guillermo. "Discussant." Symposium: Trade And Ceramics In The Uruk Expansion: Recent Insights From Archaeometric Analyses, at the Society for American Archaeology annual meetings, Austin, TX, April, 2014.

Alizadeh, Abbas , John Alden and Leah Minc. "Testing the Evidence: A Follow-up Study of Late Uruk and Proto-Elamite Ceramics from Tall-e Geser, Iran." 79th Annual Meeting of the Society for American Archaeology (SAA), Austin, TX, April 27, 2014.

Balestrieri, M.L., V. Olivetti, F.S. Stuart and S.N. Thomson. "Timing of Shortening-Extension Pair Migration and Topographic Evolution in the Catena Costiera and Sila Massif, Southern Italy." 14th International Conference on Thermochronology (Thermo2014), Chamonix, France, Abstract Accepted, 2014.

Beard, S. P. , D. A. Kring, C. E. Isachsen, T. J. Lapen, M.E. Zolensky and T. D. Swindle. "Ar-Ar Analysis of Chelyabinsk: Evidence for a Recent Impact." Lunar Planet. Sci. Conf. XLV, Abstract #1807, 2014.

Castelluccio A., B. Andreucci, L. Jankowski, R.A. Ketcham, S. Mazzoli, R. Szaniawski and M. Zattin. "Coupling Low-Temperature Thermochronometry and Sequential Restoration of Balanced Cross-Sections: New Constraints on the Tectonic Evolution of the Western Carpathians (Poland, Slovakia and Ukraine)." GSA Annual Meeting, Denver, October 27-30, 2013.

Coblyn, M., K. Heintz, K.F. Schilke, J. Snider, M. Truong, G. Jovanovic, W.-K. Lee and J. McGuire, BMES Annual Meeting, Seattle, WA. 2013.

Emberling, G. and L.D. Minc. "Ceramics and Trade within Mesopotamia during the Uruk Expansion." 79th Annual Meeting, Society for American Archaeology, Austin, TX, April 27, 2014.

Falkowski, S., J. Pfänder, K. Drost and E. Enkelmann. "Cooling History and Provenance of Cobbles from the Seward-Malaspina Glacier, SE Alaska." 14th International Conference on Thermochronology, Chamonix, France, September 8–12, 2014.

Farsoni, A.T., B. Alemayehu, L. Ranjbar and E.M. Becker. "Real-time Radioxenon Measurements with a Well-Type Phoswich Detector." The IEEE Nuclear Science Symposium, Seoul, South Korea, Oct. 26- Nov. 2, 2013.

Fosdick, J.C., B. Carrapa. "Synchronous Unroofing and Faulting in the Precordillera of Argentina: Thermochronometric Constraints on Fault-Propagation in a Thin- to Thick-Skinned Orogenic System." American Geophysical Union meeting, San Francisco, Abstract 1803286, 2013.

Herman, Frédéric, Diane Seward, Andrew Carter, Barry Kohn, Todd Ehlers. "The Impact of Glaciation on Mountain Topography and Erosion." EGU General Assembly, Vienna, Austria, 2013: id. EGU2013-11289.

Julián Esteban, José, José María Tubía, Julia Cuevas, Diane Seward, Alexander Larionov, Sergey Sergeev and Francisco Navarro-Vilá. "New approach to Date the Extensional Tectonics in the Betic Chain (Spain)." EGU General Assembly, Vienna, Austria, 2013: id. EGU2013-8100.

Kring, D. A. , T. D. Swindle and M. E. Zolensky. "Meteoritic and Geologic Context of the Chelyabinsk Near-Earth Asteroid Air Burst." American Geophysical Union Fall Meeting, San Francisco, NH21D-01, 2013.

McCaulay, Euan. "The Orogenic Evolution of the Central Kyrgz Tien Shan." Doctoral Dissertation.

Mazzoli, S., A. Castelluccio, B. Andreucci, D. Grigo, L. Jankowski, R. Szaniawski anf M. Zattin. "Tectonic Evolution of the Western Carpathians Thrust Belt–Foreland Basin System: New Structural and Thermochronometric Constraints." GSA Annual Meeting, Denver, October 27-30, 2013.

Minc, L.D. "Stepping into Some Pretty Big Shoes: Following in the Tradition of Jim Blackman in the Ancient Near East." Symposium in honor of M. James Blackman, ANS Annual Meetings, Washington, DC, November 13, 2013.

Minc, L.D. "Trace-Element Analyses of Near Eastern Ceramics: Overview and Introduction." 79th Annual Meeting, Society for American Archaeology, Austin, TX, April 27, 2014.

Minc, L.D. and J.W. Pink. "INAA in the Service of Archaeometry: Mapping Out Ancient Pottery Production and Exchange in the Valley of Oaxaca, Mexico." Symposium on Nuclear Chemistry, 68th American Chemical Society Northwest Regional Meeting, Corvallis, OR, July 22, 2013.

Mohd Faiz Hassim, B. Carrapa and P. Kapp. "Detrital Geochemical Fingerprints Of Rivers Along The Yalu Suture Zone In Tibet: Implications For Drainage Evolution, Timing Of Arc Development And Erosion." American Geophysical Union meeting, San Francisco, Abstract 1810798, 2013.

Murray, K.E., P.W. Reiners and S.N. Thomson. "Oligocene Laccoliths on the Colorado Plateau: A Key to Understanding Cenozoic Cooling and Denudation." Eos Transactions AGU, AGU Fall Meeting, Abstract Accepted, 2014.

Mutin, Benjamin. "Uruk Presence at Tepe Yahya." Symposium: Trade And Ceramics In The Uruk Expansion: Recent Insights From Archaeometric Analyses, at the Society for American Archaeology annual meetings, Austin, TX, April, 2014.

Painter, C.S., B. Carrapa, P.G. DeCelles, G.E. Gehrels and S.N. Thomson. "From Source to Sink: Exhumation of the North America Cordillera Revealed by Multi-dating of Detrital Minerals from Upper Jurassic–Upper Cretaceous Sevier Foreland Basin." American Geophysical Union meeting, San Francisco, Abstract 1808582, 2013.

Piestrzeniewicz, A., E. Enkelmann and S. Falkowski. "Spatial and Temporal Constraints of Rapid Exhumation in the St. Elias Syntaxis, Southeast Alaska and Southwest Yukon." 14th International Conference on Thermochronology, Chamonix, France, September 8–12, 2014.

Sagar, M. W., D. Seward, M. Heizler, J.M. Palin, V.G. Toy and A.J. Tulloch. "Thermochronology of Mid-Cretaceous Dioritic Granulites Adjacent "Big Bend" in Australia-Pacific Plate Boundary, Northern South Island, New Zealand, T31C-2618." AGU, San Fransisco, December, 2013.

Schultz, M., K.V. Hodges, M.C. van Soest and J-AWartho. "Thermochronologic Constraints on the Miocene Slip History of the South Tibetan Detachment System in the Everest Region, Central Himalaya." American Geophysical Union conference, abstract, 2014.

Snider, J., M. Ryder, J. McGuire and K.F. Schilke. AIChE Annual Meeting, San Francisco, CA. 2013.

Sobel, E. R., A. Bande, A. Mikolaichuk. "Kinematic Link Between Late Oligocene - Miocene Deformation in the Northern Pamir and the Western Tien Shan." 15t Symposium on Tectonics, Structural Geology and Geology of Crystalline Rocks. Potsdam, Germany, March 31-April 4, 2014.

Sobel, E. R., A. Bande, R. Thiede, A. Mikolaichuk, E. Macaulay and C. Jie. "Thermochronologic Evidence of a Late Miocene-Pliocene Change in Pamir Deformation Style." 14th International Conference on Thermochronology, Chamonix, France, September 8-12, 2014.

Stevens, A., E. Balgord, B. Carrapa and J. Restrepo. "Utility of Statistical Methods and Data Presentation in Detrital Fission Track Thermochronology." Geological Society of America, Abstracts with Programs, v. 45, no. 7, p.744, Denver, 2013.

Tang, D.L.K., D. Seward, A. Carter, C.J.N. Wilson and R.J. Sewell. "Thermo-Tectonic History of Southeast China Since the Late Mesozoic: Insights from Detailed Thermochronological Studies of Hong Kong." Geosciences Conference, Abstracts, Christchurch, New Zealand. Geoscience Society of New Zealand Miscellaneous Publication, 136A (2013): p. 92. Reid, C.M and A. Wandres, eds.

Thomson, S.N., P.W. Reiners and G.E. Gehrels. "Multi-Dating Single Detrital Mineral Grains (U-Pb, (U-Th)/He, and Fission Track): A Key to Reconstructing East Antarctic Subglacial Landscape Evolution." Eos Transactions AGU, AGU Fall Meeting, Abstract Accepted, 2014.

Veselovskiy, R., A. Arzamastsev and S.N. Thomson. "Paleomagnetic and Geochronological Studies of the KOLA Devonian Alkaline Province (Kola Peninsula, Russia) and Their Geological Implication." Eos Transactions AGU, AGU Fall Meeting, Abstract Accepted, 2014.

Wang, Shuwen. "Fine-mapping of the major perenniality gene in perennial wheat." The Land Institute.

Wang, Shuwen. "Fine-mapping of the major perenniality gene in perennial wheat." New Roots for the Ecological Intensification- International Workshop, October, 2014.

Wang, X. X., M. Zattin, C.H. Song and J.J. Li. "Cenozoic Exhumation History of Northeast Tibet Reconstructed from the Fission-Track Thermochronology of the Guide-Xining basins." Thermo, 2014.

Warren-Smith, E., D. Seward and S. Lamb. "Constraints on the Erosion and Uplift History of the Southern Lakes Region from Apatite and Zircon Fission-Track Ages." Geosciences Conference, Abstracts, Christchurch, New Zealand. Geoscience Society of New Zealand Miscellaneous Publication 136A (2013): 92. Reid, C.M and A. Wandres, eds.

Wright, Henry. "Production, Exchange, and Consumption in the Uruk World." Symposium: Trade And Ceramics In The Uruk Expansion: Recent Insights From Archaeometric Analyses, at the Society for American Archaeology annual meetings, Austin, TX, April, 2014.

Wu, X., M.P. Ryder, J. McGuire and K.F. Schilke. AIChE Annual Meeting, San Francisco, CA. 2013.

Wu, X., M.P. Ryder, M.C. Lampi, K.F. Schilke and J. McGuire. BMES Annual Meeting. Seattle, WA., 2013.

Zattin, M., D. Pace, B. Andreucci, F. Rossetti and F.M. Talarico. "Thermochronological Evidence for Cenozoic Segmentation of Transantarctic Mountains." AGU Fall Meeting, San Francisco, December 9-13, 2013.

Zhou, R., L.M. Schoenbohm, E.R. Sobel, D.F. Stockli and J. Glodny. "Cooling History for the Sierra Laguna Blanca (NW Argentina) on the Southern Puna Plateau, Central Andes." AGU fall meeting, December, 2014.

Students

Alemayehu, Bemnet. "Real-Time Radioxenon Measurement using a Compton-Suppressed Well-Type Phoswich Detector for Nuclear Explosion Monitoring." PhD, 2013. Advisor: Dr. Abi T. Farsoni.

Arkle, Jenny. Thesis: "Linking Geodynamics and Traversing Timescales: Orogenesis in the Southeast Caribbean Pate Corner." PhD candidate, expected graduation 2016. University of Cincinnati. Advisor: Lewis Owen.

Auxier, Julie. MS. Advisor: Schilke, Karl.

Bande, Alejandro. "Constraining Deformation History of the Talas-Fergana Strike-Slip Fault and Kinematically-Linked Thrust Faults, Kyrgyz Republic." Doctorate expected 2015. Advisor: apl. Prof. E. Sobel.

Beard, Sky P. PHD. Advisor: T. D. Swindle.

Berg, Rick. Master's Thesis: "Rates and Significance of Debromination in the Deep Subseafloor Biosphere." PhD student. University of Washington. Advisor: Dr. Evan A. Solomon.

Borneman, Nathaniel. Thesis: "Age and Structure of the Shyok and Yarlung Tsangpo Suture Zones." Irradiated samples are related to two projects: 1) The age and structure of the Shyok suture zone of Ladakh and (internally funded at ASU), and 2) the timing of bluechist facies metamorphism withing the Yarlung Tsangpo suture zone (NSF grant). PhD student. Advisor: Kip Hodges.

Castelluccio, Ada. "Thermo-Tectonic Evolution of the Carpathian Chain." PhD project. University of Padova. Advisor: Prof. Massimiliano Zattin.

Cattò, Silvia. "Tectonic Evolution of the Holy Cross Mountains (Poland)." MSc thesis. University of Padova. Advisor: Prof. Massimiliano Zattin.

Deeken, Anke. "Long-Term Erosion and Exhumation Rates Across Different Climatic Zones in the Indian NW Himalaya." Doctorate expected 2015. Potsdam University. Advisor: Prof. M. Strecker.

Dill, Justen. MS. Advisor: Schilke, Karl.

Falkowski, Sarah. Thesis: "Exhumation History of the St. Elias Mountain Range Using Thermochronology Data." PhD candidate, expected graduation summer 2015. University of Tuebingen, Germany. Advisor: Eva Enkelmann.

Heintz, Keely. MS. Advisor: Schilke, Karl.

Lampi, Marsha. UHC BS. Advisor: Schilke, Karl.

Mercer, Cameron. Thesis: "Laser Microprobe 40Ar/39Ar Geochronology of Apollo 16 and 17 Impact Melt Breccias." Current samples being irradiated for two projects: 1) Apollo 17 samples are for a NASA Lunar Advanced Science and Exploration Research (LASER) grant (PI's - Kip Hodges and Brad Jolliff), and 2) Apollo 16 samples for Camerons NASA Earth and Space Science Fellowship (NESSF) grant. PhD student. Advisor: Kip Hodges.

Mittiga, Francesco. "Exhumational History of South-Western Turkey." PhD. University of Bologna, Italy. Advisor: William Cavazza.

Murray, Kendra. Project: "Low-Temperature Thermochronology from Laccolith Aureoles Constrains Late Cenozoic Exhumation in the North-Central Colorado Plateau." PhD student. University of Arizona. Advisor: Peter Reiners.

Pace, Donato. "Sedimentary Provenance in the Victoria Land Basin (Antarctica)." PhD project. University of Siena. Advisor: Prof. Franco Talarico.

Painter, Clay. Thesis: "Thermochronology of Upper Cretaceous and Paleocene Deposits in the Central Cordilleran Foreland Basin." MS student. University of Arizona. Advisor: Barbara Carrapa.

Painter, Clayton. Project: "Sequence Stratigraphy, geodynamics, and detrital geothermochronology of Cretaceous foreland basin deposits, Western Interior U.S.A." PhD, 2013. Geosciences, UA. Advisor: B. Carrapa.

Piestrzeniewicz, Adam. Thesis: "Spatial and Temporal Constraints of Rock Exhumation in Southeast Alaska and Western Yukon." MS student, expected graduation spring 2015. University of Cincinnati. Advisor: Eva Enkelmann.

Pink, Jeremias. Thesis: "Rural Ceramic Production, Consumption, and Exchange in Late Classic Oaxaca, Mexico: A View from Yaasuchi." MA in Anthropology, 2014. Accepted into PhD program at OSU. Advisor: Leah Minc.

Rong, Yang. "Incising Tibet." PhD. ETH Zurich, Switzerland. Advisors: Sean Willett, ETH Zurich, Switzerland and Frederic Herman, Universiy of Lausanne, Switzerland.

Ryder, Matthew. "Binding of Bacterial Lipopolysaccharide by the Cationic Amphiphilic Peptide WLBU2 at Interfaces." PhD, CHE, 2014. Advisors: Joe McGuire and Karl Schilke.

Schultz, Mary. Thesis: "Exploring the Variability in Late Cenozoic Exhumation Rates across the Himalayan Rain Shadow." PhD student. Advisor: Kip Hodges.

Schyder, Marc. "Laser Abaltion Fission-Track Dating as a Tool to Date Apatites with Low U-Content and a Case Study: the Simplon." MS. ETH Zurich, Switzerland. Advisors: M. Giuditta Fellin and Olivier Bachman.

Sichamba, Kennedy. Thesis: "Potential for Utilizing Western Juniper (Juniperus Occidentalis) Biomass for Oil Extraction and as a Fermentation Medium." MS, 2013. Co-Advisors: S. Leavengood and Jeff Morrell.

Snider, Joshua. "Characterization and Application of PEO-Containing Triblock Copolymer Surfactants." HBS, BIOE, 2013. Advisors: Joe McGuire and Karl Schilke.

Stalder, Nadja. "Provenance Analysis of the Laga Formation (Messinian, Central Apennines)." MS. ETH Zurich, Switzerland. Advisors: M. Giuditta Fellin and Wilfired Winkler.

Taylor, Bridget. Project: "The Bias of Sample Preparation in Detrital Fission-Track Dating." BS student. University of Cincinnati. Advisor: Eva Enkelmann.

Walker, Sarah. MA in progress. Advisor: Leah Minc.

Wu, Xiangmin. PhD. Advisor: Schilke, Karl.

Xiangming, Wu. "Molecular Origins of Peptide Entrapment in Polyethylene Oxide Layers." PhD, CHE, 2014. Advisors: Joe McGuire and Karl Schilke.

Zhou, Renjie. "Cenozoic Deformation of the Southern Puna Plateau (Central Andes)." PhD expected 2015. University of Toronto Mississauga. Advisor: Prof. L. Schoenbohm.

Oregon State University Radiation Center, 100 Radiation Center, Corvallis, OR 96331

www.radiationcenter.oregonstate.edu