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October 6, 2016

U.S. Nuclear Regulatory Commission
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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, 2015 through June 30, 2016.

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: 10/6/16

Sincerely,

Steven R. Reese
Director

Cc: Michael Balazik, USNRC
Craig Bassett, USNRC
Ken Niles, ODOE
Dr. Cynthia Sagers, OSU
Dr. Roy Haggerty, OSU
Dan Harlan, OSU

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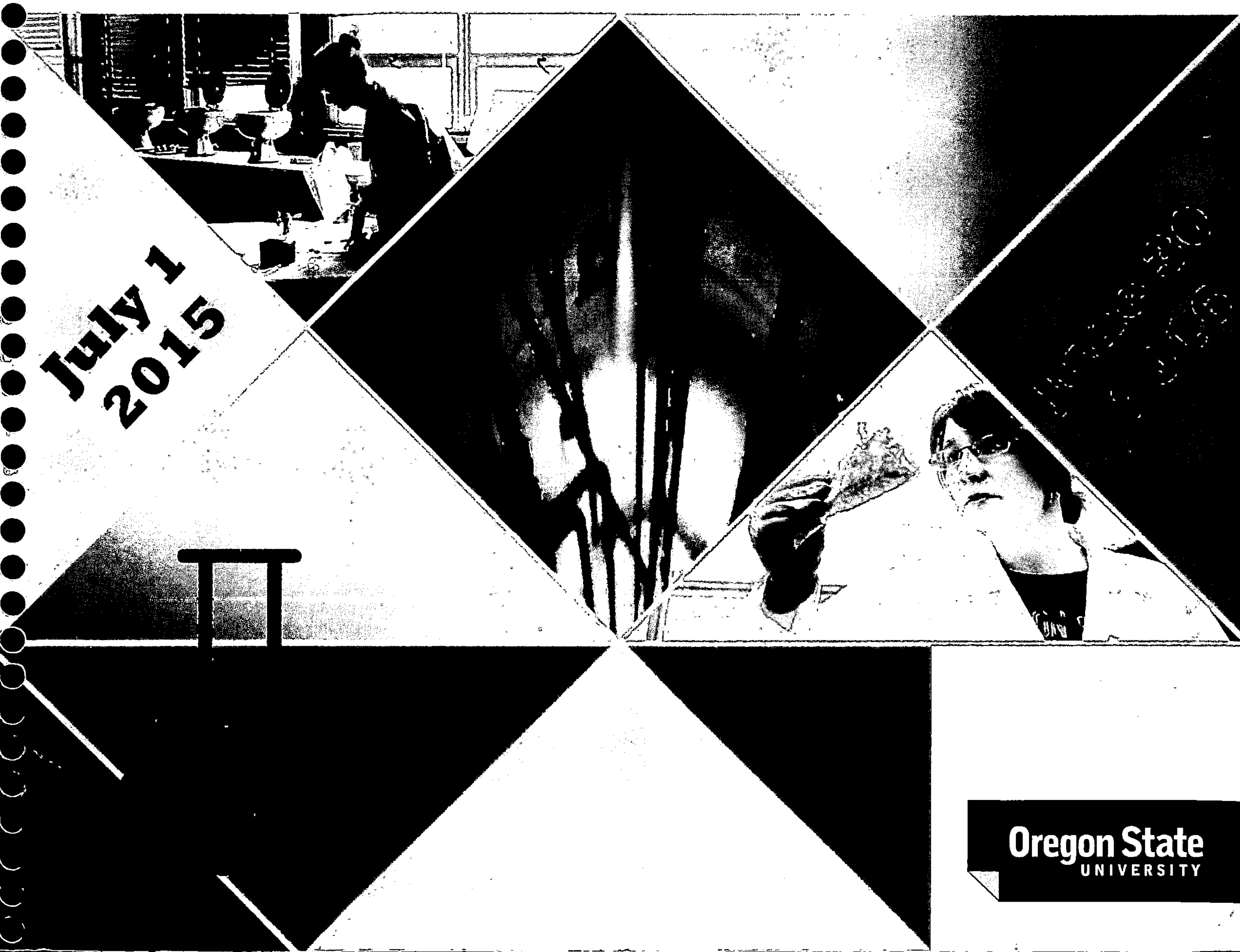
NRR

Radiation Center and TRIGA Report Annual Report



Oregon State
UNIVERSITY

Submitted by:
Steve R. Reese, Director

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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.

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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 67 different courses this year, mostly in the Department of Nuclear Engineering and Radiation Health Physics. About 28% of these courses involved the OSTR. The number of OSTR hours used for academic courses and training was 21, while 3,330 hours were used for research projects. Seventy-three percent (73%) 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 51 articles this year, and made 48 presentations on work that involved the OSTR or Radiation Center. The number of samples irradiated in the reactor during this reporting period was 1,558. Funded OSTR use hours comprised 86% of the research use.

Personnel at the Radiation Center conducted 154 tours of the facility, accommodating 1,883 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 157. Reactor related projects comprised 74% of all projects. The total research dollars in some way supported by the Radiation Center, as reported by our researchers, was $11.3 million. The actual total is likely considerably higher. This year the Radiation Center provided service to 53 different organizations/institutions, 32% of which were from other states and 47% 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, 2015 through June 30, 2016. 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

Tara DiSante, Business Manager

Brittany Combs, Receptionist

S. Todd Keller, Reactor Administrator

Celia Oney, Reactor Supervisor, Senior Reactor Operator

Robert Schickler, Reactor Engineer, Senior Reactor Operator

Scott Menn, Senior Health Physicist

Jim Darrough, Health Physicist

Leah Minc, Neutron Activation Analysis Manager

Steve Smith, Development Engineer, Senior Reactor Operator

Chris Kulah, Reactor Operator

Erin Cimbri, Custodian

Joshua Graves, Reactor Operator (Student)

Trevor Howard, Reactor Operator (Student)

Griffen Latimer, Reactor Operator (Student)

Quinn Miller, Health Physics Monitor (Student)

Shara Howard, Health Physics Monitor (Student)

Kien Tran, Health Physics Monitor (Student)

Sophia Uchiyama, Health Physics Monitor (Student)

Reactor Operations Committee

Andrew Klein, Chair
OSU Nuclear Engineering and Radiation Health Physics

Dan Harlan
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

Celia Oney *(not voting)*
OSU Radiation Center

Julie Tucker
OSU Mechanical, Industrial and Manufacturing Engineering

Haori Yang
OSU Nuclear Engineering and Radiation Health Physics

Professional and Research Faculty

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

John DeNoma
Research Assistant

****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

Camille Palmer
Research Faculty and Instructor

****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

Tack, Krystina
Assistant Professor, Medical Physics Program Director

****Celia Oney***
Reactor Supervisor, Radiation Center

Aaron Weiss
Faculty Research Assistant

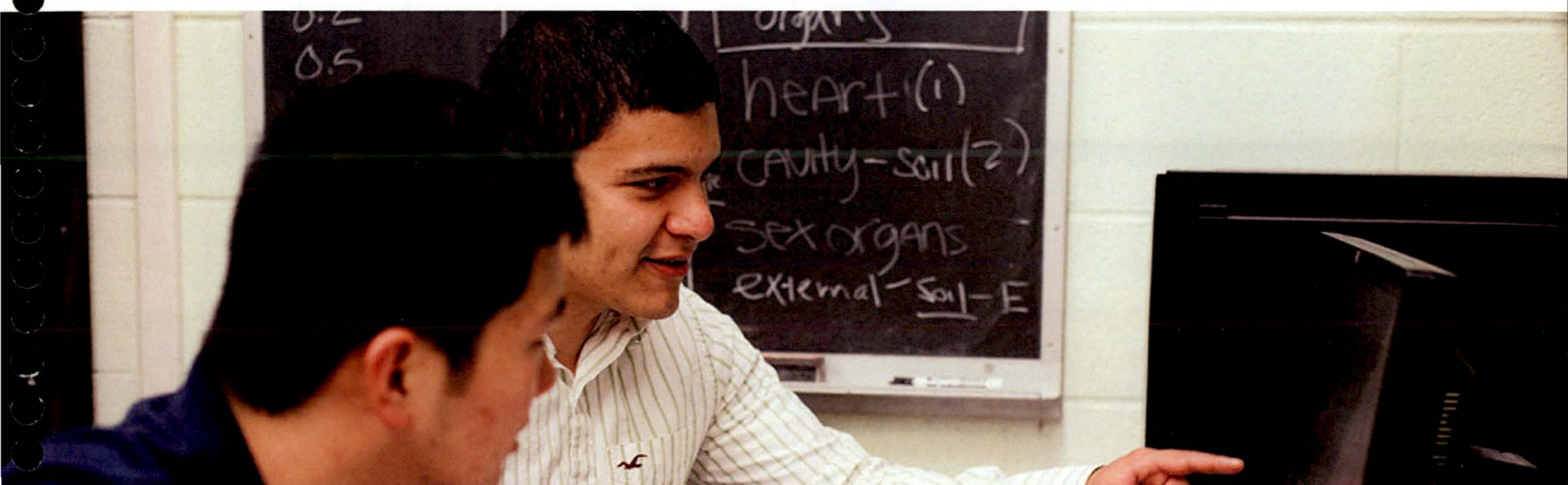
Woods, Brian
Professor, Nuclear Engineering and Radiation Health Physics

Wu, Qiao
Professor, Nuclear Engineer and Radiation Health Physics

Yanez, Ricardo
Faculty Research Associate, Chemistry

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

**OSTR users for research and/or teaching*



Facilities

Research Reactor

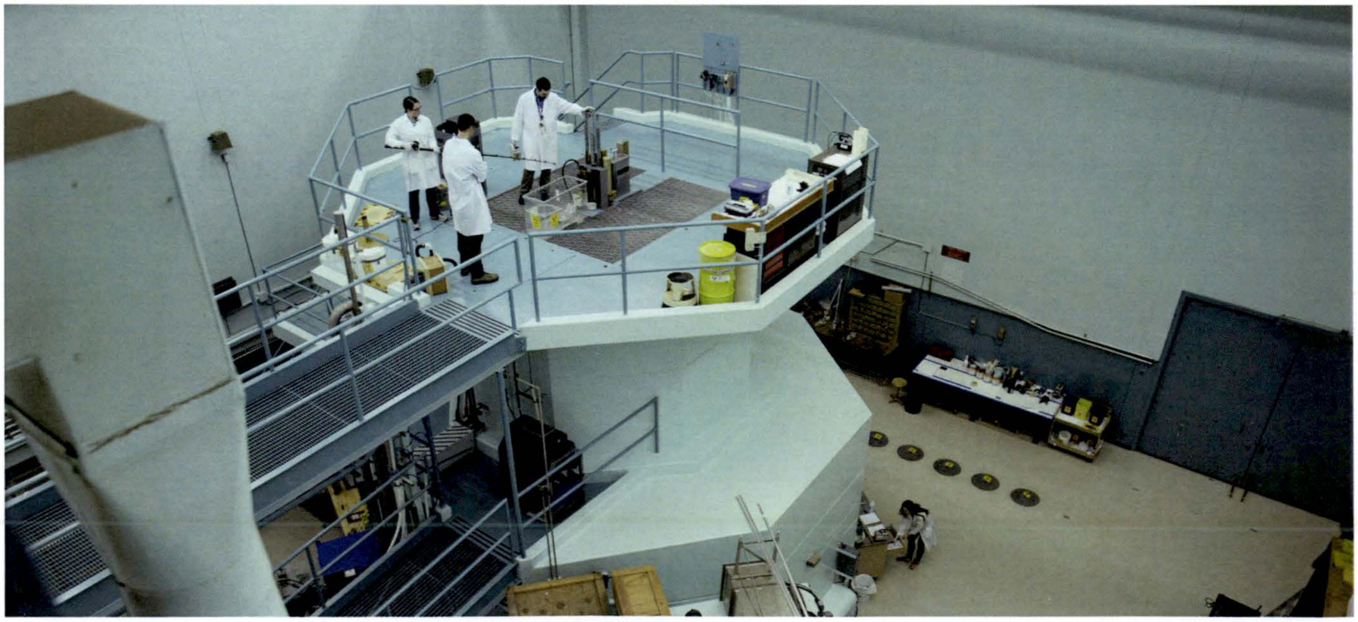
The Oregon State University TRIGA Reactor (OSTR) is a water-cooled, swimming pool type research reactor which uses uranium/zirconium hydride fuel elements in a circular grid array. The reactor core is surrounded by a ring of graphite which serves to reflect neutrons back into the core. The core is situated 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 10,200 curie (as of June, 2015) 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, soil, polymers, nanofibers, carbon filter	$1.5x10^6$ to $3.0x10^6$	15	50
Material Evaluation	silicon polymers, polymers	$3.0x10^5$ to $3.0x10^5$	17	7
Botanical Studies	pollen, hops, barley	$2.0x10^2$ to $1.2x10^4$	17	0.09
Other	sludge	$4.6x10^7$ to $4.6x10^7$	1	66
Totals			50	123.09

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 2015	Fall 2015	Winter 2016	Spring 2016
NE/RHP 114*	2	Introduction to Nuclear Engineering and Radiation Health Physics		50		
NE/RHP 115	2	Introduction to Nuclear Engineering and Radiation Health Physics			63	
NE/ RHP 234	4	Nuclear and Radiation Physics I		60		
NE/ RHP 235	4	Nuclear and Radiation Physics II			60	
NE/ RHP 236*	4	Nuclear Radiation Detection & Instrumentation				55
NE 311	4	Intro to Thermal Fluids	8	23	16	
NE 312	4	Thermodynamics			15	18
NE 319	3	Societal Aspects of Nuclear technology			80	
NE 331	4	Intro to Fluid Mechanics			19	13
NE 332	4	Heat Transfer	14	7		13
NE/RHP 333	3	Mathematical methods for NE/RHP				65
NE/RHP/MP 401/501/601	1-16	Research	2	22	18	22
NE/RHP/MP 405/505/605	1-16	Reading and Conference			22	1
NE/RHP/MP 406/506/606	1-16	Projects				
NE/RHP/MP 407/507/607	1	Nuclear Engineering Seminar		76	65	76
NE/ RHP/MP 410/510/610	1-12	Internship	1			1
NE/ RHP 415/515	2	Nuclear Rules and Regulations		44		
NE 451/551	4	Neutronic Analysis		57		
NE 452/552	4	Neutronic Analysis			58	
NE 455/555**	3	Reactor Operator Training I				
NE 456/556**	3	Reactor Operator Training II				
NE 457/557**	3	Neuclear Reactor Lab				59
NE 467/567	4	Nuclear Reactor Thermal Hydraulics		42		
NE 667	4	Nuclear Reactor Thermal Hydraulics				12
NE/RHP 435/535	3	External Dosimetry & Radiation Shielding				54
NE 565	3	Applied Thermal Hydraulics			9	
NE 473/573	3	Nuclear Reactor Systems Analysis		29		

Table III.2 (continued)

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

			Number of Students			
Course #	CREDIT	COURSE TITLE	Summer 2015	Fall 2015	Winter 2016	Spring 2016
NE/RHP 474/574	4	Nuclear System Design I			50	
NE/RHP 475/575	4	Nuclear System Design II				49
NE/RHP 479*	1-4	Individual Design Project				
NE/RHP 481*	4	Radiation Protection		32		
NE/RHP 582*	4	Applied Radiation Safety			6	
RHP 483/583	4	Radiation Biology			14	
RHP 488/588*	3	Radioecology		8		
NE/RHP 590	4	Internal Dosimetry			5	
NE/RHP/MP 503/603*	1	Thesis	12	41	43	43
NE/ RHP 516*	4	Radiochemistry			4	
NE 526	3	Numerical Methods for Engineering Analysis		11		
NE/RHP/MP 531	3	Nuclear Physics for Engineers and Scientists		8		
NE/RHP/MP 536*	3	Advanced Radiation Detection & Measurement			8	
NE/RHP 537	3	Digital Spectrometer Design				4
MP 541	3	Diagnostic Imaging Physics				
NE 550	3	Nuclear Medicine				
NE 553	3	Advanced Nuclear Reactor Physics				18
MP 563	4	Applied Medical Physics		4		
NE 468/568	3	Nuclear Reactor Safety			18	
NE/RHP/MP 599		Special Topics	8	27	15	4

Course From Other OSU Departments

CH 233*	5	General Chemistry	89			806
CH 233H*	5	Honors General Chemistry				30
CH 462*	3	Experimental Chemistry II Laboratory			23	
ENGR 111*	3	Engineering Orientation		269		28
ENGR 212H*	3	Honors Engineering				14

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

Reactor

Operating Statistics

During the operating period between July 1, 2015 and June 30, 2016, the reactor produced 1476 MWH of thermal power during its 1566 critical hours.

Experiments Performed

During the current reporting period there were ten 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 LS.
- B-34 Irradiation of Enriched Uranium in the Neutron Radiography Facility.
- B-35 Irradiation of Fissile Materials in the Prompt Gamma Neutron Activation Analysis (PGNAA) Facility.

Of these available experiments, five 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 eleven unplanned reactor shutdowns during the current reporting period. Table IV.5 details these events.

Changes Pursuant to10 CFR 50-59

There was one safety evaluation performed in support of the reactor this year. It was:

15-04, Experiment B-35 Changes Description

Description: This allows for encapsulation requirements for Experiment B-35, "Irradiation of Enriched Uranium in the Prompt Gamma Neutron Activation Analysis Facility," to be modified or waived with permission of the Senior Health Physicist and Reactor Supervisor.

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

15-04, Changes to OSTROPs 2 and 3

Description

Minor updates and grammatical corrections to startup and shutdown checklist procedures.

15-05, Changes to OSTROP 1

Description

Minor updates to the Emergency Operating Procedures for clarity and consistency.

15-06, Stack & Cam Upgrades

Description

Modifies the Reactor Top and Stack Continuous Air Monitors to have a combined Magnahelic gauge and transmitter, new flow control buttons at the pump and in the control room, and a ball valve in the Stack CAM sample line.

15-07, Changes to the Pneumatic Rabbit System

Description

Reverses the changes performed under screen 14-04, returning the system to its previous configuration.

15-08, Changes to OSTROPs 22 and 27

Description

Cancels OSTROP 27 and moves all information in it that is still applicable to OSTROP 22. Additional corrections and updates based on recent changes to the electrical power system.

15-09, Changes to OSTROP 6

Description

Updates staffing requirements so that a Reactor Operator Trainee may be counted as the second person in the facility for minimum staffing if that trainee has approval from the Director, Reactor Administrator, and Reactor Supervisor.

15-10, Changes to OSTROPs 13, 14, and 15

Description

Minor updates and corrections to the Monthly, Quarterly, and Semi-annual Surveillance procedures.

15-11, Changes to RCHPP 1

Description

Minor corrections and clarifications to the Guidelines for the Radiation Protection Program at the OSU Radiation Center.

16-01, Changes to OSTROP 4

Description

Changes the square wave procedure to allow this operation to be performed starting from initial powers of up to 1 kW.

16-02, Changes to RCHPP 5 and 6

Description

Updates and corrections to the procedures for receiving and shipping radioactive materials.

Surveillance and Maintenance

Non-Routine Maintenance

July 2015

- Redid the windings on the ventilation exhaust fan motor following a motor failure.

August 2015

- Replaced bulbs in Safety Rod ON indicator.
- Replaced broken float valve in secondary cooling tower

September 2015

- Replaced the exhaust fan for room D100.
- Installed a new seal on the secondary pump to stop a water leak.

October 2015

- Changed out some capacitors and other small parts in the power supplies for the power channels in the console's left-hand drawer.
- Replaced four connectors in the cables for the Safety Channel.

November 2015

- Replaced the Safety Channel Uncompensated Ion Chamber.
- Installed new Magnahelics on the Stack and CAM (combined flow gauge and transmitter). Also added new flow control switches at the pumps and in the control room.

December 2015

- Replaced the Safety Rod magnet.
- Replaced a broken fan belt on the air compressor in the Heat Exchanger Room.

February 2016

- Put new bearings and connector tubing on the argon exhaust fan.
- Installed a new rabbit blower.

March 2016

- Performed repairs on the ventilation supply fan (new bearings, fan belt, and motor windings).

April 2016

- Replaced the CAM pump motor.
- Repaired the emergency generator due to issues with the fuel injection system.

June 2016

- Applied adhesive to a shroud that had come loose from a bearing on the ventilation exhaust fan.
- Used a waterproof camera to perform a visual inspection of all positions of the rotating rack.

Table IV.1
Present OSTR Operating Statistics

Operational Data For LEU Core	Annual Values (2015/2016)	Cumulative Values
MWH of energy produced	1,476	10,138
MWD of energy produced	61.5	413.3
Grams ^{235}U used	85	581
Number of fuel elements added to (+) or removed(-) from the core	0	90
Number of pulses	25	251
Hours reactor critical	1,566	10,913
Hours at full power (1 MW)	1,477	10,108
Number of startup and shutdown checks	254	1,686
Number of irradiation requests processed	269	1,815
Number of samples irradiated	1,558	13,348

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)	21	13,693
OSU research	887	19,671
Off campus research	2,443	47,466
Facility time	57	7,318
Total Reactor Use Time	3,408	88,148*

* Demonstrations and Preclude Time are no longer tracked. The cumulative hours in this table are the sum of the remaining categories listed.

Table IV.3
OSTR Multiple Use Time

Number of Users	Annual Values (hours)	Cumulative Values (hours)
Two	631	10,011
Three	335	5,203
Four	108	2,752
Five	48	989
Six	15	256
Seven	1	70
Eight	0	3
Total Multiple Use Time	1,138	19,284

Table IV.4
Use of OSTR Reactor Experiments

Experiment Number	Research	Teaching	Facility Use	Total
A-1	2	4	7	13
B-3	230	12	4	246
B-12	1	0	0	1
B-31	0	0	3	3
B-35	6	0	0	6
Total	239	16	14	269

Table IV.5
Unplanned Reactor Shutdowns and Scrams

Type of Event	Number of Occurrences	Cause of Event
Mannual	2	Dropped safety rod
Mannual	1	Transient rod low air pressure
Manual	1	CAM Particulate high activity
Period	1	Operator error in square wave set-up
Period	2	Noise on fission chamber during startup
Safety channel high power	2	Operator error during startup
Safety channel high power	1	Discrepancy between safety and linear readings at full power
Safety channel high power	1	Fluctuation due to noise on channel

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

OSTROP 13, Rev. LEU-5 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		HIGH:________INCHES LOW: ________INCHES ANN:____________					
2	BULK WATER TEMPERATURE ALARM CHECK	FUNCTIONAL		Tested @______					
3A	CHANNEL TEST OF STACK CAM GAS CHANNEL	$8.5x10^4 \pm$ 8500 cpm	Ann.?	___cpm	___Ann.				
3B	CHANNEL TEST OF STACK CAM PARTICULATE CHANNEL	$8.5x10^4 \pm$ 8500 cpm	Ann.?	___cpm	___Ann.				
3C	CHANNEL TEST OF REACTOR TOP CAM PARTICULATE CHANNEL	$8.5x10^4 \pm$ 8500 cpm	Ann.?	___cpm	___Ann.				
4	MEASUREMENT OF REACTOR PRIMARY WATER CONDUCTIVITY	<5 μmho\cm							
5	PRIMARY WATER pH MEASUREMENT	MIN: 5 MAX: 9					N/A		
6	BULK SHIELD TANK WATER pH MEASUREMENT	MIN: 5 MAX: 9					N/A		
7	CHANGE LAZY SUSAN FILTER	FILTER CHANGED					N/A		
8	REACTOR TOP CAM OIL LEVEL CHECK	OSTROP 13.8		NEED OIL?______			N/A		
9	STACK CAM OIL LEVEL CHECK	OSTROP 13.9		NEED OIL?______			N/A		
10	PRIMARY PUMP BEARING OIL LEVEL CHECK	OSTROP 13.10		NEED OIL?______			N/A		
11	EMERGENCY DIESEL GENERATOR CHECKS	> 50%	Oil ok?				N/A		
		Total hours							
12	RABBIT SYSTEM RUN TIME	Total hours/Hours on current brushes					N/A		
13	OIL TRANSIENT ROD BRONZE BEARING	WD 40					N/A		
14	WATER MONITOR CHECK	RCHPP 8 App. F.4					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-3 — 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	ERP INSPECTIONS	QUARTERLY					
4	ROTATING RACK CHECK FOR UNKNOWN SAMPLES	EMPTY					
5	WATER MONITOR ALARM CHECK	FUNCTIONAL					
6A	CHECK FILTER TAPE SPEED ON STACK MONITOR	1"/HR ± 0.2					
6B	CHECK FILTER TAPE SPEED ON CAM MONITOR	1"/HR ± 0.2					
7	INCORPORATE 50.59 & ROCAS INTO DOCUMENTATION	QUARTERLY					
8	ARM SYSTEM ALARM CHECKS	FUNCTIONAL					

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

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

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

OSTROP 14, Rev. LEU-3 — Surveillance & Maintenance for the 1st / 2nd / 3rd / 4th Quarter of 20_____

SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	DATE COMPLETED	REMARKS & INITIALS
9	OPERATOR NAME	a) ≥4 hours: at console (RO), at console or as Rx. Sup. (SRO) b) Date Completed Operating Exercise	a) TOTAL OPERATION TIME	b) DATE OF OPERATING EXERCISE	REMARKS & INITIALS

Figure IV.3

Semi-Annual Surveillance and Maintenance (Sample Form)

OSTROP 15, Rev. LEU-3 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	CHANNEL TESTS OF REACTOR INTERLOCKS	NEUTRON SOURCE COUNT RATE INTERLOCK	NO WITHDRAW					
			≥5 cps					
		TRANSIENT ROD AIR INTERLOCK	NO PULSE					
		PULSE MODE ROD MOVEMENT INTERLOCK	NO MOVEMENT					
		PULSE INTERLOCK ON RANGE SWITCH	NO PULSE					
		MAXIMUM PULSE REACTIVITY INSERTION LIMIT	≤ $2.25					
		TWO ROD WITHDRAWAL PRHOHIBIT	1 ONLY					
		PULSE PROHIBIT ABOVE 1 kW	≥1 kW					
2	SAFETY CIRCUIT TEST	PERIOD SCRAM	≥3 sec					
3	TEST PULSE	PREVIOUS PULSE DATA FOR COMPARION PULSE # ________ $______________ ____________ MW ______________ °C	≤20% CHANGE	PULSE # _____ $__________ __________ MW __________ °C				
4	CLEANING & LUBRICATION OF TRANSIENT ROD CARRIER INTERNAL BARREL							
5	LUBRICATION OF BALL-NUT DRIVE ON TRANSIENT ROD CARRIER							
6	LUBRICATION OF THE ROTATING RACK BEARINGS		WD-40					
7	CONSOLE CHECK LIST		OSTROP 15.V11					
8	INVERTER MAINTENANCE		See User Manual					
9	STANDARD CONTROL ROD MOTOR CHECKS		LO-17 Bodine Oil					

*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
10	ION CHAMBER RESISTANCE MEASUREMENTS WITH MEGGAR INDUCED VOLTAGE		(SAFETY CHANNEL)					
			(%POWER CHANNEL)					
11	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)					
12	FUNCTIONAL CHECK OF HOLDUP TANK WATER LEVEL ALARMS		OSTROP 15.XII	HIGH _______ FULL________				
13	INSPECTION OF THE PNEUMATIC TRANSFER SYSTEM	BRUSH INSPECTION						
		SAMPLE INSERTION AND WITHDRAWAL TIME CHECK	Observed insertion/withdrawal time					

*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	STANDARD CONTROL ROD DRIVE INSPECTON		OSTROP 16.2					
3	CONTROL ROD CALIBRATION:	NORMAL	OSTROP 9.0					
		CLICIT						
		ICIT/DUMMY						
4	CONTROL ROD WITHDRAWAL INSERTION & SCRAM TIMES	TRANS / SAFE / SHIM / REG						
		SCRAM	≤2 sec					
		W/D	≤50 sec					
		INSERT	≤50 sec					
5	FUEL ELEMENT INSPECTION FOR SELECTED ELEMENTS		≥ 20% FE's inspected. No damage deterioration or well.					
6	REACTOR POWER CALIBRATION		OSTROP 8					
7	FUEL ELEMENT TEMPERATURE CHANNEL CALIBRATION		Per Checklist					
8	CALIBRATION OF REACTOR TANK WATER TEMP TEMPERATURE METERS		OSTROP 16.8					
9	CONTINUOUS AIR MONITOR CALIBRATION	Particulate Monitor	RCHPP 18					
		Gas Monitor						
10	CAM OIL/GREASE MAINTENANCE							
11	STACK MONITOR CALIBRATION	Particulate Monitor	RCHPP 18 & 26					
		Gas Monitor						
12	STACK MONITOR OIL/GREASE MAINTENANCE							
13	AREA RADIATION MONITOR CALIBRATION		RCHPP 18					

* 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
14	CORE EXCESS		≤$7.55	NORMAL $___ ICIT $___ CLICIT $___				
15	REACTOR BAY VENTILATION SYSTEM SHUTDOWN TEST		DAMPERS CLOSE IN ≤5 SECONDS	1ST FLOOR ___ 4TH FLOOR ___				
16	DECOMMISSIONING COST UPDATE		N/A	N/A	AUGUST			
17	SNM PHYSICAL INVENTORY		N/A	N/A	OCTOBER			
18	MATERIAL BALANCE REPORTS		N/A	N/A	NOVEMBER			
19	EMERGENCY RESPONSE PLAN	CFD TRAINING						
		GOOD SAM TRAINING						
		ERP REVIEW						
		ERP DRILL						
		CPR CERT FOR:						
		CPR CERT FOR:						
		FIRST AID CERT FOR:						
		FIRST AID CERT FOR:						
		EVACUATION DRILL						
		AUTO EVAC ANNOUNCEMENT TEST						
		ERP EQUIPMENT INVENTORY						
		BIENNIAL SUPPORT AGREEMENTS						
20	PHYSICAL SECURITY PLAN	PSP REVIEW						
		PSP DRILL						
		OSP/DPS TRAINING						
		LOCK/SAFE COMBO CHANGES						
		AUTHORIZATION LIST UPDATE						

* 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
21	ANNUAL REPORT	NOV 1		OCT 1	NOV 1		
22	KEY INVENTORY	ANNUAL					
23	REACTOR TANK AND CORE COMPONENT INSPECTION	NO WHITE SPOTS					
24	EMERGENCY LIGHT LOAD TEST	RCHPP 18.0					
25	NEUTRON RADIOGRAPHY FACILTIY INTERLOCKS						
26	PGNAA FACILITY INTERLOCKS						

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

* Date not 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.

Radiation Protection

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.

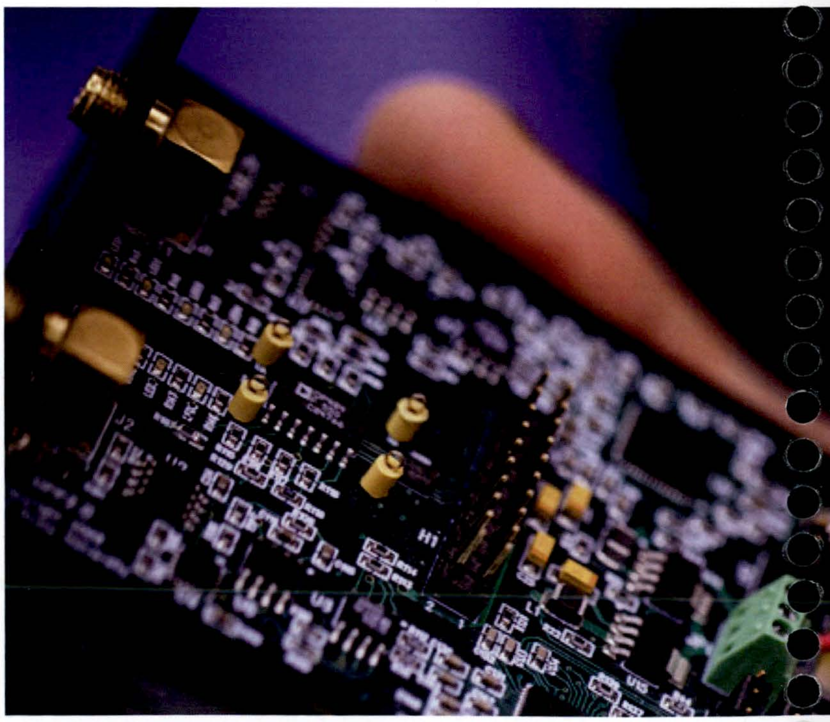
Liquid Effluents Released

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 $3x10^{-11}$ 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.

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 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 TLD samples for the reporting period was 108. A summary of the 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 TLD samples for the reporting period was 240. A summary of 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)
Nov 2015	9.44×10^{-7}	Co-60	Co-60, 2.26×10^{-7}	Co-60, 9.44×10^{-7}	Co-60, 1.92×10^{-9}	Co-60, 0.006	129,712
Dec 2015	N/A	N/A	N/A	N/A	N/A	N/A	131,723
Annual Total for Radiation Center	9.44×10^{-7}	Co-60	Co-60, 2.26×10^{-7}	Co-60, 9.44×10^{-7}	1.92×10^{-9}	0.006	261,435

(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
Radiation Center Laboratories	29.4	Pu-239, U-233, Cs-134. H-3, C-14, U-238, Am-241, Sr-90, Ra-226	5.97x10^{-4}	10/12/15 3/16/16 5/27/16
TOTAL	**29.4**	**See above**	**5.97x10^{-4}**	

(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.

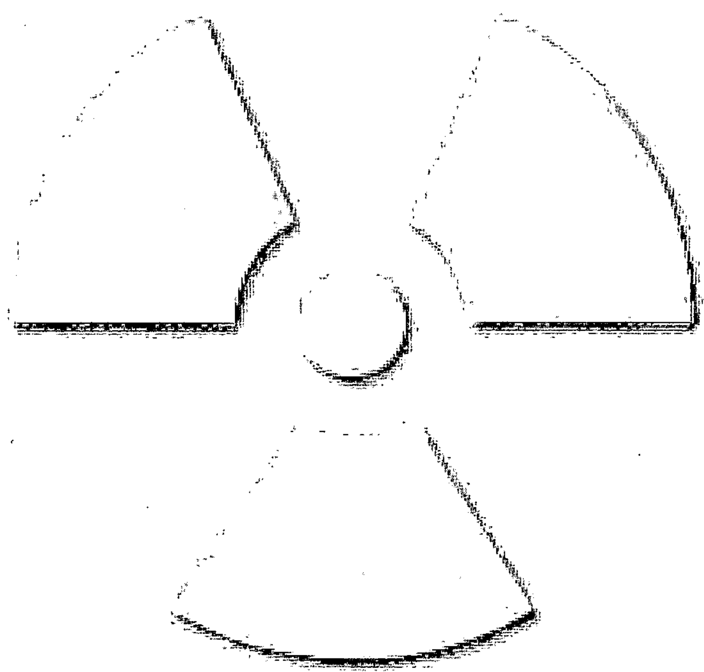


Table V.4

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	1.40	1.40	$1.11x10^{-7}$	2.77
August	1.32	1.32	$1.05x10^{-7}$	2.62
September	0.99	0.99	$8.12x10^{-8}$	2.03
October	1.57	1.57	$1.25x10^{-7}$	3.12
November	1.52	1.52	$1.25x10^{-7}$	3.11
December	2.34	2.34	$1.86x10^{-7}$	4.64
January	1.46	1.46	$1.16x10^{-7}$	2.89
February	1.37	1.37	$1.16x10^{-7}$	2.90
March	1.30	1.30	$1.03x10^{-7}$	2.58
April	1.65	1.65	$1.36x10^{-7}$	3.39
May	1.78	1.78	$1.41x10^{-7}$	3.53
June	1.74	1.74	$1.42x10^{-7}$	3.56
TOTAL ('15-'16)	**18.44**	**18.44**	$1.24x10^{-7}$[2]	**3.10**[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	29.5	Co-60, Zn-65, Sc-46, Cr-51, Fe-59, Co-58, As-74, Mn-54, Sb-124, Eu-154, Se-75, Hf-181, Hg-203, Pa-233, Sr-85, In-192	1.1×10^{-2}	10/12/15 3/16/16 5/27/16
Radiation Center Laboratories	22	Pu-239, Am-243, Sr-85, Eu-152, Eu-154, U-238, U-233, U-235	1.6×10^{-5}	3/16/16 5/27/16
TOTAL	51.5	See Above	1.1×10^{-2}	

(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	121	309	229	1,364	845	2,468
Key Facility Research Personnel	12	7	18	61	18	61
Facilities Services Maintenance Personnel	<1	N/A	<1	N/A	<1	N/A
Laboratory Class Students	2	30	66	622	686	137
Campus Police and Security Personnel	<1	N/A	13	N/A	13	N/A
Visitors	1	N/A	12	N/A	173	N/A

(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	294	ND
MRCTSE	D104: South Badge East Wall	150	ND
MRCTSW	D104: South Badge West Wall	530	ND
MRCTNW	D104: North Badge West Wall	333	ND
MRCTWN	D104: West Badge North Wall	562	ND
MRCTEN	D104: East Badge North Wall	352	ND
MRCTES	D104: East Badge South Wall	1,501	ND
MRCTWS	D104: West Badge South Wall	445	ND
MRCTTOP	D104: Reactor Top Badge	1,168	ND
MRCTHXS	D104A: South Badge HX Room	652	ND
MRCTHXW	D104A: West Badge HX Room	246	ND
MRCD-302	D302: Reactor Control Room	457	ND
MRCD-302A	D302A: Reactor Supervisor's Office	142	N/A
MRCBP1	D104: Beam Port Number 1	529	ND
MRCBP2	D104: Beam Port Number 2	267	ND
MRCBP3	D104: Beam Port Number 3	913	ND
MRCBP4	D104: Beam Port Number 4	898	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	10	N/A
MRCBRF	A102H: Front Personnel Dosimetry Storage Rack	48	N/A
MRCA120	A120: Stock Room	53	N/A
MRCA120A	A120A: NAA Temporary Storage	135	N/A
MRCA126	A126: Radioisotope Research Laboratory	358	N/A
MRCCO-60	A128: ^{60}Co Irradiator Room	1,397	N/A
MRCA130	A130: Shielded Exposure Room	65	N/A
MRCA132	A132: TLD Equipment Room	63	N/A
MRCA138	A138: Health Physics Laboratory	47	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)	1,513	N/A
MRCB119-1	B119: Source Storage Room	61	N/A
MRCB119-2	B119: Source Storage Room	160	N/A
MRCB119A	B119A: Sealed Source Storage Room	4,270	811
MRCB120	B120: Instrument Calibration Facility	228	N/A
MRCB122-2	B122: Radioisotope Hood	292	N/A
MRCB122-3	B122: Radioisotope Research Laboratory	104	N/A
MRCB124-1	B124: Radioisotope Research Laboratory (Hood)	126	N/A
MRCB124-2	B124: Radioisotope Research Laboratory	52	N/A
MRCB124-6	B124: Radioisotope Research Laboratory	52	N/A
MRCB128	B128: Instrument Repair Shop	51	N/A
MRCB136	B136 Gamma Analyzer Room	24	N/A
MRCC100	C100: Radiation Center Director's Office	41	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	42	N/A
MRCC106B	C106B: Custodian Supply Storage	0	N/A
MRCC106-H	C106H: East Loading Dock	40	N/A
MRCC118	C118: Radiochemistry Laboratory	10	N/A
MRCC120	C120: Student Counting Laboratory	26	N/A
MRCF100	F100: APEX Facility	12	N/A
MRCF102	F102: APEX Control Room	21	N/A
MRCB125N	B125: Gamma Analyzer Room (Storage Cave)	65	N/A
MRCN125S	B125: Gamma Analyzer Room	42	N/A
MRCC124	C124: Classroom	44	N/A
MRCC130	C130: Radioisotope Laboratory (Hood)	30	N/A
MRCD100	D100: Reactor Support Laboratory	40	N/A
MRCD102	D102: Pneumatic Transfer Terminal Laboratory	227	ND
MRCD102-H	D102H: 1st Floor Corridor at D102	115	ND
MRCD106-H	D106H: 1st Floor Corridor at D106	363	N/A
MRCD200	D200: Reactor Administrator's Office	191	ND
MRCD202	D202: Senior Health Physicist's Office	273	ND
MRCBRR	D200H: Rear Personnel Dosimetry Storage Rack	60	N/A
MRCD204	D204: Health Physicist Office	314	ND
MRCATHRL	F104: ATHRL	11	N/A
MRCD300	D300: 3rd Floor Conference Room	186	ND
MRCA144	A144: Radioisotope Research Laboratory	36	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)	1.5	90	<500	2,885
Reactor 2nd Deck Area (D104)	5.6	40	<500	<500
Reactor Bay SW (D104)	<1	42	<500	1,607
Reactor Bay NW (D104)	<1	5	<500	6,964
Reactor Bay NE (D104)	<1	28	<500	7,500
Reactor Bay SE (D104)	<1	22.2	<500	2,292
Class Experiments (D104, D302)	<1	<1	<500	<500
Demineralizer Tank & Make Up Water System (D104A)	<1	9	<500	<500
Particulate Filter--Outside Shielding (D104A)	<1	3.4	<500	1,250
Radiation Center:				
NAA Counting Rooms (A146, B100)	<1	1.4	<500	<500
Health Physics Laboratory (A138)	<1	<1	<500	<500
^{60}Co Irradiator Room and Calibration Rooms (A128, B120, A130)	<1	12	<500	<500
Radiation Research Labs (A126, A136) (B108, B114, B122, B124, C126, C130, A144)	<1	6	<500	<500
Radioactive Source Storage (B119, B119A, A120A, A132A)	<1	8	<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	2	<500	<500
RX support Room (D100)	<1	1.12	<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	83 ± 8
MRCFE-2	86 ± 6
MRCFE-3	80 ± 6
MRCFE-4	85 ± 3
MRCFE-5	91 ± 4
MRCFE-6	84 ± 5
MRCFE-7	87 ± 5
MRCFE-8	87 ± 4
MRCFE-9	85 ± 5

(1) Average Corvallis area natural background using Mirion TLDs totals 81 ± 11 mrem for the same period.

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

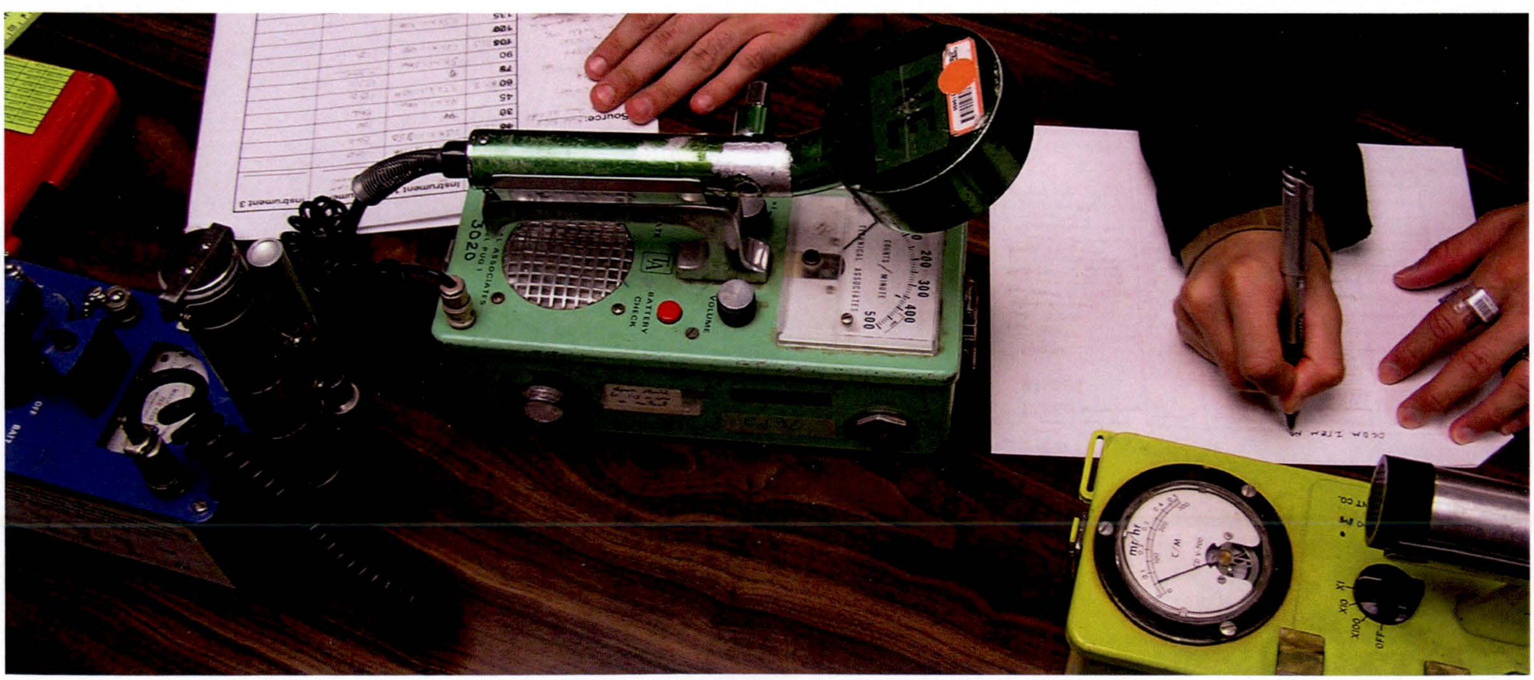


Table V.11

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	87 ± 6
MRCTE-3	87 ± 6
MRCTE-4	85 ± 6
MRCTE-5	92 ± 6
MRCTE-6	87 ± 7
MRCTE-7	87 ± 4
MRCTE-8	103 ± 9
MRCTE-9	92 ± 6
MRCTE-10	78 ± 6
MRCTE-12	96 ± 6
MRCTE-13	85 ± 6
MRCTE-14	87 ± 4
MRCTE-15	84 ± 7
MRCTE-16	90 ± 5
MRCTE-17	82 ± 5
MRCTE-18	87 ± 6
MRCTE-19	85 ± 5
MRCTE-20	82 ± 5
MRCTE-21	76 ± 6
MRCTE-22	80 ± 5

(1) Average Corvallis area natural background using Mirion TLDs totals 81 ± 11 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	N/A	μCi ml^{-1}
4-W	Water	N/A	μCi ml^{-1}
11-W	Water	7.43x10^{-8}[2]	μCi ml^{-1}
19-RW	Water	N/A	μCi ml^{-1}
3-S	Soil	1.92x10^{-5} [2]	μCi g^{-1} of dry soil
5-S	Soil	1.64x10^{-5} [2]	μCi g^{-1} of dry soil
20-S	Soil	1.59x10^{-5}[2]	μCi g^{-1} of dry soil
21-S	Soil	1.49x10^{-5} [2]	μCi g^{-1} of dry soil
2-G	Grass	4.79x10^{-5} ± 7.48x10^{-6}	μCi g^{-1} of dry ash
6-G	Grass	2.60x10^{-5} ± 8.54x10^{-6}	μCi g^{-1} of dry ash
7-G	Grass	2.60x10^{-5} ± 6.93x10^{-6}	μCi g^{-1} of dry ash
8-G	Grass	4.24x10^{-5} ± 1.07x10^{-5}	μCi g^{-1} of dry ash
9-G	Grass	1.69x10^{-5} [2]	μCi g^{-1} of dry ash
10-G	Grass	1.96x10^{-5} ± 7.82x10^{-6}	μCi g^{-1} of dry ash
12-G	Grass	5.66x10^{-5} ± 1.25x10^{-5}	μCi g^{-1} of dry ash
13-G	Grass	1.83x10^{-5} [2]	μCi g^{-1} of dry ash
14-G	Grass	4.07x10^{-5} ± 8.91x10^{-6}	μCi g^{-1} of dry ash
15-G	Grass	1.99x10^{-5} [2]	μCi g^{-1} of dry ash
16-G	Grass	2.23x10^{-5} [2]	μCi g^{-1} of dry ash
17-G	Grass	2.23x10^{-5} ± 9.82x10^{-6}	μCi g^{-1} of dry ash
18-G	Grass	2.03x10^{-5} [2]	μCi g^{-1} of dry ash
22-G	Grass	2.39x10^{-5} [2]	μCi 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	1.66×10^{-5} (1)	1.49×10^{-5} to 1.92×10^{-5} (1)	$\mu Ci\ g^{-1}$ of dry soil
Water	7.43×10^{-8} (1)	7.43×10^{-8} (1)	$\mu Ci\ ml^{-1}$
Vegetation	3.52×10^{-5}	1.96×10^{-5} to 5.66×10^{-5}	$\mu Ci\ g^{-1}$ 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 Radiation Regulatory Agency Phoenix, AZ USA	$2.16x10^{-3}$	0	0	1	0	1
Arizona State University Tucson, AZ USA	$1.19x10^{-6}$	1	0	1	0	2
Berkeley Geochronology Center Berkeley, CA USA	$8.81x10^{-7}$	9	1	0	0	10
Lawrence Livermore National Lab Livermore, CA USA	$1.34x10^{-7}$	1	0	0	0	1
Materion Corporation Elmore, OH USA	$3.79x10^{-2}$	0	0	0	4	4
Materion Natural Resources Delta, UT USA	$1.01x10^{-1}$	0	0	0	21	21
Nevada Radiation Control Program Carson City, NV	$2.65x10^{-3}$	0	0	1	0	1
Occidental College Los Angeles, CA USA	$6.76x10^{-9}$	1	0	0	0	1
Oregon State University Corvallis, OR USA	$4.73x10^{-6}$	3	2	2	0	7
Plattsburgh State University Plattsburgh, NY USA	$1.35x10^{-8}$	1	0	0	0	1
Syracuse University Syracuse, NY USA	$7.70x10^{-9}$	2	0	0	0	2
University of Arizona Tucson, AZ USA	$2.17x10^{-6}$	3	0	1	0	4
University of Cincinnati Cincinnati, OH USA	$4.73x10^{-9}$	4	0	0	0	4
University of Vermont Burlington, VT USA	$1.70x10^{-8}$	1	0	0	0	1
University of Wisconsin-Madison Madison, WI USA	$4.93x10^{-6}$	5	1	1	0	7
US Army 102CST Salem, OR USA	$2.14x10^{-3}$	0	0	1	0	1
Wyoming Homeland Security Cheyenne, WY USA	$2.33x10^{-3}$	0	0	1	0	1
Totals	**$1.48x10^{-1}$**	**31**	**4**	**9**	**25**	**69**

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
Argonne National lab Argonne, IL USA	1.10×10^{-7}	0	1	0	0	1
Lawrence Livermore National Lab Livermore, CA USA	1.42×10^{-10}	1	0	0	0	1
Los Alamos National Lab Los Alamos, NM USA	2.75×10^{-6}	3	3	2	0	8
Totals	**2.86×10^{-6}**	**4**	**4**	**2**	**0**	**10**

Table V.16

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

		Number of Shipments			
Shipped To	Total Activity (TBq)	Exempt	Limited Quantity	Yellow II	Total
Australian National University Canberra, AUSTRALIA	5.20×10^{-12}	1	0	0	1
China University of Petroleum Beijing, CHINA	9.95×10^{-3}	1	0	0	1
Curtin University of Technology Bently Western Australia AUSTRALIA	1.16×10^{-5}	0	0	2	2
Dalhousie University Halifax, Nova Scotia CANADA	1.35×10^{-8}	2	0	0	2
Geological Survey of japan Ibaraki, JAPAN	1.07×10^{-7}	2	0	0	2
Geomar Helmholtz Center for Ocean Research Kiel, GERMANY	5.67×10^{-8}	1	0	0	1
Glasgow University Glasgow SCOTLAND	5.63×10^{-9}	1	0	0	1
Korean Baskic Science Institute Cheongju-si, Chungcheongbuk-do KOREA	6.18×10^{-8}	3	0	0	3
Lanzhou Center of Oil and Gas Resources Lanzhou, CHINA	1.13×10^{-8}	2	0	0	2
Lanzhou University Lanzhou, Gansu CHINA	3.33×10^{-8}	2	0	0	2

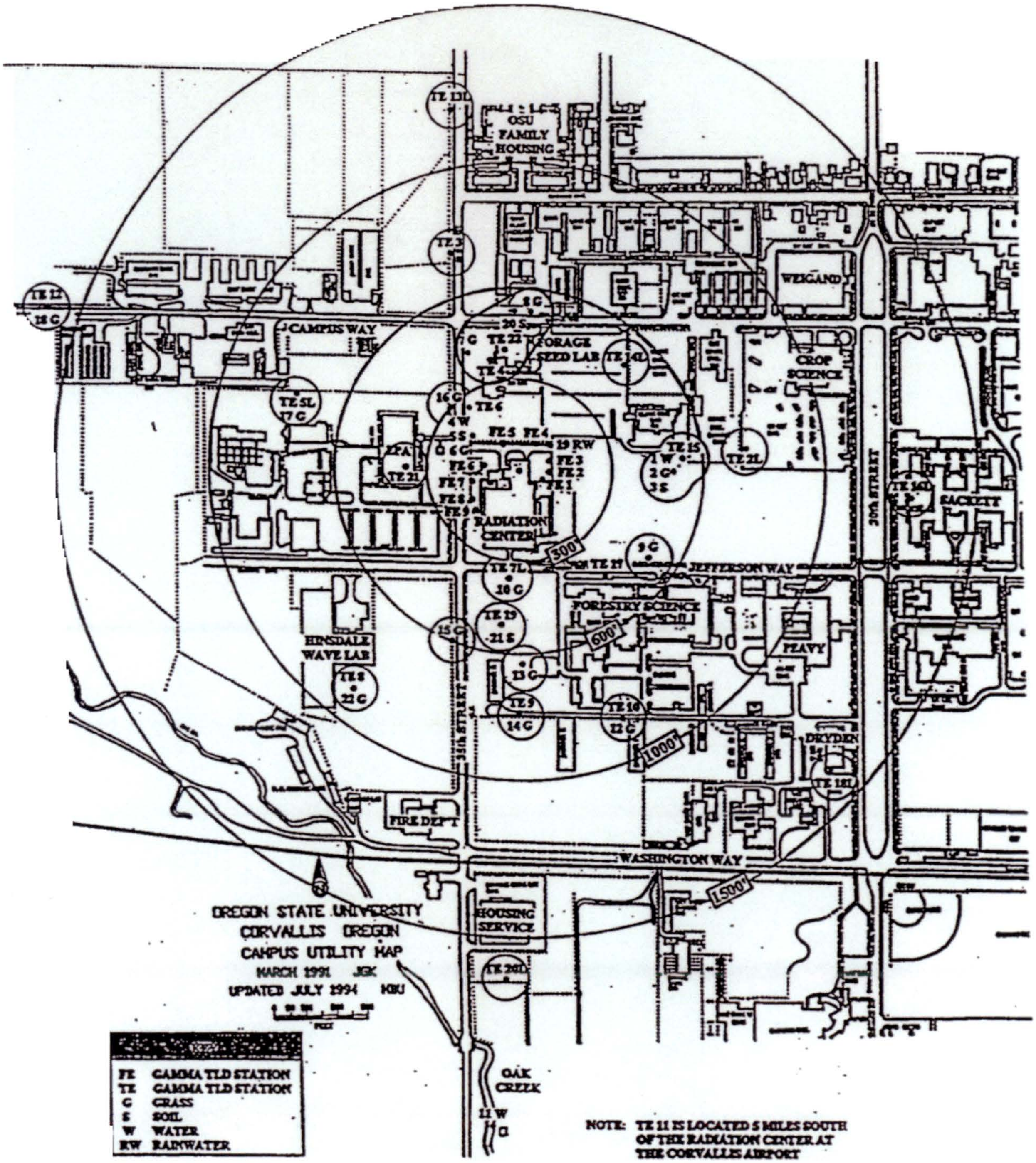
Table V.16 (continued)

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

		Number of Shipments			
Shipped To	Total Activity (TBq)	Exempt	Limited Quantity	Yellow II	Total
Lund University Lund, SWEDEN	$1.35x10^{-7}$	1	0	0	1
Polish Academy of Sciences Krakow, POLAND	$2.85x10^{-8}$	2	0	0	2
QUAD-Lab, Roskilde University Roskilde DEMARK	$3.26x10^{-9}$	2	0	0	2
Scottish Universities Research & Reactor Centre East Kilbride, SCOTLAND	$2.61x10^{-6}$	7	2	0	9
Universidade de Sao Paulo San Paulo, BRAZIL	$6.91x10^{-8}$	2	0	0	2
Universitat Potsdam Postdam, GERMANY	$3.36x10^{-8}$	2	0	0	2
Universite Paris-Sud Paris, FRANCE	$1.51x10^{-6}$	0	0	1	1
University of Geneva Geneva, SWITZERLAND	$2.27x10^{-7}$	6	0	0	6
University of Manitoba Winnipeg, CANADA	$4.81x10^{-6}$	0	3	0	3
University of Melbourne Parkville, Victoria AUSTRALIA	$1.60x10^{-6}$	2	2	0	4
University of Milano-Bicocca Milano ITALY	$4.01x10^{-9}$	1	0	0	1
University of Padova Padova, ITALY	$2.83x10^{-8}$	4	0	0	4
University of Queensland Brisbane, Queensland AUSTRALIA	$1.32x10^{-6}$	0	3	0	3
University of Rennes Rennes, FRANCE	$3.04x10^{-8}$	2	0	0	2
University of Waikato Hamilton, NEW ZEALAND	$1.34x10^{-8}$	1	0	0	1
University of Zurich Zurich, SWITZERLAND	$4.59x10^{-9}$	1	0	0	1
Victoria University of Wellington Wellington, NEW ZELAND	$6.56x10^{-8}$	1	0	0	1
Vrijc Universiteit Amsterdam, THE NETHERLANDS	$9.99x10^{-7}$	2	1	0	3
Totals	**$9.98x10^{-3}$**	**51**	**11**	**3**	**65**

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

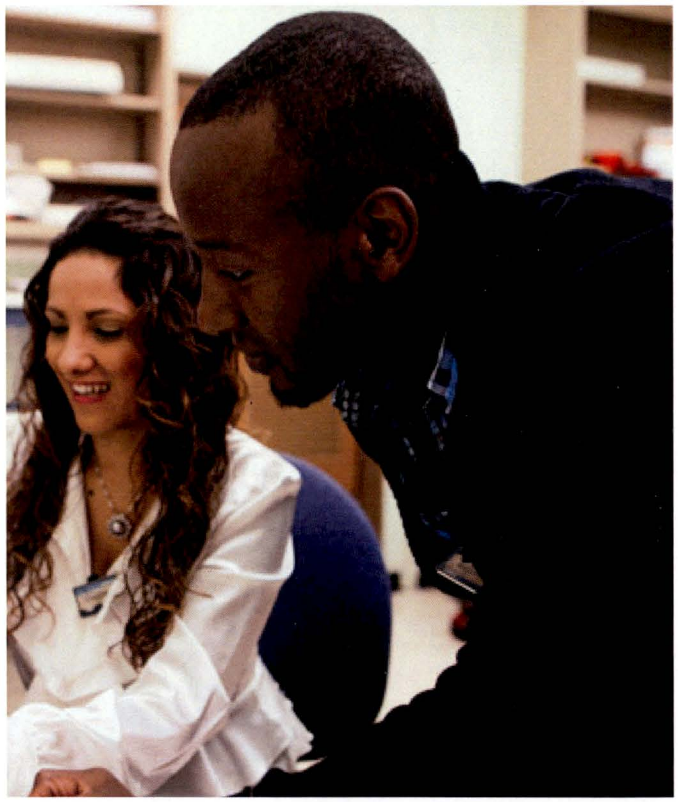
Almost all Radiation Center research and service work is tracked by means of a project database. When a request for facility use is received, a project number is assigned and the project is added to the database. The database includes such information as the project number, data about the person and 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
*Arizona State University Tempe, AZ USA	1	1	3
*ATI Albany, OR USA	1	0	1
*Berkeley Geochronology Center Berkeley, CA USA	1	0	9
Branch Engineering Springfield, OR USA	1	0	1
Chemical Bilogical &Environmental Engineering Corvallis, OR USA	1	1	17
*Chinga University of Petroleum - Beijing Changping, Beijing CHINA	1	1	2
Crystal Solutions, LLC Portland, OR USA	1	1	2
*CSTA, USARNORTH Fort Sam Houston, TX USA	1	0	4
*Dalhousie University Halifax, Novia Scotia CANADA	1	2	2
*Geological Survey of Japan/AIST Tsukuba, Ibaraki, JAPAN	1	0	1
*Geologisch-Palaontologisches Institut Basel, SWITZERLAND	1	1	2
*Helmoholtz-Zentrum fur Ozeanforschung Kiel (GEOMAR) Kiel, GERMANY	1	0	1
*Korea Basic Science Institute Cheongwon-gun, Chungcheongbuk-do SOUTH KOREA	1	1	4
*Lanzhou Center of Oil and Gas Resources, CAS Lanzhou, CHINA	1	1	2
*Lanzhou University Lanzhou, CHINA	1	0	2
*Lawrence Livermore National Laboratory Livermore, CA USA	1	0	1
*Lund University Lund, SWEDEN	1	0	1
*Mas Oro Sahuarita, AZ USA	1	0	2
*Materion Brush, Inc. Elmore, OH USA	1	0	4
*Materion Natural Resources Delta, UT USA	1	0	14
NeuraMedica Beavercreek, OR USA	1	0	1

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
*Occidental College Los Angeles, CA USA	1	1	1
*Oregon State University(1) Corvallis, OR USA	20	59	74 (2)
*Oregon State University - Educational Tours Corvallis, OR USA	1	0	17
*Oregon State University Radiation Center Corvallis, OR USA	1	1	14
*Plattsburgh State University Plattsburgh, NY USA	1	1	1
*Polish Academy of Sciences Krakow, POLAND	1	0	2
*Quaternary Dating Laboratory Roskilde, DENMARK	1	0	3
*Scottish Universities Enfironmental Research Centre East Kilbride UK	1	0	27
*Syracuse University Syracuse, NY USA	2	2	2
*The University of Waikato Hamilton, NEW ZEALAND	1	1	2
*Universita' Degli Studi di Padova Padova ITALIA	1	2	4
*Universitat Potsdam Potsdam, GERMANY	1	0	1
Universite Paris-Sud Paris, FRANCE	1	1	1
*Universite Rennes 1 Rennes FRANCE	1	1	1
*University at Albany, SUNY Albany, NY USA	1	2	6
*University of Arizona Tucson, AZ USA	3	3	7
*University of California at Santa Barbara Santa Barbara, CA USA	1	1	1
*University of Cincinnati Cincinnati, OH USA	1	1	3
*University of Geneva Geneva SWITZERLAND	1	1	7
*University of Glasgow Glasgow SCOTLAND	1	0	1

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 Manitoba Winnipeg, Manitoba CANADA	1	1	3
*University of Melbourne Melbourne, Victoria AUSTRALIA	1	1	5
*University of Michigan Ann Arbor, MI USA	1	4	1
*University of Oregon Eugene, OR USA	3	4	26
* University of Postdam Postdam GERMANY	1	0	1
*University of Queensland Brisbane, Queensland AUSTRALIA	1	1	3
*University of Sao Paulo Sao Paulo BRAZIL	2	1	2
*University of Vermont Burlington, VT USA	1	1	1
*University of Wisconsin Madison, WI USA	1	1	7
US National Parks Service Crater Lake, OR USA	1	0	3
USDA Forest Service Crater Lake, OR USA	1	0	7
*Victoria University of Wellington Wellington, NEW ZEALAND	1	0	2
*Vrije Universiteit Amsterdam THE NETHERLANDS	1	1	3
*Western Australian Argon Isotope Facility Perth, Western Australia AUSTRALIA	1	0	6
Totals	**80**	**101**	**321**

* 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
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
1074	Wijbrans	Vrije Universiteit	Ar/Ar Dating of Rocks and Minerals	Ar/Ar dating of rocks and minerals.	Vrije Universiteit, Amsterdam
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
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
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
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
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

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
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
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
1523	Zattin	Universita' Degli Studi di Padova	Fission track analysis of Apatites	Fission track dating method on apatites by fission track analysis.	NA
1542	Teaching and Tours	Oregon State University - Educational Tours	Engineering Sciences Classes	OSTR tour.	NA
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
1568	Spell	University of Nevada Las Vegas	Ar/Ar geochronology and Fission Track dating	Argon dating of Chilean granites.	University of Nevada Las Vegas

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
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
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
1717	Baldwin	Syracuse University	Ar/Ar Dating	Ar/Ar Dating.	Syracuse University
1720	Teaching and Tours	Saturday Academy	OSTR Tour	OSTR Tour.	NA
1745	Girdner	US National Parks Service	C14 Measurements	LSC analysis of samples for C14 measurements.	US National Parks Service
1767	Korlipara	Terra Nova Nurseries, Inc.	Genera Modifications using gamma irradiation	Use of gamma and fast neutron irradiations for genetic studies in genera.	Terra Nova Nurseries, Inc.
1768	Bringman	Brush-Wellman	Antimony Source Production	Production of Sb-124 sources.	Brush-Wellman
1777	Storey	Quaternary Dating Laboratory	Quaternary Dating	Production of Ar-39 from K-39 to determine radiometric ages of geological materials.	Quaternary Dating Laboratory
1778	Gislason	Genis, Inc	Gamma exposure of Chitosan polymer	This project subjects chitosan polymer in 40 and 70% DDA formulations to 9 and 18 Kgy, boundary doses for commerical sterilization for the purpose of determine changes in the molecular weight and product formulation properites.	Genis, Inc.
1816	Kounov	Geologisch-Palaontologisches Institut	Fission Track Analysis	Geochronology analysis using fission track dating.	Geologisch-Palaontol-ogisches Instut

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
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
1855	Anczkiewicz	Polish Academy of Sciences	Fission Track Services	Verification of AFT data for illite-mechte data.	Polish Academy of Sciences
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
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
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

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
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
1904	Minc	Oregon State University	INAA of Archaeological Ceramics from Ecuador	Trace-element analyses of ceramics from Ecuador for provenance determination.	N/A
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
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.	N/A
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
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
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
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
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
1971	Shaik	New Earth	Testing Blue Green Algae	Testing of blue green algae to determine if it is contaminated with radioactive material.	New Earth
1975	McDonald	University of Glasgow	Samuel Jaanne	Use of fissin tracks to determine last heating event of apatites.	School of Geographical and Earth Science

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
1979	Paulenova	Oregon State University	Mixed Matrix Extraction Testing	Multi-element, transition metal salt production for mixed matrix extraction testing.	
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
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
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.	

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
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.	
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

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
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
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
2017	Jourdan	Wester Australian Argon Isotope Facility	Age dating of geological material	Ar/Af geochronology.	Curtin University
2018	Kent	Oregon State University	Gamma Irradiation of Zebra Fish	Gamma irradiation of zebra fish to induce specific growth.	N/A
2019	Krugh	Calfornia State University-Bakersfield	Sierra Geomorph	The use of low-temperature thermochronology to constrain the exhumation history of the Eastern Sierra Nevada. This data will also be used as a tracer to examine the relationship between grain size and the elevation of the sediment source area.	Calfornia State University-Bakersfield
2020	Contreras	Oregon State University	Mutagenesis of carpenteria californica using varying rates of gamma radiation	Carpenteria californica (Hydrangeaceae) is a shrub with large white flowers and yellow eyespots. It is prized for its large flowers but often the growth form is poor. There are few cultivars available, with 'Elizabeth' being reported as a double-flowered form but most often it is a weak semi-double at best. Our goal is to induce mutations in Carpenteria californica to select for mutations in growth form and flowering traits. A superior selection would be one that exhibits compact growth form (shortened internodes compared to the type) and is extremely floriferous.	OSU Horticulture

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
2021	Reese	Oregon State University	Neutron radiography of heater rods	Use of neutron radiography to determine precise location of the internal components of heater rods.	OSU NERHP
2022	Simonian	Cypress Grove Chevre	Dill pollen irradiation	Gamma irradiation of dill pollen to sterlize yeast.	Lawrence Livermore National Laboratory
2023	Cassata	Lawrence Livermore National Laboratory	Ar/Ar dating	Production of neutron induced 39Ar from 39K for Ar/Ar dating.	Lawrence Livermore National Laboratory
2024	Iwaniec	Oregon State University	Role of bone marrow adipocytes in bone loss during simulated spaceflight	This study involves bone marrow transplantation followed by hindlimb-unloading (a ground-based model of spaceflight). Four groups of mice will be studied: (1) weight-bearing WT mice transplanted with WT bone marrow derived hematopoietic stem cells, (2) hindlimb unloaded WT mice transplanted with WT bone marrow derived hematopoietic stem cells, (3) weight-bearing Kitw/w-v mice transplanted with WT bone marrow derived hematopoietic stem cells, and (4) hindlimb unloaded Kitw/w-v mice transplanted with bone marrow derived hematopoietic stem cells; the mice will be hindlimb unloaded for 14 days and sacrificed.	OSU Nutrition and Exercise Sciences
2025	Tucker	Oregon State University	INAA of Niobium	Neutron activation analysis of Niobium for characterization of impurities.	OSU Mechanical Industrial and Manufacturing Engineering
2026	Brown	CSTA, USARNORTH	Source production for training purposes	Source production to be used for training purposes for response teams.	U.S. Army
2027	Reese	Oregon State University	Neutron Radiography of Antennae	Neutron radiography of radio antennae.	N/A
2028	Minc	Oregon State University	INAA of ceramics from the Ancient Near East	Provenance determination of ceramics from the Ancient Near East via trace-element analysis.	OSU Anthropology
2029	Kim	Korea Basic Science Institute	Ar/Ar geochronology	Ar/Ar analysis for age dating of geological samples.	Korea Basic Science Institute
2030	Fleishman	Northstar Glassworks, Inc.	Uranium glass testing for alpha, beta, gamma radiation	Determination of alpha, beta, gamma contamination, dose and activity of uranium glass sample.	Northstar Glassworks, Inc.

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
2031	Malusa	University of Milano-Bicocca	Fission track dating	Use of fission tracks from U-235 to determine age of rocks.	Universita degli Studi di Milano-Bicocca
2032	Parham	PECO, Inc., an Astronics Company	Leaktest of Po-210 sources	Leaktest of Po-210 sources used for static discharge.	
2033	Chang	China University of Petroleum - Beijing	Fission Track	Fission track dating of rock samples.	China University of Petroleum - Beijing
2034	Morrell	Oregon State University	Sterilization of Wood Products	Sterilization of wood to 2.0 Mrad for fungal experiments.	OSU Forest Products
2035	Wang	Lanzhou Center of Oil and Gas Resources, CAS	Fission Track	Fission track dating of rock samples.	Lanzhou Center of Oil and Gas Resources, CAS
2037	Marcum	Oregon State University	Core parameter Measurements using Cherenkov Detection	Using Cherenkov detectors to validate core operating history with large changes in reactor power (i.e., square wave).	
2038	Blakestad	Mas Oro	PGE determination of placer samples	PGE determination of placer samples via INAA.	N/A
2039	Gombart	Oregon State University	Prevention of Infections Associated with Combat-related Injuries by Local Sustained Co-Delivery	Prevention of Infections Associated with Combat-related Injuries by Local Sustained Co-Delivery of Vitamin D3 and Other Immune-Boosting Compounds Award Mechanism. We are preparing nanofiber wound dressings that contain compounds that will be released over time to induce the immune response in wounds to help prevent infection and speed wound healing. The nanofibers must be irradiated so that they are sterile. These experiments will be performed in cell culture and in animal models.	
2040	Tucker	Oregon State University	Niobium Impurity Determination	PGNAA of Niobium for characterization of impurities. This technique will be evaluated against current standard methods for impurity determination.	
2041	Marcum	Oregon State University	Neutron Radiography of ATR Capsules	Use of neutron radiography to view degradation in aluminum ATR capsules from endurance testing of these capsules under continuous hydraulic loading over the course of a year.	
2042	Walsh	University of Oregon	INAA of Ancient Ceramics from Korea	Trace-element analyses of Neolithic and Bronze Age ceramics from SE Korea.	University of Oregon

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
2044	Olson	University of Michigan	point-of-use devices as incubators of halogenated phenol-mediated antibiotic resistant bacteria	This project investigates the bacterial colonization, changes of bacterial community structures, and development of antibiotic resistance in a drinking water point-of-use filtration device.	University of Michigan
2045	van den Bogaard	Helmholtz-Zentrum fur Ozeanforschung Kiel (GEOMAR)	GEOMAR Ar/Ar	Ar/Ar dating research of geological samples.	GEOMAR Helmholtz Centre for Ocean Research
2046	Cann	Oregon State University	Determination of oxygen content in metal alloys	Investigation into PGNAA to determine oxygen content in BaTiO3.	
2047	Parra	University of Sao Paulo	Fission Track Dating	Fission track dating of geologic materials.	University of Sao Paulo
2048	Christensen	Oregon State University	INAA of IV Fluids	INAA to determine trace metal in TPN and additives.	OSU College of Pharmacy
2050	Lee	University of Oregon	Archaeological Ceramics fron Juju Island, Korea	INAA to determine trace-element signature and provenance ofarchaeological ceramics.	National Geographic Explorer Grant
2051	Perez Rodriguez	University at Albany, SUNY	Archaeological Ceramics from Cerro Jazmin	INAA to determine trace-element composition and provenance of ceramics from Cerro Jazmin, Oaxaca.	
2052	Stone-Sundberg	Crystal Solutions, LLC	Dopants in Synthetic Sapphire	INAA to verify trace-element content of synthetic sapphires.	Crystal Solutions, LLC
2053	Paulenova	Oregon State University	Measuring the uptake of strontium	Measuring the uptake of strontium by inorganic (IONSIV) and organic (chitosan-based) sorbent materials. Kinetics of uptake will also be evaluated. Natural strontium will be used as a carrier, and Sr-85 will serve as a tracer.	
2054	Buffington	Oregon State University	137-Cs activity in coastal sediments	137-Cs activity in coastal sediments.	OSU
2055	Loveland	Oregon State University	Gamma Irradition Effects on HLW Sludge	Evaluation of the effects of high levels of gamma radiation on simulated Handord waste tank sludge.	
2056	Loveland	Oregon State University	Reactor Irradiation of HLW Sludge	Investigation into the effects of low level gamma and source neutrons on simulated Hanford waste tank sludge.	
2057	Dreilinger	NeuraMedica	Dural Clip Development	We're developing a resorbable polymer surgical clip and applicator for durotomy closure (closure of incisions of the dura mater, membrane covering brain and spinal cord).	NeuraMedica

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
2058	Cronn	USDA Forest Service	Gamma irradiation of Port-Orford Cedar pollen to generate chromosomal segment deletions	Gamma irradiation of pollen has been used successfully by plant geneticists to facilitate discovery of genes and chromosomal regions that control traits of interest in crops and trees like poplar. Geneticists in the US Forest Service have identified valuable single gene traits in Port-Orford Cedar, an ecologically and economically important conifer native to Oregon. We would like to test whether pollen irradiation can be used to create deletion lines that have modified traits, with the goal of identifying the genes controlling these traits.	USDA Forest Service
2059	Alanko	ATI	Detection of Boron in Niobium Metal	Use of neutron radiography to determine the presense of boron minerals in niobium metal ingots samples	
2060	Ishizuka	Geological Survey of Japan/AIST	Ar/Ar Geochronology	Ar/Ar geochronology of volcanic and igneous rocks associated with subduction initiation of oceanic island arc.	Geological Survey of Japan
2061	Weiss	Oregon State University	Neutron Radiography Imaging of Concrete	Investigation into the applicablity of neutron radiography for evaluating concrete curing processes.	
2062	Reese	Oregon State University	Temporal Spectroscopy of Fissile Materials	Use of PGNAA facility to perform temporal spectroscopy for the purpose of determining fissile material content	OSU Radiation Center, DNDO Grant
2063	Bohanan	University of Oregon	Microbial Inheritance in Seeds	The plant microbiome is composed of bacteria and fungi that are vertically transmitted via the seed and horizontally transmitted via the soil. The goal of this project it to understand the relative contribution of seedborne versus soilborne microbes in producing the corn microbiome.	University of Oregon
2064	Schaefer	CDM Smith	Abiotic Dechlorination of chlorinated solvents in soil matrices.	We will be performing bench scale microcosm studies to measure the abiotic dechlorination in different soil matrices. Gamma irradiation will be used to sterilize the samples.	CDM Smith
2069	Scaillet	INSU-CNRS-Universite d'Orleans	Ar/Ar dating of geologic samples	Ar/Ar analysis for age dating of geologic samples (solid rock chips and minerals)	INSU-CNRS-Universite d'Orleans

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

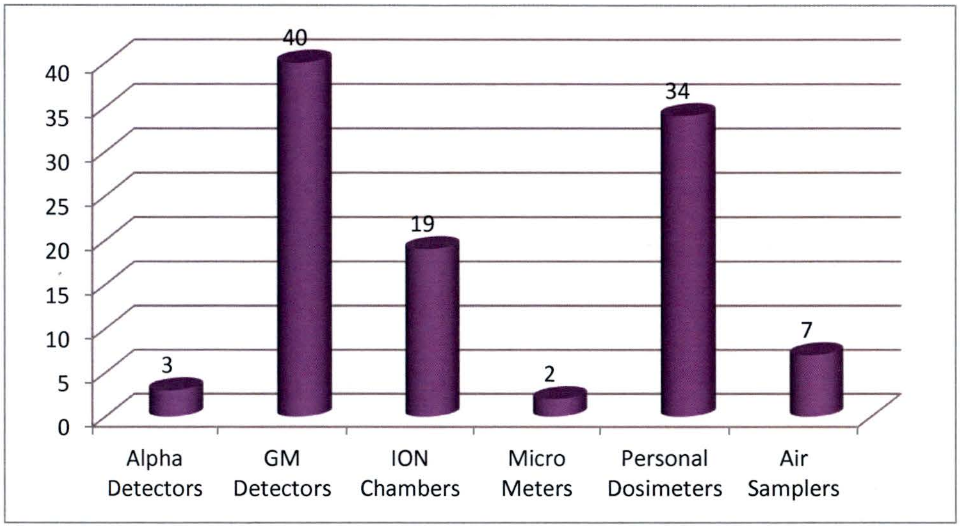


Table VI.3
Summary of Radiological Instrumentation Calibrated to Support OSU Departments

OSUDepartment	Number of Calibrations
Biochem/Biophysics	1
Civil Engineering	2
COAS	1
Linus Pauling Institute	2
Microbiology	3
Nutrition & Exercise Science	1
Physics	3
Radiation Safety Office	22
Veterinary Medicine	1
Total	**36**

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

Agency	Number of Calibrations
Clair Company	1
Columbia Steel Casting	3
Doug Evans, DVM	2
Epic Imaging	2
ESCO Corporation	6
Eugene Sand and Gravel	1
Fire Marshall/Hazmat	120
Gene Tools	3
Health Division	108
Hollingsworth & Vose	1
Knife River	3
NETL, Albany	4
Occupational Health Lab	1
ODOT	8
Oregon Health and Sciences University	40
PSU	19
Republic Services	2
Salem Hospital	12
Samaritan Health	37
Silverton Hospital	5
Weyerhaeuser	1
Total	**379**

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Pfeifer, L.S., G.S. Soreghan, S. Pochat, J. Van Den Driessche, and S.N. Thomson. 2016. "Rapid Permian Exhumation of the Montagne Noire Metamorphic Core Complex Recorded in Provenance of Upper Paleozoic Clastic Strata in the Graissessac-Lodève Basin, France." Basin Research. doi:10.1111/bre.12197.

Ranjbar, L., A. Farsoni, and E.M. Becker. 2016. "A CZT-based Radioxenon Detection System in Support of the Comprehensive Nuclear-Test-Ban Treaty." Journal of Radioanalytical and Nuclear Chemistry. doi:10.1007/s10967-016-4872-8.

Ring, U., I.T. Uysal, J. Glodny, T. Little, S. Cox, S.N. Thomson, K. Stübner, and Ö. Bozkaya. n.d. "Fault-gouge Dating in the Southern Alps, New Zealand." Submitted to Tectonics. Preprint.

Thomson, S.N. 2016. "Fission Track Analysis." In Encylopedia of Geochemistry, edited by W.M. White. Springer, Berlin. In press.

Thomson, S.N., G.S. Soreghan, P.W. Reiners, S.L. Peyton, and K.E. Murray. n.d. "A Definitive 6 Ma Onset Age for Carving of the Northeastern Colorado Plateau Canyonlands (Utah and Colorado)." Submitted to Geology. Preprint.

V. Bosch, G., A. Teixell, M. Jolivet, P. Labaume, D. Stockli, M. Doménech, and P. Monié. 2016. "Timing of Eocene-Miocene Thrust Activity in the Western Axial Zone and Chaînon Béarnais (West-Central Pyrenees) Revealed by Multi-method Thermochronology." Comptes Rendus Géoscience 348: 246-256.

Wang, X., C. Song, M. Zattin, P. He, A. Song, J. Li, and W. Wang. 2016. "Cenozoic Pulsed Deformation History of Northeastern Tibetan Plateau Reconstructed from Fission-track Thermochronology." Tectonophysics 672-673: 212-227.

Yanez, R., and W. Loveland. 2015. "Predicting the Production of Neutron-rich Heavy Nuclei in Multi-nucleon Transfer Reactions Using a Semi-Classical Model Including Evaporation and Fission Competition, GRAZING-F." Phys. Rev. C 91: 044608.

Yanez, R., W. Loveland, J. King, J.S. Barett, N. Fotiades, and H.Y. Lee. n.d. "Total Kinetic Energy in the Fast Neutron-induced Fission of 235U." Submitted to Phys. Rev. C. Preprint.

Yang, W., G. Dupont-Nivet, M. Jolivet, Zh. Guo, L. Bougeois, R. Bosboom, Z. Zhang, B. Zhu, and G. Heilbronn. 2015. "Magnetostratigraphic Record of the Early Evolution of the Southwestern Tian Shan Foreland Basin (Ulugqat Area), Interactions with Pamir Indentation and India-Asia Collision." Tectonophysics 644-645: 122-137.

Zhou, R., L.M. Schoennohm, E.R. Sobel, B. Carrapa, and D.W. Davis. 2016. "Sedimentary Record of Regional Deformation and Dynamics of the Thick-skinned Southern Puna Plateau, Central Andes (26-27°S)." Earth and Planetary Science Letters 433: 317-325. doi:doi.org/10.1016/j.epsl.2015.11.012.

Presentations

Ault, A.K., M. Frenzel, P.W. Reiners, N.H. Woodcock, and S.N. Thomson. 2015. "Hematite (U-Th)/He and Apatite Fission-track Dating Constrain Paleofluid Circulation in Faults: an Example from Gower Peninsula Fissure Fills, Wales." Eos Transactions AGU. AGU Fall Meeting. V51H-07.

Ault, A.K., P.W. Reiners, J.P. Evans, and S.N. Thomson. 2015. "Linking Hematite (U-Th)/He Dating with the Microtextural Record of Seismicity in the Wasatch Fault Damage Zone, Utah." GSA Abstracts with Programs 47: 224.

Ault, A.K., P.W. Reiners, S.N. Thomson, and G.H. Miller. 2015. "Inverted Apatite (U-Th)/He and Fission-track Dates from the Rae Craton, Baffin Island, Canada, and Implications for Apatite Radiation Damage-He Diffusivity Models." Eos Transactions AGU. AGU Fall Meeting. V32B-04.

Baldwin, S.L. February 25, 2016. "Discovering the World's Youngest Exhumed Ultrahigh-pressure Terrane." Christchurch, New Zealand: Department of Geological Sciences, University of Canterbury.

Baldwin, S.L. March 31, 2016. "Geodynamic Evolution of New Zealand." Christchurch, New Zealand: Department of Geological Sciences, University of Canterbury.

Baldwin, S.L. October 1, 2015. "Discovering the World's Youngest Exhumed Ultrahigh-pressure Terrane." University of Pittsburgh: Department of Geology and Planetary Science Colloquium Series.

Baldwin, S.L., M.G. Malusà, P.G. Fitzgerald, and L.E. Webb. November 1-4, 2015. "Deciphering the 4-D Evolution of Cenozoic (U)HP Terranes." Invited, Geological Society of America Abstracts with Programs. Baltimore, MD.

Ballouard, C., M. Poujol, M. Jolivet, C. Dubois, E. Hallot, P. Boulvais, M.P. Dabard, and R. Tartése. 2015. "Geochronological and Thermochronological Constraints on the Carboniferous Magmatism of the Armorican Massif: from the Source to the Exhumation." Rennes: Variscan Meeting.

Ballouard, C., M. Poujol, P. Boulvais, J. Mercadier, R. Tartése, D. Gapais, P. Yamato, M. Jolivet, T. Vennemann, E. Deloule, M. Cathelineau, and M. Cuney. 2015. "Tectonic Record, Magmatic History and Hydrothermal Alteration in the Guérande Carboniferous Leucogranite, Armorican Massif, France: Implications on the Genesis of U Mineralization." Florianopolis, Brazil: 8th Hutton Symposium on Granites and Related Rocks.

Betka, P.M., S.N. Thomson, L. Seeber, M.S. Steckler, and R. Sincavage. Submitted abstract, 2016. "The Indo-Burma Ranges: Eocene - Pliocene Coevolution of the Paleo-Brahmaputra Fluvial-deltaic System and Indo-Burma Accretionary Prism." San Francisco, CA: AGU Fall Meeting.

Brigantic, A., Marcum, W.R. August 30-September 4, 2015. "Applying Uncertainty and Sensitivity on Thermal Hydraulic Subchannel Analysis for the Multi-Application Small Light Water Reactor." Chricago, IL: 16th International Topical Meeting on Nuclear Reactor Thermal Hydraulics 5512-5525.

Darin, M.H., P.J. Umhoefer, S.N. Thomson, and C. Lefebvre. 2015. "Structural Geology and Exhumation of the Paleogene Southern Sivas Fold and Thrust Belt, Central Anatolia, Turkey." Eos Transactions AGU. AGU Fall Meeting. T13B-2988.

Darin, M.H., P.J. Umhoefer, S.N. Thomson, and C. Lefebvre. Abstract accepted, 2016. "Orogen-parallel Variations in Structural Style and Tectonic Exhumation during the Miocene Collision-escape Transition in Anatolia." Denver, CO: GSA Annual Meeting.

Farsoni, A.T., E. Becker, L. Ranjbar, S. Czyz, and D.M. Hamby. October 15-16, 2015. "Radioxenon Detection via Beta-Gamma Coincidence Technique." University of Michigan, Ann Arbor, MI: 2015 CVT Workshop.

Fitzgerald, P.G., S.L. Baldwin, M.A. Bermúdez, L.E. Webb, T.A. Little, M.G. Malusà, S.R. Miller, and D. Seward. November 1-4, 2015. "Constraints from Low Temperature Thermochronology on Exhumation of (U)HP Terranes: the Eastern Papuan New Guinea Example." Geological Society of America Abstracts with Programs. Baltimore, MD.

Hansman, R., U. Ring, S.N. Thomson, B. den Brok, P.W. Reiners, and K. Stübner. Submitted abstract, 2016. "Constraining the Uplift History of the Jabal Akhdar and Saih Hatat Culminations, Al Hajar Mountains, Oman, with Fission-track and (U-Th)/He Ages." San Francisco, CA: AGU Fall Meeting.

Harmon, P.L., Marcum, W.R. August 30-September 4, 2015. "Comprehensive Characterization of a Helix Motion due to Flow Induced Vibration." Chicago, IL: 16th International Topical Meeting on Nuclear Reactor Thermal Hydraulics 7701-7713.

Hemming, S.R., S.A. Brachfeld, C.P. Cook, K.J. Licht, E.L. Pierce, P.W. Reiners, S.N. Thomson, T. van der Flierdt, and T.J. Williams. 2015. "Detrital Thermochronology of Antarctic Glacigenic Sediments: Insights into Past Ice Sheet Behavior and Antarctica's Hidden Geology." GSA Abstracts with Programs 47(7): 292.

Holschuh, T.V., Marcum, W.R., Chichester, D.L., Watson, S.M., Morrell, S.R. May 1-5, 2016. "Using Cherenkov Light to Quantify Reactor Kinetics Parameters and Infer Fissile Material Inventory for Nuclear Nonproliferation." Sun Valley, ID: The Physics of Reactors Conference, PHYSOR 2016 1-12.

Holschuh, T.V., Marcum, W.R., Morrell, S., Chichester, D.L. July 12-16, 2015. "Quantifying Kinetics Parameters using Cherenkov Light for Nonproliferation." Atlanta, GA: Institute of Nuclear Materials Management Annual Meeting 1-10.

Howard, T.K., Marcum, W.R., Jones, W.F. June 12-16, 2016. "Scaling Analysis of Vortex Shedding Frequency between Inline Plates." New Orleans, LA: American Nuclear Society Annual Meeting. Accepted.

Howard, T.K., Marcum, W.R., Latimer, G.D., Weiss, A., Jones, W.F., Phillips, A.M., Woolstenhulme, N., Holdaway, K., Campbell, J. June 12-16, 2016. "Accelerometers in Flow Fields: A Structural Analysis of the Chopped Dummy In-Pile Tube." New Orleans, Louisiana: Advances in Thermal Hydraulics, 2016 American Nuclear Society Annual Conference, Accepted.

King, J., R. Yanez, J.S. Barrett, W. Loveland, F. Tovesson, and N. Fotiades. February 2016. "Measurement of the Total Kinetic Energy Release as a Function of Bombarding Neutron Energy for 232Th(n,f)." Baltimore, MD: SSAA Symposium.

Latimer, G.D., Marcum, W.R., Jones, W.F. June 12-16, 2016. "Advanced Test Reactor Mini-Plate Hydraulic Testing." New Orleans, LA: American Nuclear Society Annual Meeting, Accepted.

Lefebvre, C., S.N. Thomson, D.L. Whitney, and C. Teyssier. 2015. "Uplift and Exhumation in Central Anatolia: New Results from Low-Temperature Chronometry in a Deeply Incised Granite in the Central Tauride Mountains, Turkey." Eos Transactions AGU. AGU Fall Meeting. T13B-2988.

Long, S.P., S.N. Thomson, P.W. Reiners, and R.V. DiFiori. 2015. "The Role of Upper-crustal Thickening in Spatially-focusing Synorogenic Extension: a Case Study from the Late Cretaceous-Paleocene Nevadaplano." Eos Transactions AGU. AGU Fall Meeting. T21B-2812.

Loveland, W. April 2016. "Large Scale Nuclear Collective Motion: Fusion, Fission, and Heavy Elements." College Station, TX: TAMU Student Selected Seminar.

Loveland, W. June 2015. "Heavy Element Fusion/Fission." New London, NH: 2015 Nuclear Chemistry Gordon Conference.

Loveland, W. June 2015. "The Quest for Superheavy Elements." Tahoe, CA: National Nuclear Physics Summer School.

Loveland, W. June 2016. "Characterizing the Mechanism(s) of Heavy Element Synthesis Reactions." Lund, Sweden: Proceedings of the 160th Nobel Symposium.

Loveland, W. May 2016. "Fission Product Yields and Nuclear Forensics." Corvallis, OR: OSU Nuclear Physics Program.

Minc, L., J. Pink, and V. Pérez Rodríguez. April 2016. "Evaluating the Evidence for Ceramic Exchange with the Valley of Oaxaca during the Late to Terminal Formative." The Cerro Jazmin Archaeological Project 2008-2015 - Discussing Early Urbanism and City Life in the Late and Terminal Formative Mixteca Alta, Mexico. Orlando, FL: 81st Annual Meeting, Society for American Archaeology.

Minc, L.D. October 30, 2015. "Pots, Clays, and Wasters: Mapping Out Ceramic Exchange Networks in the Late Classic Valley of Oaxaca." Invited lecture for the University of Oregon Anthropology Colloquium Series.

Murray, K.E., P.W. Reiners, X. Robert, S.N. Thomson, and K.X. Whipple. Abstract accepted, 2016. "Ogliocene Rock Cooling of the North-Central Colorado Plateau Region: Erosion or a Variable Geothermal Gradient?" Denver, CO: GSA Annual Meeting.

Painter, C.S., B. Carrapa, P.G. DeCelles, G.E. Gehrels, and S.N. Thomson. 2015. "Cretaceous Exhumation of the North American Cordillera Measured through Mineral Multi-dating: Insights into Basin Filling Models and Orogenic Architecture." Eos Transactions AGU. AGU Fall Meeting. V52C-04.

Ranjbar, L., A.T. Farsoni, and E.M. Becker. October 31 - November 7, 2015. "Development of a Two-channel CZT-based Detection System for Atmospheric Radioxenon Measurement." San Diego, CA: The IEEE Nuclear Science Symposium.

Ranjbar, L., A.T. Farsoni, E. Becker, and D.M. Hamby. October 15-16, 2015. "Coincidence Simulation of a Two-channel CZT-based Radioxenon Detector." University of Michigan, Ann Arbor, MI: 2015 CVT Workshop.

Ring, U., K. Gessner, S.N. Thomson, and V. Markwitz. 2015. "Why Lithospheric Extension Separated the Aegean from Turkey." Eos Transactions AGU. AGU Fall Meeting. T23F-05.

Sobczyk, A., and E.R. Sobel. October 4-7, 2015. "Apatite Fission-track Dating Reveals post-Variscan History of the Orlica-Snieznik Dome, Eastern Sudetes Mts. (Bohemian Massif, SW Poland)." Berlin: GeoBerlin2015 - Dynamic Earth from Alfred Wegener to Today and Beyond. doi:10.2312/gfz.lis.2015.003.

Sobel, E.R. October 4-7, 2015. "Cenozoic Evolution of the North Pamir and the Tien Shan." Berlin: GeoBerlin2015 - Dynamic Earth from Alfred Wegener to Today and Beyond. doi:10.2312/gfz.lis.2015.003.

Thomson, S.N. Submitted abstract, 2016. "Constraining the Uplift History of the Jabal Akhdar and Saih Hatat Culminations, Al Hajar Mountains, Oman, with Fission-track and (U-Th)/He Ages." San Francisco, CA: AGU Fall Meeting.

Thomson, S.N., C. Lefebvre, P.J. Umhoefer, M.H. Darin, D.L. Whitney, and C. Teyssier. Submitted abstract, 2016. "Late Cenozoic Thermochronology and Exhumation History of Central Anatolia: Implications for the Timing and Nature of Transition from Collision to Escape Tectonics." San Francisco, CA: AGU Fall Meeting.

Thomson, S.N., G.S. Soreghan, P.W. Reiners, S.L. Peyton, and K.E. Murray. Abstract accepted, 2016. "A Definitive 6 Ma Start Date for Carving of the Northeastern Colorado Plateau Canyonlands." Denver, CO: GSA Annual Meeting.

Thomson, S.N., G.S. Soreghan, P.W. Reiners, S.L. Peyton, and K.E. Murray. 2015. "A Precise 6 Ma Start Date for Fluvial Incision of the Northeastern Colorado Plateau Canyonlands." Eos Transactions AGU. AGU Fall Meeting. EP41A-0914.

Veselovskiy, R.V., S.N. Thomson, A.A. Arzamastsev, and V.S. Zakharov. 2015. "Apatite Fission-track Thermochronology of Khibina Massif (Kola Peninsula, Russia): Implications for post-Devonian Tectonics of the NE Fennoscandia." Eos Transactions AGU. AGU Fall Meeting. T13A-2953.

Walker, K.L., B. Carrapa, S.N. Thomson, and A.L. Stevens. Abstract accepted, 2016. "Climatic and Tectonic Control on Erosion across the Alpine Fault, South Island, New Zealand." Denver, CO: GSA Annual Meeting.

Webb, L.E., and K.A. Klepeis. 2015. "Punctuated Melt-enhanced Deformation and Tectonic Reactivation Above a Long-lived Subduction Zone, Coastal Andes, Central Chile." Geological Society of America Abstracts with Programs 47 (7): 495.

Whitney, D.L., M.J. Meijers, C. Lefebvre, M.A. Cosca, S.N. Thomson, and A. Mulch. 2016. "Tracking Anatolian Lithosphere Evolution with 'Tectonochemistry'." Goldschmidt Conference Abstracts. 3409.

Students

Ballouard, C. PhD thesis, December 2016. "Geochronology and Thermochronology of the Carboniferous High Heat Production Belt Granites, Armorican Massif (France)." University of Rennes. (Advisors M. Poujol and M. Jolivet).

Bande, Alejandro. PhD thesis, expected 2016. "Constraining Deformation History of the Talas-Fergana Strike-Slip Fault and Kinematically-linked Thrust Faults, Kyrgyz Republic." (Advisor Prof. E. Sobel).

Barrett, J.S. PhD, September 2015. "The 136Xe + 208Pb Reaction: a Test of Models of Multi-nucleon Transfer Reactions."

Brombin, Valentina. PhD in progress. "Geochemical Characterization of Lithotypes of Veneto Volcanic Province." University of Ferrara, Italy. (Advisor M. Coltorti).

Brown, Emory. MS student, expected 2017. "Numerical Benchmark of a prototypic TREAT Water Flow Loop using TRACE." Nuclear Engineering, OSU.

Danielson, Jordan. MS student, expected summer 2016. "On the Design of a Particle Image Velocimetry System to support NuScale Design Certification Testing." Nuclear Engineering, OSU. (Co-chair W.R. Marcum).

Deeken, Anke. PhD thesis, expected 2017. "Long-term Erosion and Exhumation Rates across Different Climatic Zones in the Indian NW Himalaya." Universitaet Potsdam. (Advisor Prof. M. Strecker).

Eugster, Patricia. PhD thesis, expected 2016. "Competing Influence of Fluvial and Glacial Erosion in the Western Himalaya." (Advisor M. Strecker).

Georgieva, Viktoria. PhD thesis, expected 2016. "The Late Cenozoic Evolution of Topography in the Patagonian Andes." (Advisor M. Strecker).

Goodrich, Samuel. PhD candidate, expected winter 2016. "The Transition to Turbulence in Natural Convection Flow Adjacent to Vertical Heated Cylinders." Nuclear Engineering, OSU.

Holschuh, Thomas, PhD candidate, expected summer 2016. "Quantifying Reactor Kinetics Parameters for Nonproliferation Using Cherenkov Light." Nuclear Engineering, OSU.

Howard, Trevor. PhD candidate, expected winter 2017. "On the Influence of Vortical Structures and Trailing Plates in axial flow." Nuclear Engineering, OSU.

Jia, Y. PhD, January 2016. "Cenozoic Tectonic and Geomorphological Evolution of the SW Chinese Tian Shan." Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing. (Advisors B. Fu and M. Jolivet).

King, J. PhD in progress. Study of the 232Th(n.f) reaction.

Lagor, Samuel. MS, 2016. "The Relationship between Magmatism, Deformation, and Metamorphism during the Acadian Orogeny: A Case Study from the Knox Mountain Pluton, Green Mountains, Vermont, USA." University of Vermont. (Advisor L. Webb).

Latimer, Griffen. MS student, expected spring 2016. "Comprehensive Characterization of Motion of In-Pile Advanced Test Reactor Fuel Experiments based on Accelerometer Measurements and Fluid Structure Interactions." Nuclear Engineering, OSU.

McCaleb, K. PhD in progress. Study of Multi-nucleon transfer reactions.

Nation, Humberto. PhD in progress.

Nieblas, Andrew. MS, 2016. "Pressure-Temperature-Time-Deformation History of the Lahul Valley, NW Indian Himalaya." San Francisco State University. (Advisor M. Leech).

Nighbert, Christopher. MS student, expected spring 2017. "Thermal and Hydrodynamic Mixing in the Suppression Pool of the NuScale Integral Scaled Test Facility using PIV and LIF." Nuclear Engineering, OSU. (Co-chair W.R. Marcum).

Nixon, Chad. PhD student, expected spring 2017. "A New Measurement Technique for Quantifying Flow Induced Vibration of a Cylindrical Rod under Axial Flow." Nuclear Engineering, OSU.

Pink, Jeremias. PhD in progress.

Ranjbar, Leila. PhD, March 2016. "A Two-channel CZT-based Radioxenon Detection System for Nuclear Weapons Test Monitoring."

Robertson, B.R. MS, December 2015.

Ruksznis, Abigail. MS, 2015. "Geology and Geochronology of Cenozoic Sedimentary Basins, East-Central Nevada." Stanford University. (Advisor E. Miller).

Torres, Veronica Acosta. PhD, 2016. "Morphotectonic Evolution of the Kenya rift and Erosion Processes on Different Time Scales Using Cosmogenic Nuclides and (U-Th)/He Dating." (Advisor M. Strecker).

Walker, Sarah T. MA thesis, 2016. "Pottery, Politics, and Trade Routes: Evaluating Independence in Late Classic Jalieza, Oaxaca." Applied Anthropology, OSU.

Wei, Youran. MS student, expected fall 2015. "Experimental Measurement and Characterization of Oxide Growth on Preconditioned Aluminum." Material Science, OSU. (Co-chair W.R. Marcum).

Yao, L. PhD in progress. Study of PCN in hot fusion reactions.

Zabriskie, Adam. PhD candidate, expected spring 2016. "Fuel Particle Effects on TREAT Fuel Transients using MAMMOTH." Nuclear Engineering, OSU.

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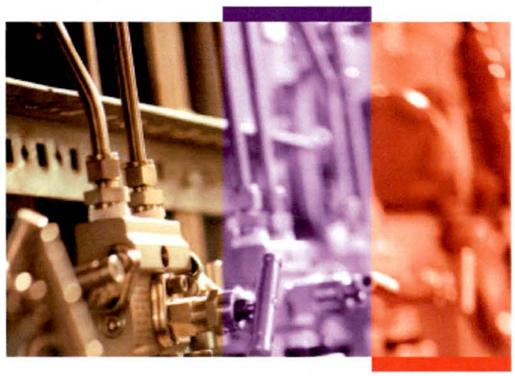

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