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October 26, 2011

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, 2010 through June 30, 2011.

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: 10/26/11

Sincerely,

Steven R. Reese
Director

Cc: Alexander Adams, USNRC
Craig Bassett, USNRC
Ken Niles, ODOE
Rick Spinrad, OSU
Rich Holdren, OSU
Andy Klein, OSU

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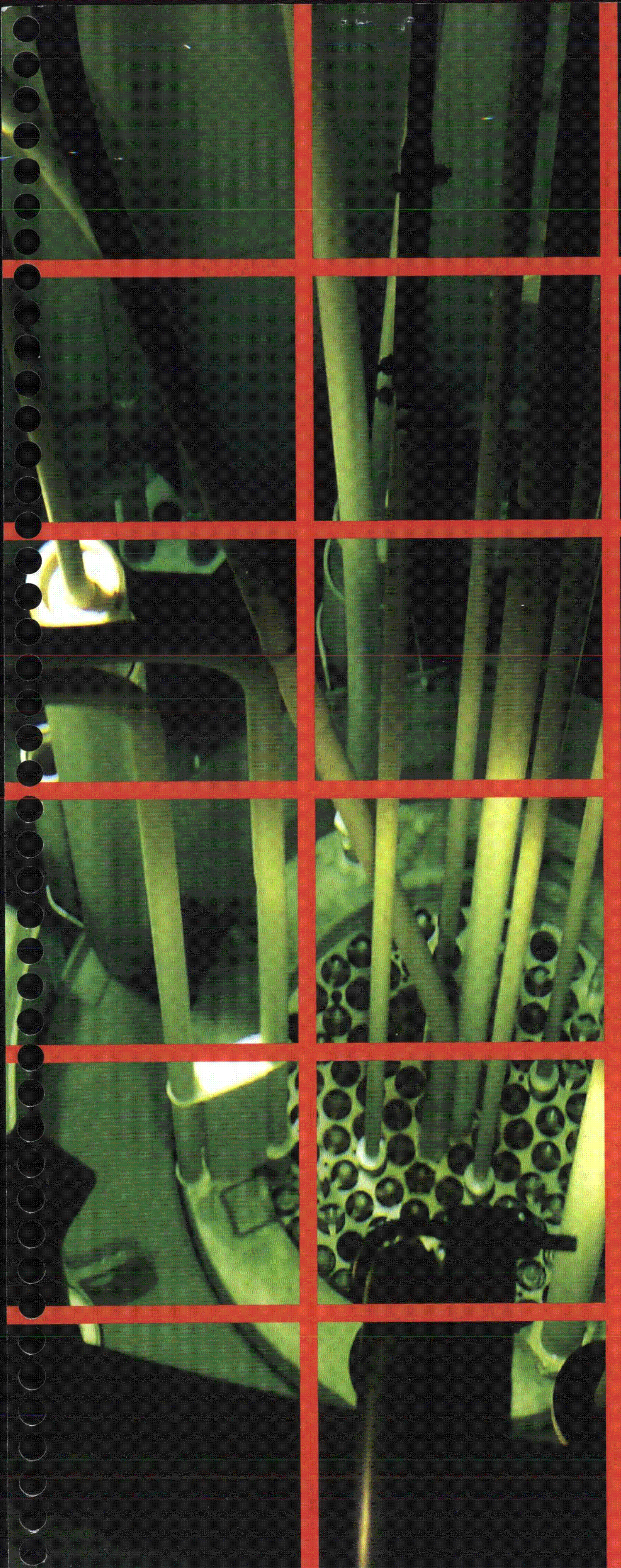
NRR



Radiation Center and TRIGA Reactor

Annual Report

July 1, 2010 — June 30, 2011

OSU
Oregon State
UNIVERSITY

Submitted by:
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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.

Contents

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Overview

Executive Summary

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

The Radiation Center supported 61 different courses this year, mostly in the Department of Nuclear Engineering and Radiation Health Physics. About 25% of these courses involved the OSTR. The number of OSTR hours used for academic courses and training was 60, while 3,395 hours were used for research projects. Seventy-four percent 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 100 articles this year, and made 93 presentations on work that involved the OSTR or Radiation Center. The number of samples irradiated in the reactor during this reporting period was 688. Funded OSTR use hours comprised 88% of the research use.

Personnel at the Radiation Center conducted 147 tours of the facility, accommodating 2,313 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 201. Reactor related projects comprised 68% of all projects. The total research supported by the Radiation Center, as reported by our researchers, was $3,813,423. The actual total is likely considerably higher. This year the Radiation Center provided service to 65 different organizations/institutions, 29% of which were from other states and 23% 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, 2010 through June 30, 2011. 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 Radiation Center staff regularly provides direct support and assistance to OSU teaching and research programs. Areas of expertise commonly involved in such efforts include nuclear engineering, nuclear and radiation chemistry, neutron activation analysis, radiation effects on biological systems, radiation dosimetry, environmental radioactivity, production of short-lived radioisotopes, radiation shielding, nuclear instrumentation, emergency response, transportation of radioactive materials, instrument calibration, radiation health physics, radioactive waste disposal, and other related areas.

In addition to formal academic and research support, the Center's staff provides a wide variety of other services including public tours and instructional programs, and professional consultation associated with the feasibility, design, safety, and execution of experiments using radiation and radioactive materials.

People

This section contains a listing of all people who were residents of the Radiation Center or who worked a significant amount of time at the Center during this reporting period.

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

Radiation Center Staff

Steve Reese, Director

Dina Pope, Office Manager

Shaun Bromagem, Business Manager

Carla Gibson, Receptionist

S. Todd Keller, Reactor Administrator

Gary Wachs, Reactor Supervisor, Senior Reactor Operator

Robert Schickler, Senior Reactor Operator

Wade Marcum, Reactor Operator

Scott Menn, Senior Health Physicist

Jim Darrough, Health Physicist

Leah Minc, Neutron Activation Analysis Manager

Steve Smith, Scientific Instrument Technician, Senior Reactor Operator

Erin Cimbri, Custodian

Alison Arnold, Health Physics Monitor (Student)

Ryne Burgess, Health Physics Monitor (Student)

Kyle Combs, Health Physics Monitor (Student)

Joel Moreno, Health Physics Monitor (Student)

Joey DeShields, Graduate Teaching Assistant

Reactor Operations Committee

Todd Palmer, Chair
OSU Nuclear Engineering and Radiation Health Physics

Rainier Farmer
OSU Radiation Safety

Abi Tavakoli Farsoni
OSU Nuclear Engineering and Radiation Health Physics

Michael Hartman
University of Michigan

Todd Keller
OSU Radiation Center

Mario Magana
OSU Electrical Engineering

Scott Menn
OSU Radiation Center

Wade Richards
National Institute of Standards and Technology

Steve Reese *(not voting)*
OSU Radiation Center

Gary Wachs *(not voting)*
OSU Radiation Center

Bill Warnes
OSU Mechanical Engineering

Professional and Research Faculty

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

Daniels, Malcolm
Professor Emeritus, Chemistry

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

Hart, Lucas P.
Faculty Research Associate, Chemistry

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

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

Johnson, Arthur G.
Director Emeritus, Radiation Center, Professor Emeritus, 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

Camille Lodwick
Assistant Professor, Nuclear Engineering and Radiation Health Physics

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

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

****Minc, Leah***
Assistant Professor, Anthropology

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

****Paulenova, Alena***
Associate Professor, Senior Research, Radiation Center

Pope, Dina
Office Manager, Radiation Center

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

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

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

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

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

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

Woods, Brian
Associate Professor, Nuclear Engineering and Radiation Health Physics

Wu, Qiao
Professor, Nuclear Engineer and Radiation Health Physics

**OSTR users for research and/or teaching*

Facilities

Research Reactor

The Oregon State University TRIGA Reactor (OSTR) is a water-cooled, swimming pool type research reactor which uses uranium/zirconium hydride fuel elements in a circular grid array. The reactor core is surrounded by a ring of graphite which serves to reflect neutrons back into the core. The core is situated near the bottom of a 22-foot deep water-filled tank, and the tank is surrounded by a concrete bioshield which acts as a radiation shield and structural support. The reactor is licensed by the U.S. Nuclear Regulatory Commission to operate at a maximum steady state power of 1.1 MW and can also be pulsed up to a peak power of about 2500 MW.

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

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

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

The **beam ports** are tubular penetrations in the reactor's main concrete shield which enable neutron and gamma radiation to stream from the core when a beam port's shield plugs are removed. The neutron radiography facility utilized the tangential beam port (beam port #3) to produce ASTM E545 category I radiography capability. The other beam ports are available for a variety of experiments.

If samples to be irradiated require a large neutron fluence, especially from higher energy neutrons, they may be inserted into a dummy fuel element. This device will then be placed into one of the core's inner grid positions which would normally be occupied by a fuel element. Similarly samples can be placed in the **in-core irradiation tube (ICIT)** which can be inserted in the same core location.

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

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

Instruction

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

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

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

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

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

Analytical Equipment

The Radiation Center has a large variety of radiation detection instrumentation. This equipment is upgraded as necessary, especially the gamma ray spectrometers with their associated computers and germanium detectors. Additional equipment for classroom use and an extensive inventory of portable radiation detection instrumentation are also available.

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

Radioisotope Irradiation Sources

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

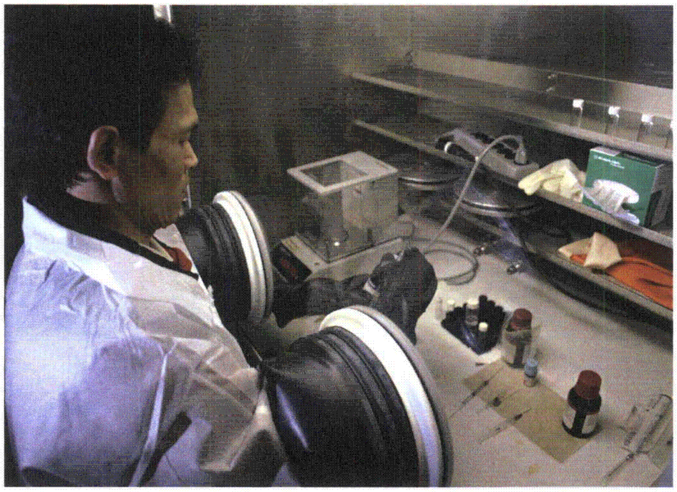
Typically, the irradiator is used by researchers wishing to perform mutation and other biological effects studies; studies in the area of radiation chemistry; dosimeter testing; sterilization of food materials, soils, sediments, biological specimen, and other media; gamma radiation damage studies; and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

During this reporting period there was a diverse group of projects using the ^{60}Co irradiator. These projects included the irradiation of a variety of biological materials including different types of seeds.

In addition, the irradiator was used for sterilization of several media and the evaluation of the radiation effects on different materials. Table III.1 provides use data for the Gammacell 220 irradiator.

Laboratories and Classrooms

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



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

In addition to these dedicated instructional facilities, many other research laboratories and pieces of specialized equipment are regularly used for teaching. In particular, classes are routinely given access to gamma spectrometry equipment located in Center laboratories. A number of classes also regularly use the OSTR and the Reactor Bay as an integral part of their instructional coursework.

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

This reporting period saw continued high utilization of the Radiation Center's thermal hydraulics laboratory. This laboratory is being used by Nuclear Engineering faculty members to accommodate a one-quarter scale model of the Palisades Nuclear Power reactor. The multi-million dollar advanced plant experimental (APEX) facility was fully utilized by the U. S. Nuclear Regulatory Commission to provide licensing data and to test safety systems in "beyond design basis" accidents. The fully scaled, integral model APEX facility uses electrical heating elements to simulate the fuel elements, operates at 450°F and 400 psia, and responds at twice real time. It is the only facility of its type in the world and is owned by the U. S. Department of Energy and operated by OSU. In addition, a new building, Advanced Thermal Hydraulics Research Laboratory (ATHRL) was constructed next to the Reactor Building in 1998.

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 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 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, rock cores, pig skin	$2.5x10^6$ to $4.0x10^6$	35	3362
Material Evaluation	polymers, wood, electronic components	$3.0x10^5$ to $2.5x10^6$	4	188
Botanical Studies	wheat seeds, wheat pollen	$1.5x10^3$ to $2.5x10^3$	78	4
Totals			117	3554

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 2010	Fall 2010	Winter 2011	Spring 2011
NE/ RHP 114*	2	Introduction to Nuclear Engineering and Radiation Health Physics		41		
NE/ RHP 115	2	Introduction to Nuclear Engineering and Radiation Health Physics			64	
NE/ RHP 116**	2	Introduction to Nuclear Engineering and Radiation Health Physics				53
NE/ RHP 234	4	Nuclear and Radiation Physics I		70		
NE/ RHP 235	4	Nuclear and Radiation Physics II			68	
NE/ RHP 236*	4	Nuclear Radiation Detection & Instrumentation				57
NE 311	4	Intro to Thermal Fluids	1	25	6	
NE 312	4	Thermodynamics			19	11
NE 319	3	Societal Aspects of Nuclear technology			46	
NE 331	4	Intro to Fluid Mechanics			16	12
NE 332	4	Heat Transfer		11		18
NE/RHP 333	3	Mathematical methods for NE/RHP			25	
NE/RHP 401/501/601	1-16	Research	6	19	16	15
NE/RHP 405/505/605	1-16	Reading and Conference	1	10	7	1
NE/RHP 406/506/606	1-16	Projects	1	1		
NE/RHP 407/507/607	1	Nuclear Engineering Seminar		62	70	43
NE/ RHP 410/510/610	1-12	Internship		2	1	
NE/ RHP 415/515	2	Nuclear Rules and Regulations		60		
NE 451/551	4	Neutronic Analysis		34		
NE 452/552	4	Neutronic Analysis			31	
NE 457/557**		Neuclear Reactor Lab				30
NE 467/567	4	Nuclear Reactor Thermal Hydraulics		27		
NE 667	4	Nuclear Reactor Thermal Hydraulics				
NE/RHP 435/535		External Dosimetry & Radiation Shielding				51
NE 474/574	4	Nuclear System Design I			25	
NE/RHP 475/575	4	Nuclear System Design II				31
NE/RHP 479*	1-4	Individual Design Project				
NE/RHP 481*	4	Radiation Protection		40		

Table III.2 (continued)

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

Course #	CREDIT	COURSE TITLE	Number of Students Summer 2010	Fall 2010	Winter 2011	Spring 2011
NE/RHP 582*	4	Applied Radiation Safety			31	
RHP 483/583	4	Radiation Biology			32	
RHP 488/588*	3	Radioecology		32		
NE/RHP 590	4	Internal Dosimetry			11	
NE/RHP 503/603	1	Thesis	17	45	37	39
NE/ RHP 516*	4	Radiochemistry	17			7
NE 526	3	Numerical Methods for Engineering Analysis			8	
NE/RHP 531	3	Nuclear Physics for Engineers and Scientists		49		
NE/RHP 536*		Advanced Radiation Detection & Measurement			21	
NE/RHP 537		Digital Spectrometer Design				
MP 541		Diagnostic Imaging Physics			19	
NE 550	3	Nuclear Medicine				
NE 553*	3	Advanced Nuclear Reactor Physics				13
NE 568	3	Nuclear Reactor Safety				
Course From Other OSU Departments						
CH 123*	5	General Chemistry				546
CH 222*	5	General Chemistry (Science Majors)			769	
CH 225H*	5	Honors General Chemistry			45	
CH 462*	3	Experimental Chemistry II Laboratory			21	
GEO 330*	3	Environmental Conservation			0	
PH 202	5	General Physics			314	

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

Reactor

Operating Status

During the operating period between July 1, 2010 and June 30, 2011, the reactor produced 1283 MWH of thermal power during its 1380 critical hours. The new low enriched uranium (LEU) fuel loading continued to provide a neutron fluence consistent with SAR analysis values.

Experiments Performed

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

- A-1 Normal TRIGA Operation (No Sample Irradiation).
- B-3 Irradiation of Materials in the Standard OSTR Irradiation Facilities.
- B-11 Irradiation of Materials Involving Specific Quantities of Uranium and Thorium in the Standard OSTR Irradiation Facilities.
- B-12 Exploratory Experiments.
- B-23 Studies Using TRIGA Thermal Column.
- B-29 Reactivity Worth of Fuel.
- B-31 TRIGA Flux Mapping.
- B-33 Irradiation of Combustible Liquids in Rotating Rack.
- B-34 Irradiation of enriched uranium in the Neutron Radiography Facility.
- B-35 Irradiation of enriched uranium in the PGNAA Facility.

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

Inactive Experiments

Presently 33 experiments are in the inactive file. This consists of experiments which have been performed in the past and may be reactivated. Many of these experiments are now performed under the more general experiments listed in the previous section. The following list identifies these inactive experiments.

- A-2 Measurement of Reactor Power Level via Mn Activation.
- A-3 Measurement of Cd Ratios for Mn, In, and Au in Rotating Rack.
- A-4 Neutron Flux Measurements in TRIGA.
- A-5 Copper Wire Irradiation.
- A-6 In-core Irradiation of LiF Crystals.
- A-7 Investigation of TRIGA's Reactor Bath Water Temperature Coefficient and High Power Level Power Fluctuation.
- B-1 Activation Analysis of Stone Meteorites, Other Meteorites, and Terrestrial Rocks.
- B-2 Measurements of Cd Ratios of Mn, In, and Au in Thermal Column.
- B-4 Flux Mapping.
- B-5 In-core Irradiation of Foils for Neutron Spectral Measurements.
- B-6 Measurements of Neutron Spectra in External Irradiation Facilities.
- B-7 Measurements of Gamma Doses in External Irradiation Facilities.
- B-8 Isotope Production.
- B-9 Neutron Radiography.
- B-10 Neutron Diffraction.
- B-13 This experiment number was changed to A-7.
- B-14 Detection of Chemically Bound Neutrons.

B-15 This experiment number was changed to C-1.
B-16 Production and Preparation of ^{18}F.
B-17 Fission Fragment Gamma Ray Angular Correlations.
B-18 A Study of Delayed Status (n, γ) Produced Nuclei.
B-19 Instrument Timing via Light Triggering.
B-20 Sinusoidal Pile Oscillator.
B-21 Beam Port #3 Neutron Radiography Facility.
B-22 Water Flow Measurements Through TRIGA Core.
B-24 General Neutron Radiography.
B-25 Neutron Flux Monitors.
B-26 Fast Neutron Spectrum Generator.
B-27 Neutron Flux Determination Adjacent to the OSTR Core.
B-28 Gamma Scan of Sodium (TED) Capsule.
B-30 NAA of Jet, Diesel, and Furnace Fuels.
B-32 Argon Production Facility
C-1 PuO_2 Transient Experiment.

Unplanned Shutdowns

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

Changes Pursuant to10 CFR 50-59

Nine new safety evaluation screens were performed in support of reactor operations this year. They were:

10-04, RCHPP-6, Changes to update or correct to current shipping regulations

Description

Change maintains compliance with domestic and international radioactive materials shipping regulations.

10-05, OSTROP 5, Procedural changes

Description

Typographical or clerical changes made to add clarification to procedure. Items identified during ROC and independent reviews.

10-06, Changes to the Pneumatic Rabbit System

Description

Rabbit system hardware upgrade utilizing programmable logic controller (PLC) in place of current relay logic system, and the replacement of analog exposure timer with digital system. Optical sensor installed to detect sample insertion and installation of a static pressure sensor to determine loss of motive flow. An inline solenoid operated valve at discharge of blower to prevent idle time Argon production.

10-07, Changes to RCHPP 34, Orientation and Training Programs

Description

Added new facility (ANSEL) and removed references to reactor bay fire door. Call lists were updated, floor maps revised and clerical errors corrected.

10-08, Changes to the Pneumatic Rabbit System

Description

An additional vibration sensor was added to the return portion of the rabbit transit tube to achieve greater accuracy of irradiation and transit times to allow higher power/shorter irradiation times. Software was modifies to automatically record transit times.

11-01, Replacement of the Console Trendview Recorder

Description

Failed console digital recording meter replaced with similar type.

11-02, Changes to OSTROP 10, Operating Procedures for Reactor Experimental Facilities

Description

Procedural correction for Technical Specification violation 3.8.1.a, Reactivity Limits; adds statement to measure reactivity of unsecured experiments in ICIT, CLICIT and GRICIT before being used as a movable experiment.

11-03, Changes to the Beam Port #4 PGNAA controller and OSTROP 10

Description

Existing PGNAA relay logic control system replaced with a new PLC based controller. Remote and local status lights upgraded and local interface display created to clearly show component status and to provide a touch screen operating platform. System outputs are also provided for external system operation and monitoring. Change over includes interlock and operation testing criteria.

11-04, Changes to the Beam Port #4 PGNAA Controller

Description

One additional output created to allow external access to pulse output from the installed beam monitor fission chamber. Optical isolation maintained for all output signals.

Surveillance and Maintenance

Non-Routine Maintenance

October 2010

- Replaced bay heating system large steam supply with an even larger 2.5" valve. The engineer had determined that the supply of steam was inadequate to meet heat demand for bay.
- Reactor bay crane inspected by KoneCranes, Several deficiencies were corrected.
- Replaced 24VAC power supplies for console RPIs and the Percent Power channel.

November 2010

- Upgraded the pneumatic transfer system controller and added additional control components.
- Both bay heating system condensate return pump seals were replaced by Facility Services.

December 2010

- Replenished our supply of secondary system pH control chemical.

January 2011

- Inverter batteries replaced due to failure during short power spike.
- Replaced failed fission chamber pre-amp.

February 2011

- Replaced failed bay air compressor (Corkin) with a standard upright tank type.

March 2011

- Replaced a failed Trendview console recorder with similar type.

May 2011

- Replaced older720p flat screen in visitor's gallery with new 42" 1280p model.

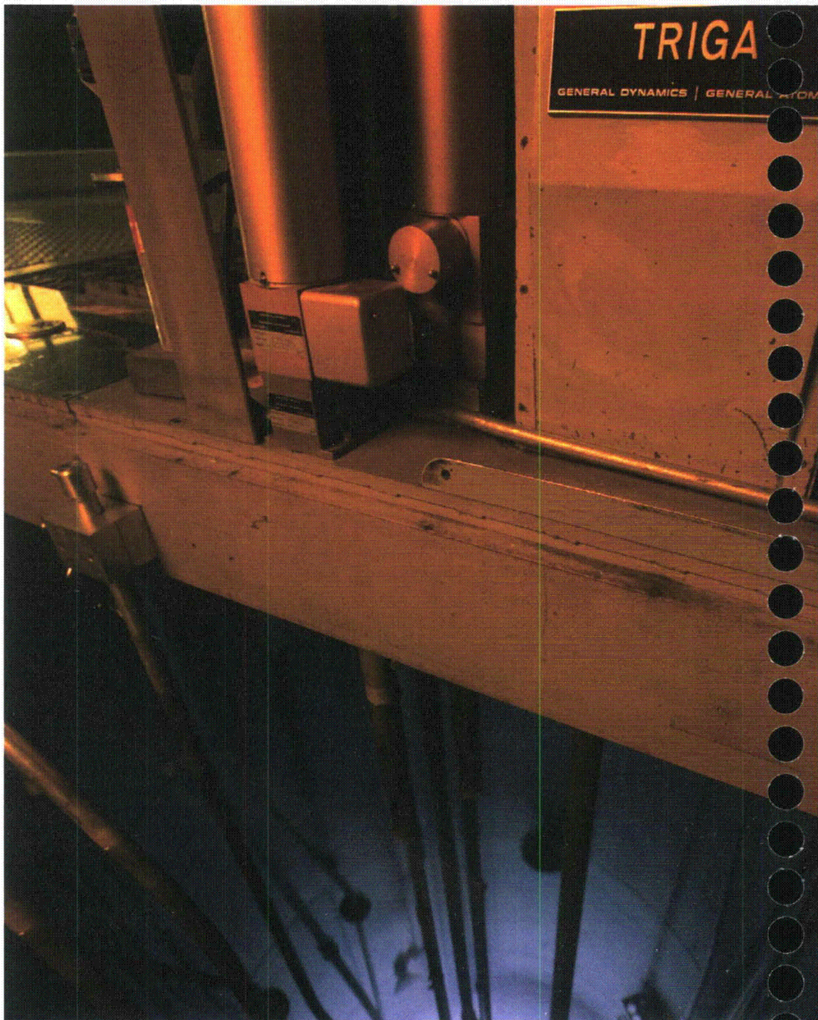


Table IV.1
Present OSTR Operating Statistics

Operational Data For LEU Core	Annual Values (2010/2011)	Cumulative Values
MWH of energy produced	1283	3258
MWD of energy produced	53.5	135.8
Grams ^{235}U used	74	188
Number of fuel elements added to (+) or removed(-) from the core	0	90
Number of pulses	30	95
Hours reactor critical	1381	3586
Hours at full power (1 MW)	1279	3240
Number of startup and shutdown checks	254	438
Number of irradiation requests processed	279	467
Number of samples irradiated	1116	2308

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)	60	13,531.5
OSU Research	885	14,278
Off Campus research	2,510	34,142
Demonstrations	3	20
Reactor preclude time	936	29,408
Facility time	0	7,196
Total Reactor Use Time	4,394	98,809.5

Table IV.3
OSTR Multiple Use Time

Number of Users	Annual Values (hours)	Cumulative Values (hours)
Two	490	7,987
Three	369	3,532
Four	216	1,658
Five	78	460
Six	0.5	98
Seven	0	23
Total Multiple Use Time	1,153.5	13,758

Table IV.4
Use of OSTR Reactor Experiments

Experiment Number	Research	Teaching	Other	Total
A-1	7	8	0	15
B-3	227	27	0	254
B-35	3	0	0	3
B-31	7	0	0	7
Total	244	35	0	279

Table IV.5
Unplanned Reactor Shutdowns and Scrams

Type of Event	Number of Occurrences	Cause of Event
Manual Scram	1	Radiation Center drill response.
Manual Scram	3	Training scrams.
Period	1	Fission Chamber preamp failure.
Percent Power Channel	1	Void creation during power calibration.

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

OSTROP 13, Rev. LEU-1 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 $\pm$3 INCHES	UP:________INCHES DN: ________INCHES ANN:__________				
2	BULK WATER TEMPERATURE ALARM CHECK	FUNCTIONAL					
3	CHANNEL TEST OF REACTOR TOP CAM AND STACK CAM	3600$\pm$100 cpm	Rx Top______ Stack ________	—	—	—	—
4.A	MEASUREMENT OF REACTOR PRIMARY WATER CONDUCTIVITY	<5 µmho\cm					
4.B	PRIMARY WATER Ph MEASUREMENT	MIN: 5 MAX: 8.5					
5	BULK SHIELD TANK WATER Ph MEASUREMENT	MIN: 5 MAX: 8.5					
6	CHANGE LAZY SUSAN FILTER	FILTER CHANGED					
7	REACTOR TOP CAM OIL LEVEL CHECK	OSTROP 13.10	NEED OIL?______				
8	PROPANE TANK LIQUID LEVEL CHECK	> 50%					
9	PRIMARY PUMP BEARINGS OIL LEVEL CHECK	OSTROP 13.13	NEED OIL?______				
10	WATER MONITOR CHECK						

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

Figure IV.2

Quarterly Surveillance and Maintenance (Sample Form)

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

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	REACTOR OPERATION COMMITTEE (ROC) AUDIT	QUARTERLY					
2	QUARTERLY ROC MEETING	QUARTERLY					
3	NOT CURRENTLY USED	N/A					N/A
4	ERP INSPECTIONS	QUARTERLY					
5	NOT CURRENTLY USED	N/A					N/A
6	ROTATING RACK CHECK FOR UNKNOWN SAMPLES	EMPTY					
7	WATER MONITOR ALARM CHECK	FUNCTIONAL					
8	STACK MONITOR CHECKS (OIL DRIVE MOTORS, H.V. READINGS)	MOTORS OILED					
		PART: 1150 V ± 50	_____V				
		GAS: 900 V ± 50	_____V				
9	CHECK FILTER TAPE SPEED ON STACK MONITOR	1"/HR ± 0.2					
10	INCORPORATE 50.59 & ROCAS INTO DOCUMENTATION	QUARTERLY					
11	STACK MONITOR ALARM CIRCUIT CHECKS	ALARM ON CONTACT					

Figure IV.2 (continued)

Quarterly Surveillance and Maintenance (Sample Form)

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

	SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
12	ARM SYSTEM ALARM CHECKS	FUNCTIONAL					

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

13	OPERATOR LOG	a) ≥4 hours: at console (RO) or as Rx. Sup. (SRO) b) Complete Operating Exercise	a) TIME	b) OPERATING EXERCISE			

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

Figure IV.3

Semi-Annual Surveillance and Maintenance (Sample Form)

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

		SURVEILLANCE & MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]	LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	FUNCTIONAL CHECKS OF REACTOR INTERLOCKS	NEUTRON SOURCE COUNT RATE INTERLOCK	NO WITHDRAW					
			≥5 cps					
		TRANSIENT ROD AIR INTERLOCK	NO PULSE					
		PULSE PROHIBIT ABOVE 1 kW	≥1 kW					
		TWO ROD WITHDRAWAL PROHIBIT	1 only					
		PULSE MODE ROD MOVEMENT INTERLOCK	NO MOVEMENT					
		MAXIMUM PULSE REACTIVITY INSERTION LIMIT	≤ $2.50					
		PULSE INTERLOCK ON RANGE SWITCH	NO PULSE					
2	SAFETY CIRCUIT TEST	PERIOD SCRAM	≥3 sec					
3	NOT CURENTLY USED							
4	TEST PULSE	PULSE # ________ $________ ________MW ________°C	≤20% CHANGE	PULSE # ______ $________ ________MW ________°C				
5	NOT CURRENTLY USED							N/A
6	NOT CURRENTLY USED							N/A
7	NOT CURRENTLY USED							N/A

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

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

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

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

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

Figure IV.4

Annual Surveillance and Maintenance (Sample Form)

OSTROP 16, Rev. LEU-1 Annual Surveillance and Maintenance for 20______

	SURVEILLANCE AND MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]		LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
1	BIENNIAL INSPECTION OF CONTROL RODS:	FFCRS	OSTROP 12.0					
		TRANS						
2	ANNUAL REPORT		NOV 1		OCT 1	NOV 1		
3	CONTROL ROD CALIBRATION:	NORMAL	OSTROP 9.0					
		CLICIT						
		ICIT/DUMMY						
4	REACTOR POWER CALIBRATION		OSTROP 8.0					
5	CALIBRATION OF REACTOR TANK WATER TEMP TEMPERATURE METERS		OSTROP 16.5					
6	CONTINUOUS AIR MONITOR CALIBRATION:	Particulate Monitor	RCHPP 18					
		Gas Monitor						
7	STACK MONITOR CALIBRATION	Particulate Monitor	RCHPP 18 & 26					
		Gas Monitor						
8	AREA RADIATION MONITOR CALIBRATION		RCHPP 18.0					
9	DECOMMISSIONING COST UPDATE		N/A	N/A		AUGUST 1		

* Date not be exceeded is only applicable to shaded items. It is equal to the date completed last year plus 15 months.
For biennial license requirements, it is equal to the date completed last time plus 2 1/2 years.

Figure IV.4 (continued)

Annual Surveillance and Maintenance (Sample Form)

OSTROP 16, Rev. LEU-1 — Annual Surveillance and Maintenance for 20______

SURVEILLANCE AND MAINTENANCE [SHADE INDICATES LICENSE REQUIREMENT]			LIMITS	AS FOUND	TARGET DATE	DATE NOT TO BE EXCEEDED*	DATE COMPLETED	REMARKS & INITIALS
10	SNM PHYSICAL INVENTORY							
11	MATERIAL BALANCE REPORTS							
12	STANDARD CONTROL ROD DRIVE INSPECTION							
13	CORE EXCESS		≤$7.55	NORMAL ___ ICIT ___ CLICIT ___				
14	EMERGENCY RESPONSE PLAN	CFD TRAINING						
		GOOD SAM TRAINING						
		ERP REVIEW						
		ERP DRILL						
		FIRST AID FOR:						
		FIRST AID FOR:						
		EVACUATION DRILL						
		AUTO EVAC ANNOUNCEMENT TEST						
		ERP EQUIPMENT INVENTORY						
		BIENNIAL SUPPORT AGREEMENTS						
15	PHYSICAL SECURITY PLAN	OSP/DPS TRAINING						
		PSP REVIEW						
		PSP DRILL						
		LOCK/SAFE COMBO CHANGES						
		AUTHORIZATION LIST UPDATE						
		SPOOF MEASUREMENTS						

* Date not be exceeded is only applicable to shaded items. It is equal to the date completed last year plus 15 months.
For biennial license requirements, it is equal to the date completed last time plus 2 1/2 years.

Figure IV.4 (continued)

Annual Surveillance and Maintenance (Sample Form)

OSTROP 16, Rev. LEU-1 | Annual Surveillance and Maintenance for 20______

No.	Item		TRANS	SAFE	SHIM	REG	Requirement					
16	KEY INVENTORY						ANNUAL					
17	CONTROL ROD WITHDRAWAL INSERTION & SCRAM TIMES	SCRAM					≤2 sec					
		W/D					<50 sec					
		INSERT					≤50 sec					
18	REACTOR BAY VENTILLATION SYSTEM SHUTDOWN TEST						DAMPERS CLOSE IN ≤5 SECONDS		1st Floor _____ 2nd Floor _____			
19	CALIBRATION OF THE FUEL ELEMENT TEMPERATURE CHANNEL						Per Checksheet					
20	FUEL ELEMENT INSPECTION FOR SELECTED ELEMENTS											
21	REACTOR TANK AND CORE COMPONENT INSPECTION						NO WHITE SPOTS					
22	EMERGENCY LIGHT LOAD TEST						RCHPP 18.0					

No.	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	
23										
24	NEUTRON RADIOGRAPHY FACILITY INTERLOCKS									

* Date not be exceeded is only applicable to shaded items. It is equal to the date completed last year plus 15 months.
For biennial license requirements, it is equal to the date completed last time plus 2 1/2 years.

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 three 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, Thomas Gray Associates, Inc., for burial at its installation located near Richland, Washington.

Personnel Dose

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

Facility operating personnel include the reactor operations and health physics staff. The dosimeters used to monitor these individuals include quarterly TLD badges, quarterly track-etch/ albedo neutron dosimeters, monthly TLD (finger) extremity dosimeters, pocket ion chambers, electronic dosimetry.

Key facility research personnel consist of Radiation Center staff, faculty, and graduate students who perform research using the reactor, reactor-activated materials, or using other research facilities present at the Center. The individual dosimetry requirements for these personnel will vary with the type of research being conducted, but will generally include a quarterly TLD film badge and TLD (finger) extremity dosimeters. If the possibility of neutron exposure exists, researchers are also monitored with a track-etch/ albedo neutron dosimeter.

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

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

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

OSU police and security personnel are issued a quarterly Xß(γ) TLD badge to be used during their patrols of the Radiation Center and reactor facility.

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

An annual summary of the radiation doses received by each of the above six groups is shown in Table V.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 Global Dosimetry Solutions, Inc. (GDS), Irvine, California. Each GDS packet contained three LiF TLDs and was exchanged quarterly for a total of 108 samples during the reporting period (9 stations x 3 TLDs per station x 4 quarters). The total number of GDS TLD samples for the reporting period was 108. A summary of the GDS TLD data is also shown in Table V.10.

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

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

Each monitoring station is located about four feet above the ground (MRCTE 21 and MRCTE 22 are mounted on the roof of the EPA Laboratory and National Forage Seed Laboratory, respectively). These monitors are exchanged and processed quarterly, and the total number of TLD samples during the current one-year reporting period was 240 (20 stations x 3 chips per station per quarter x 4 quarters per year). The total number of GDS TLD samples for the reporting period was 240. A summary of GDS TLD data for the off-site monitoring stations is given in Table V.11.

After a review of the data in Table V.11, it is concluded that, like the dosimeters on the TRIGA facility fence, all of the doses recorded by the off-site dosimeters can be attributed to natural background radiation, which is about 110 mrem per year for Oregon (Refs. 1, 2).

Soil, Water, and Vegetation Surveys

The soil, water, and vegetation monitoring program consists of the collection and analysis of a limited number of samples in each category on a annual basis. The program monitors highly unlikely radioactive material releases from either the TRIGA reactor facility or the OSU Radiation Center, and also helps indicate the general trend of the radioactivity concentration in each of the various substances sampled. See Figure V.1 for the locations of the sampling stations for grass (G), soil (S), water (W) and rainwater (RW) samples. Most locations are within a 1000 foot radius of the reactor facility and the Radiation Center. In general, samples are collected over a local area having a radius of about ten feet at the positions indicated in Figure V.1.

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

The annual concentration of total net beta radioactivity (minus tritium) for samples collected at each environmental soil, water, and vegetation sampling location (sampling station) is listed in Table V.12. Calculation of the total net beta disintegration rate incorporates subtraction of only the counting system back-ground from the gross beta counting rate, followed by application of an appropriate counting system efficiency.

The annual concentrations were calculated using sample results which exceeded the lower limit of detection (LLD), except that sample results which were less than or equal to the LLD were averaged in at the corresponding LLD concentration. Table V.13 gives the concentration and the range of values for each sample category for the current reporting period.

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

Identification of specific radionuclides is not routinely carried out as part of this monitoring program, but would be conducted if unusual radioactivity levels above natural background were detected. However, from Table V.12 it can be seen that the levels of radioactivity detected were consistent with naturally occurring radioactivity and comparable to values reported in previous years.

Radioactive Materials Shipments

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

References

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

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

Table V.1

Radiation Protection Program Requirements and Frequencies

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

Table V.2

Monthly Summary of Liquid Effluent Release to the Sanitary Sewer(1)

Date of Discharge (Month and Year)	Total Quantity of Radioactivity Released (Curies)	Detectable Radionuclide in the Waste	Specific Activity For Each Detectable Radionuclide in the Waste, Where The Release Concentration Was>1 x 10^{-7} (μCi ml^{-1})	Total Quantity of Each Detectable Radionuclide Released in the Waste (Curies)	Average Concentration Of Released Radioactive Material at the Point of Release (μCi ml^{-1})	Percent of Applicable Monthly Average Concentration for Released Radioactive Material (%)(2)	Total Volume of Liquid Effluent Released Including Diluent (gal)
July 2010	6.3×10^{-4}	H-3	6.8×10^{-7}	6.3×10^{-4}	6.8×10^{-7}	0.006	245,687
October 2010	5.8×10^{-4}	H-3	2.16×10^{-6}	5.8×10^{-4}	2.16×10^{-6}	0.02	71,064
March 2011	2.76×10^{-4}	H-3	1.5×10^{-6}	2.76×10^{-4}	1.50×10^{-6}	0.02	15,560
Annual Total for Radiation Center	1.49×10^{-3}	H-3	4.34×10^{-6}	1.49×10^{-3}	4.34×10^{-6}	0.046	332,311

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

Table V.3

Annual Summary of Liquid Waste Generated and Transferred

Origin of Liquid Waste	Volume of Liquid Waste Packaged[1] (gallons)	Detectable Radionuclides in the Waste	Total Quantity of Radioactivity in the Waste (Curies)	Dates of Waste Pickup for Transfer to the Waste Processing Facility
TRIGA Reactor Facility	5	Co-60, Sb-124, H-3, Ag-110m, Rb-89	4.35×10^{-2}	8/25/10
Radiation Center Laboratories	41.25	Cl-36, Ce-144, U-238, Ce-141, Tc-99	1.60×10^{-4}	8/25/11 2/18/11
TOTAL	**46.25**		**4.37×10^{-2}**	

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

Table V.4

Monthly TRIGA Reactor Gaseous Waste Discharges and Analysis

Month	Total Estimated Activity Released (Curies)	Total Estimated Quantity of Argon-41 Released(1) (Curies)	Estimated Atmospheric Diluted Concentration of Argon-41 at Point of Release (μCi/cc)	Fraction of the Technical Specification Annual Average Argon-41 Concentration Limit (%)
July	0.35	0.35	2.82×10^{-8}	0.70
August	0.32	0.32	2.57×10^{-8}	0.64
September	0.28	0.28	2.35×10^{-8}	0.59
October	0.25	0.25	1.98×10^{-8}	0.49
November	0.41	0.41	3.36×10^{-8}	0.84
December	0.61	0.61	4.90×10^{-8}	1.23
January	0.50	0.50	3.97×10^{-8}	0.99
February	0.49	0.49	4.35×10^{-8}	1.09
March	0.46	0.46	3.72×10^{-8}	0.93
April	0.48	0.48	3.99×10^{-8}	1.00
May	0.49	0.49	3.92×10^{-8}	0.98
June	0.49	0.49	4.08×10^{-8}	1.02
TOTAL ('10-'11)	**5.14**	**5.14**	**3.50×10^{-8}(2)**	**0.87(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	27	Mn-54, Co-58, Co-60, Zn-65, As-74, Ga-72, Ag-110m, Cs-137, Eu-152, Eu-154, Sc-46, Cs-51, Fe-59, Sb-124, Se-75, H-3, Hf-181	4.74×10^{-3}	8/25/10 2/18/11 4/15/11
Radiation Center Laboratories	58.05	Cl-36, U-238, Np-237, Pu-242, Eu-152, Eu-154, Mn-54, Pu-239, Am-241, U-235, Th-232, Tc-99	8.61×10^{-5}	8/25/10 2/18/11 4/15/11
TOTAL	85.05	See Above	4.83×10^{-3}	---

(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	101.57	258.14	166	663	711	1807
Key Facility Research Personnel	8.0	33.2	40	332	88	332
Facilities Services Maintenance Personnel	0.07	N/A	0.4	N/A	0.8	N/A
Laboratory Class Students	2.49	22.64	72	192	641	498
Campus Police and Security Personnel	4.4	N/A	36	N/A	110	N/A
Visitors	0.42	N/A	9.6	N/A	258	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	201	ND
MRCTSE	D104: South Badge East Wall	142	ND
MRCTSW	D104: South Badge West Wall	848	ND
MRCTNW	D104: North Badge West Wall	162	ND
MRCTWN	D104: West Badge North Wall	369	ND
MRCTEN	D104: East Badge North Wall	289	ND
MRCTES	D104: East Badge South Wall	1341	ND
MRCTWS	D104: West Badge South Wall	429	ND
MRCTTOP	D104: Reactor Top Badge	602	ND
MRCTHXS	D104A: South Badge HX Room	841	ND
MRCTHXW	D104A: West Badge HX Room	676	ND
MRCD-302	D302: Reactor Control Room	348	ND
MRCD-302A	D302A: Reactor Supervisor's Office	133	N/A
MRCBP1	D104: Beam Port Number 1	295	ND
MRCBP2	D104: Beam Port Number 2	218	ND
MRCBP3	D104: Beam Port Number 3	443	ND
MRCBP4	D104: Beam Port Number 4	668	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	14	N/A
MRCBRF	A102H: Front Personnel Dosimetry Storage Rack	72	N/A
MRCA120	A120: Stock Room	56	N/A
MRCA120A	A120A: NAA Temporary Storage	0	N/A
MRCA126	A126: Radioisotope Research Lab	98	N/A
MRCCO-60	A128: ^{60}Co Irradiator Room	262	N/A
MRCA130	A130: Shielded Exposure Room	41	N/A
MRCA132	A132: TLD Equipment Room	56	N/A
MRCA138	A138: Health Physics Laboratory	66	N/A
MRCA146	A146: Gamma Analyzer Room (Storage Cave)	153	N/A
MRCB100	B100: Gamma Analyzer Room (Storage Cave)	0	N/A
MRCB114	B114: Lab (^{226}Ra Storage Facility)	1607	ND
MRCB119-1	B119: Source Storage Room	256	N/A
MRCB119-2	B119: Source Storage Room	371	N/A
MRCB119A	B119A: Sealed Source Storage Room	3594	1343
MRCB120	B120: Instrument Calibration Facility	83	N/A
MRCB122-2	B122: Radioisotope Hood	148	N/A
MRCB122-3	B122: Radioisotope Research Laboratory	90	N/A
MRCB124-1	B124: Radioisotope Research Lab (Hood)	65	N/A
MRCB124-2	B124: Radioisotope Research Laboratory	85	N/A
MRCB124-6	B124: Radioisotope Research Laboratory	68	N/A
MRCB136	B136 Gamma Analyzer Room	53	N/A
MRCB128	B128: Instrument Repair Shop	67	N/A
MRCC100	C100: Radiation Center Director's Office	55	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	57	N/A
MRCC106B	C106B: Custodian Supply Storage	23	N/A
MRCC106-H	C106H: East Loading Dock	53	N/A
MRCC118	C118: Radiochemistry Laboratory	41	N/A
MRCC120	C120: Student Counting Laboratory	35	N/A
MRCF100	F100: APEX Facility	48	N/A
MRCF102	F102: APEX Control Room	50	N/A
MRCB125N	B125: Gamma Analyzer Room (Storage Cave)	92	N/A
MRCN125S	B125: Gamma Analyzer Room	48	N/A
MRCC124	C124: Classroom	53	N/A
MRCC130	C130: Radioisotope Laboratory (Hood)	55	N/A
MRCD100	D100: Reactor Support Laboratory	86	ND
MRCD102	D102: Pneumatic Transfer Terminal Lab`	217	ND
MRCD102-H	D102H: 1st Floor Corridor at D102	102	ND
MRCD106-H	D106H: 1st Floor Corridor at D106	279	N/A
MRCD200	D200: Reactor Administrator's Office	214	ND
MRCD202	D202: Senior Health Physicist's Office	249	ND
MRCBRR	D200H: Rear Personnel Dosimetry Storage Rack	82	N/A
MRCD204	D204: Health Physicist Office	206	ND
MRCATHRL	F104: ATHRL	35	N/A
MRCD300	D300: 3rd Floor Conference Room	158	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)	1.66	95	<500	16,522
Reactor 2nd Deck Area (D104)	5.73	35	<500	<500
Reactor Bay SW (D104)	<1	32	<500	652
Reactor Bay NW (D104)	<1	47	<500	3,695
Reactor Bay NE (D104)	<1	54.5	<500	867
Reactor Bay SE (D104)	<1	7	<500	1,000
Class Experiments (D104, D302)	<1	<1	<500	<500
Demineralizer Tank & Make Up Water System (D104A)	<1	60	<500	<500
Particulate Filter--Outside Shielding (D104A)	<1	4.5	<500	<500
Radiation Center:				
NAA Counting Rooms (A146, B100)	<1	3.5	<500	<500
Health Physics Laboratory (A138)	<1	1.5	<500	<500
^{60}Co Irradiator Room and Calibration Rooms (A128, B120, A130)	<1	100	<500	<500
Radiation Research Labs (A126, A136) (B108, B114, B122, B124, C126, C130, C132A)	<1	5	<500	<500
Radioactive Source Storage (B119, B119A, A120A, A132A)	<1	90	<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	7	<500	<500
RX support Room (D100)	<1	<1	<500	<500

(1) <500 dpm/100 cm2 = Less than the lower limit of detection for the portable survey instrument used.

Table V.10

Total Dose Equivalent at the TRIGA Reactor Facility Fence

Fence Environmental Monitoring Station (See Figure V.1)	Total Recorded Dose Equivalent (Including Background) Based on GSD TLDs[1,2] (mrem)
MRCFE-1	88 ± 4
MRCFE-2	81 ± 5
MRCFE-3	77 ± 6
MRCFE-4	84 ± 7
MRCFE-5	88 ± 5
MRCFE-6	83 ± 8
MRCFE-7	81 ± 6
MRCFE-8	81 ± 5
MRCFE-9	84 ± 9

(1) Average Corvallis area natural background using GDS TLDs totals 73 ± 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 GDS TLDs[1,2] (mrem)
MRCTE-2	83 ± 5
MRCTE-3	66 ± 9
MRCTE-4	79 ± 4
MRCTE-5	92 ± 6
MRCTE-6	77 ± 6
MRCTE-7	82 ± 5
MRCTE-8	94 ± 6
MRCTE-9	85 ± 8
MRCTE-10	75 ± 6
MRCTE-12	64 ± 18
MRCTE-13	67 ± 8
MRCTE-14	87 ± 6
MRCTE-15	78 ± 5
MRCTE-16	89 ± 7
MRCTE-17	80 ± 5
MRCTE-18	83 ± 4
MRCTE-19	84 ± 6
MRCTE-20	82 ± 5
MRCTE-21	69 ± 6
MRCTE-22	76 ± 5

(1) Average Corvallis area natural background using GDS TLDs totals 73 ± 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	$5.42x10^{-6}$[2]	$\mu Ci\ ml^{-1}$
4-W	Water	$5.42x10^{-6}$[2]	$\mu Ci\ ml^{-1}$
11-W	Water	$5.42x10^{-6}$[2]	$\mu Ci\ ml^{-1}$
19-RW	Water	$5.42x10^{-6}$[2]	$\mu Ci\ ml^{-1}$
3-S	Soil	$1.70x10^{-5}$ [2]	$\mu Ci\ g^{-1}$ of dry soil
5-S	Soil	$1.88x10^{-5} \pm 8.05x10^{-6}$	$\mu Ci\ g^{-1}$ of dry soil
20-S	Soil	$1.44x10^{-5}$ [2]	$\mu Ci\ g^{-1}$ of dry soil
21-S	Soil	$1.42x10^{-5}$ [2]	$\mu Ci\ g^{-1}$ of dry soil
2-G	Grass	$3.50x10^{-4} \pm 2.74x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
6-G	Grass	$2.76x10^{-4} \pm 2.70x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
7-G	Grass	$3.89x10^{-4} \pm 2.87x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
8-G	Grass	$2.80x10^{-4} \pm 2.41x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
9-G	Grass	$2.98x10^{-4} \pm 2.37x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
10-G	Grass	$2.74x10^{-4} \pm 2.55x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
12-G	Grass	$3.16x10^{-4} \pm 2.79x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
13-G	Grass	$2.50x10^{-4} \pm 3.24x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
14-G	Grass	$8.84x10^{-5} \pm 1.29x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
15-G	Grass	$2.03x10^{-4} \pm 2.56x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
16-G	Grass	$2.37x10^{-4} \pm 2.67x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
17-G	Grass	$2.68x10^{-4} \pm 2.21x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
18-G	Grass	$8.96x10^{-5} \pm 1.32x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash
22-G	Grass	$1.67x10^{-4} \pm 1.50x10^{-5}$	$\mu Ci\ g^{-1}$ of dry ash

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

Table V.13

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

Sample Type	Average Value	Range of Values	Reporting Units
Soil	1.58×10^{-5}	1.42×10^{-5} to 1.75×10^{-5}	$\mu Ci\ g^{-1}$ of dry soil
Water	5.42×10^{-6} (1)	5.42×10^{-6} (1)	$\mu Ci\ ml^{-1}$
Vegetation	3.46×10^{-5}	2.11×10^{-5} to 5.35×10^{-5}	$\mu Ci\ g^{-1}$ of dry ash

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

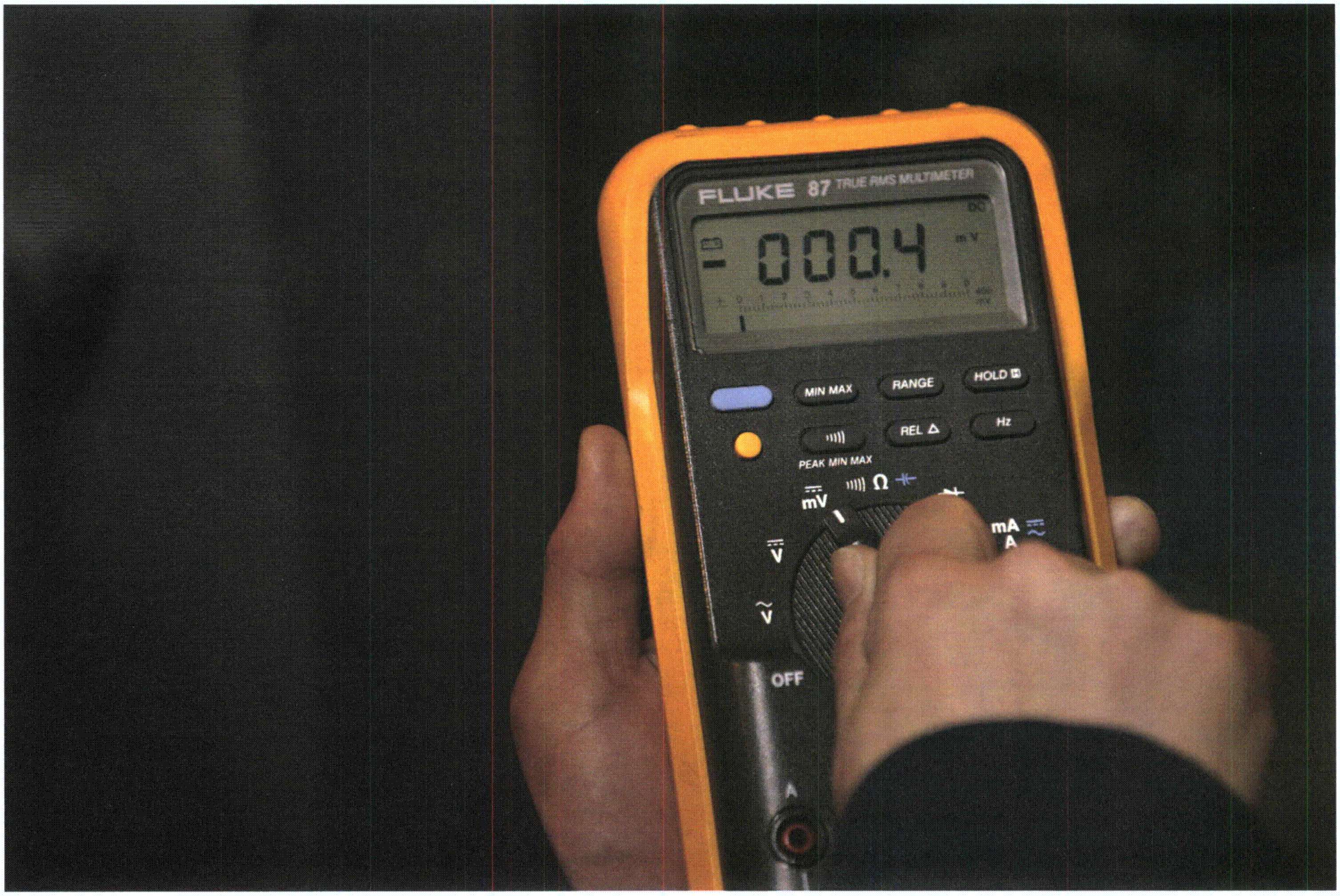


Table V.14

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
Berkeley Geochronology Center Berkeley, CA USA	2.37×10^{-7}	5	0	0	0	5
Brush Resources Inc. Delta, UT USA	8.50×10^{-2}	0	0	0	16	16
Brush Wellman Inc. Elmore, OH USA	9.32×10^{-3}	0	0	0	1	1
Materion Coperation Elmore, OH USA	9.32×10^{-3}	0	0	0	1	1
Materion Natural Resources Delta, UT USA	3.31×10^{-2}	0	0	0	7	7
Oregon State University Corvallis, OR USA	1.27×10^{-5}	1	0	2	0	3
Plattsburgh State University Plattsburgh, NY USA	1.54×10^{-9}	1	0	0	0	1
Reed College Portland, OR USA	3.50×10^{-10}	1	0	0	0	1
Stanford University Stanford, CA, USA	7.57×10^{-9}	1	0	0	0	1
Syracuse University Syracuse, NY USA	2.01×10^{-8}	1	0	0	0	1
Union College Schenectady, NY USA	4.72×10^{-9}	2	0	0	0	2
University of Arizona Tucson, AZ USA	3.33×10^{-7}	8	0	0	0	8
University of California at Berkeley Berkeley, CA USA	4.30×10^{-6}	1	0	2	0	3
University of California at Santa Barbara Santa Barbara, CA USA	1.10×10^{-7}	0	1	0	0	1
University of Florida Gainesville, FL USA	1.05×10^{-7}	1	1	0	0	2
University of Michigan Ann Arbor, MI USA	6.30×10^{-8}	1	0	0	0	1
University of Minnesota Minneapolis, MN USA	1.34×10^{-7}	1	0	0	0	1
University of Wisconsin-Madison Madison, WI USA	3.96×10^{-6}	1	1	1	0	3
Totals	**1.37×10^{-1}**	**25**	**3**	**5**	**25**	**58**

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	Total
Argonne National Lab Argonne, IL USA	$6.50x10^{-11}$	1	0	1
Lawrence Berkeley National Laboratory Berkeley, CA USA	$8.55x10^{-10}$	2	0	2
Los Alamos National Lab Los Alamos, NM USA	$2.13x10^{-9}$	5	1	6
Oak Ridge National Lab Oak Ridge, TN USA	$1.79x10^{-11}$	1	0	1
University of Nevada Las Vegas Las Vegas, NV USA	$2.49x10^{-10}$	1	0	1
Totals	**$3.32x10^{-9}$**	**10**	**1**	**11**

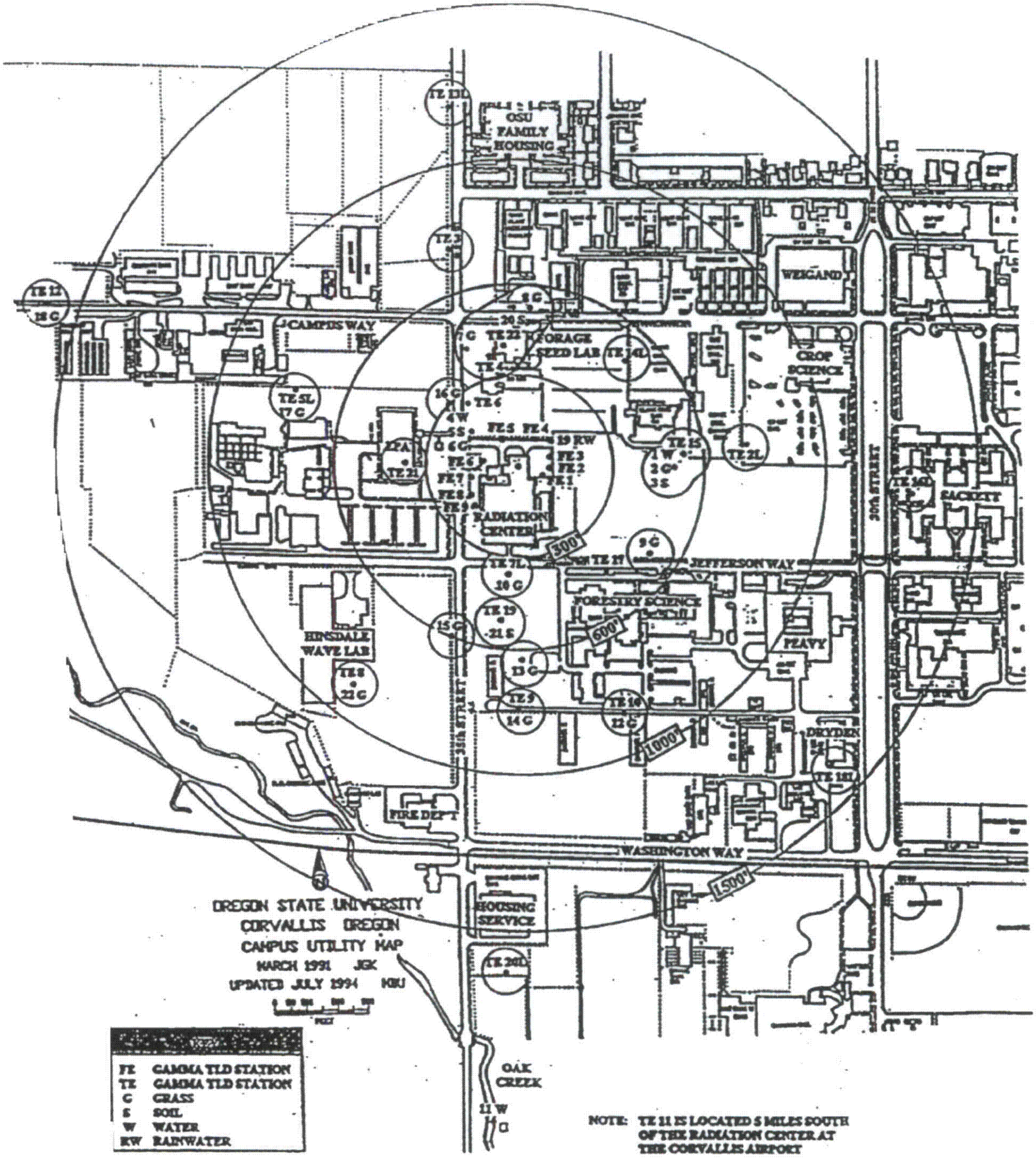
Table V.16

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
Dalhousie University Halifax, Nova Scotia CANADA	$1.96x10^{-8}$	2	0	0	2
Lund University Lund, SWEDEN	$8.97x10^{-7}$	4	0	0	4
Polish Academy of Sciences Krakow, POLAND	$2.12x10^{-8}$	1	0	0	1
QUAD-Lab, Roskilde University Roskilde, DENMARK	$2.38x10^{-7}$	6	0	0	6
Scottish Universities Research & Reactor Centre East Kilbride, SCOTLAND	$9.67x10^{-8}$	2	0	0	2
Universita' Degli Studi di Bologna Bologna, ITALY	$8.50x10^{-9}$	1	0	0	1
Universitat Gottingen Gottingen, GERMANY	$3.84x10^{-9}$	1	0	0	1
Universitat Potsdam Postdam, GERMANY	$8.78x10^{-9}$	1	0	0	1
Universite Paris-Sud Paris, FRANCE	$5.24x10^{-7}$	0	0	1	1
University of Geneva Geneva, SWITZERLAND	$5.67x10^{-8}$	2	0	0	2
University of Manchester Manchester, UK	$7.71x10^{-10}$	1	0	0	1
University of Milano-Bicocca Milano, ITALY	$9.17x10^{-9}$	1	0	0	1
University of Padova Padova, ITALY	$5.00x10^{-9}$	1	0	0	1
University of Queensland Brisbane, Queensland AUSTRALIA	$4.48x10^{-6}$	0	0	3	3
University of Rennes Rennes, FRANCE	$4.85x10^{-8}$	2	0	0	2
University of Zurich Zurich, SWITZERLAND	$4.21x10^{-8}$	3	0	0	3
Totals	**$6.46x10^{-6}$**	**28**	**0**	**4**	**32**

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 purposeof 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.

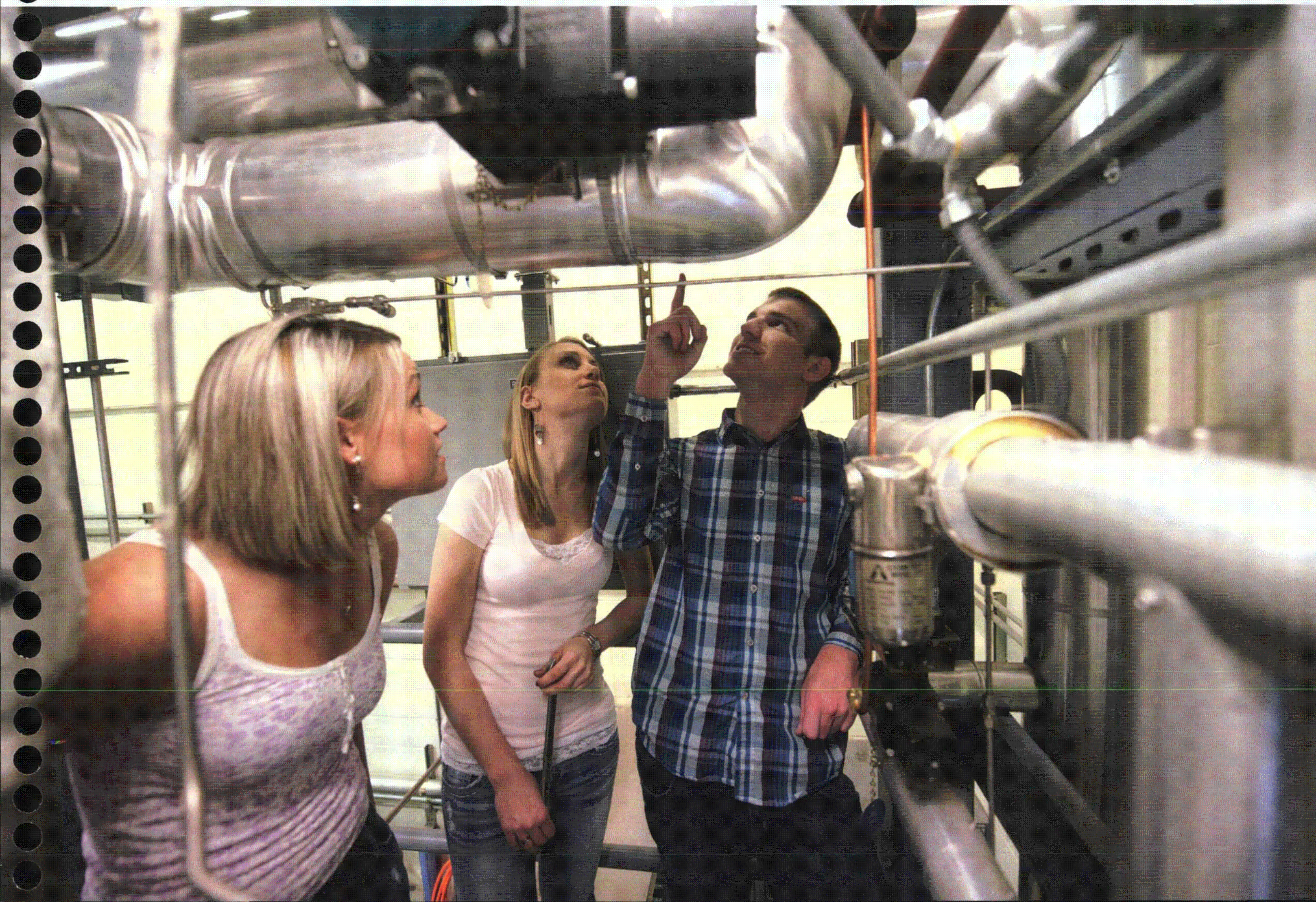
The Radiation Center maintains dedicated stocks of radiological emergency response equipment and instrumentation. These items are located at the Radiation Center and at the Good Samaritan Hospital in Corvallis.

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
Institutions, Agencies and Groups Which Utilized the Radiation Center

Intuitions, Agencies and Groups	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
*Oregon State University[1] Corvallis, OR USA	23	41	11	257[2]
*Oregon State University - Educational Tours Corvallis, OR USA	3	16	0	44
102nd Oregon Civil Support Unit Salem, OR USA	1	0	0	2
CH2M Hill Inc Corvallis, OR USA	1	0	0	2
NETL Albany, OR USA	1	0	0	5
Oregon Department of Energy Salem, OR USA	1	1	0	4
Oregon State Fire Marshal Salem, OR USA	1	0	0	36
U.S. EPA Corvallis, OR USA	1	0	0	1
University of Oregon Eugene, OR USA	1	1	0	1
Amrhein Associates, Inc. Ashalnd, OR USA	1	0	0	2
Coos County Public Health North Bend, OR USA	1	0	0	1
ESCO Corporation Portland, OR USA	1	0	0	6
Federal Aviation Administration Portland, OR USA	1	0	0	3
Gene Tools, LLC Philomath, OR USA	1	0	0	3
Grande Ronde Hospital La Grande, OR USA	1	0	0	2

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

Intuitions, Agencies and Groups	Number of Projects	Number of Times of Faculty Involvement	Number of Students Involved	Number of Uses of Center Facilities
Knife River Tangent, OR USA	1	0	0	1
Lake District Hospital Lakeview, OR USA	1	0	0	5
Lebanon Community Hospital Lebanon, OR USA	1	0	0	3
Marquess & Associates, Inc. Medford, OR USA	1	0	0	1
Mushka Dairy Hillsboro, OR USA	1	0	0	1
Occupational Health Lab Portland, OR USA	1	0	0	2
*Oregon Health Sciences University Portland, OR USA	1	0	0	26
Radiation Protection Services Portland, OR USA	1	0	0	79
*Reed College Portland, OR USA	1	1	0	1
Rogue Community College Grants Pass, OR USA	1	0	0	2
US National Parks Service Crater Lake, OR USA	1	0	0	3
Veterinary Diagnostic Imaging & Cytopathology Clackamas, OR USA	1	0	0	2
Weyerhaeuser Sweet Home, OR USA	1	0	0	1
Yaquina River Constructors Eddyville, OR USA	1	0	0	1
*Pacific Northwest National Laboratory Richland, WA USA	2	1	0	11

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 Students Involved	Number of Uses of Center Facilities
*Berkeley Geochronology Center Berkeley, CA USA	1	0	9	9
Dalhousie University Halifax Nova Scotia, CANADA	1	2	0	3
*Occidental College Los Angeles, CA USA	1	1	0	1
*Stanford University Stanford, CA USA	1	1	0	1
*University of California at Berkeley Berkeley, CA USA	2	2	1	3
*University of California at Santa Barbara Santa Barbara, CA USA	1	1	0	3
*Materion Natural Resources Delta, UT USA	1	0	0	21
*University of Arizona Tucson, AZ USA	3	3	1	9
*University of Minnesota Minneappolis, MN USA	1	0	0	2
*Oriental Institute of Chicago Chicago, IL USA	1	3	0	9
*University of Wisconsin Madison, WI USA	1	1	0	6
*University of Michigan Ann Arbor, MI USA	5	11	0	28
Wayne State University Detroit, MI USA	1	2	0	2
Arch Chemicals, Inc. Alpharetta, GA USA	1	1	0	10
*Materion Brush, Inc. Elmore, OH USA	1	0	0	3

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 Students Involved	Number of Uses of Center Facilities
*Plattsburgh State University Plattsburgh, NY USA	1	1	0	1
*Syracuse University Syracuse, NY USA	1	2	4	1
*Union College Schenectady, NY USA	1	1	0	1
*University of Florida Gainesville, FL USA	1	1	6	2
*Quaternary Dating Laboratory Roskilde, Denmark	1	0	0	6
*Scottish Universities Environmantal Research Centre East Kilbride, UK	1	0	0	4
*University College of London London, UK	1	2	0	2
*University of Manchester Manchester, UK	1	0	0	1
*Universite Paris-Sud Paris, FRANCE	1	1	0	1
*Universite Rennes 1 Rennes, FRANCE	1	1	0	2
*Geologisch-Palaontologisches Institut Basel, SWITZERLAND	1	1	0	3
*Lund University Lund, SWEDEN	1	0	0	4
Universita' Degli Studi di Padova Padova,	1	2	0	1
*Universita' di Bologna Bologna, ITALY	1	1	0	2
*Universitat Potsdam Postdam, GERMANY	1	0	3	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 Students Involved	Number of Uses of Center Facilities
*University of Basel CH-4056 Basel, SWITZERLAND	1	1	0	2
*University of Geneva Geneva, SWITZERLAND	1	1	4	3
University of Goettingen Gottingen, GERMANY	1	1	5	3
*University of Queensland Brisbane, Queensland Australia	1	1	0	3
Totals	**96**	**106**	**44**	**661**

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

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

Project	Users	Organization Name	Project Title	Description	Funding
444	Duncan	Oregon State University	Ar-40/Ar-39 Dating of Oceanographic Samples	Production of Ar-39 from K-39 to measure radiometric ages on basaltic rocks from ocean basins.	OSU Oceanography Department
481	Le	Oregon Health Sciences University	Instrument Calibration	Instrument calibration.	Oregon Health Sciences University
488	Farmer	Oregon State University	Instrument Calibration	Instrument calibration.	OSU - various departments
664	Reese	Oregon State University	Good Samaritan Hospital Instrument Calibration	Instrument calibration.	OSU Radiation Center
815	Morrell	Oregon State University	Sterilization of Wood Samples	Sterilization of wood samples to 2.5 Mrads in Co-60 irradiator for fungal evaluations.	OSU Forest Products
920	Becker	Berkeley Geochronology Center	Ar-39/Ar-40 Age Dating	Production of Ar-39 from K-39 to determine ages in various anthropologic and geologic materials.	Berkeley Geochronology Center
932	Dumitru	Stanford University	Fission Track Dating	Thermal column irradiation of geological samples for fission track age-dating.	Stanford University Geology Department
1018	Gashwiler	Occupational Health Lab	Calibration of Nuclear Instruments	Instrument calibration.	Occupational Health Laboratory
1074	Wijbrans	Vrije Universiteit	40Ar-39 Ar Dating of Rocks and Minerals	40Ar-39Ar dating of rocks and minerals.	Vrije Universiteit, Amsterdam
1075	Teaching and Tours	University of California at Berkeley	Activation Analysis Experiment for NE Class	Activation Analysis Experiment for NE Class. Irradiation of small, stainless steel discs for use in a nuclear engineering radiation measurements laboratory.	University of California at Berkeley
1177	Garver	Union College	Fission Track Analysis of Rock Ages	Use of thermal column irradiations to perform fission track analysis to determine rock ages.	Union College, NY
1185	Elting	University of Oregon	Instrument Calibration	Radiological instrument calibration for the Environmental Health and Safety Office.	University of Oregon
1188	Salinas	Rogue Community College	Photoplankton Growth in Southern Oregon Lakes	C-14 liquid scintillation counting of radiotracers produced in a photoplankton study of southern Oregon lakes: Miller Lake, Lake of the Woods, Diamond Lake, and Waldo Lake.	Rogue Community College

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
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
1354	Lindsay	Radiation Protection Services	Radiological Instrument Calibration	Instrument calibration.	State of Oregon Radiation Protection Services
1366	Quidelleur	Universite Paris-Sud	Ar-Ar Geochronology	Determination of geological samples via Ar-Ar radiometric dating.	Universite Paris-Sud
1404	Riera-Lizarau	Oregon State University	Evaluation of wheat DNA	Gamma irradiation of wheat seeds	OSU Crop and Soil Science
1415	McGinness	ESCO Corporation	Calibration of Instruments	Instrument calibration	ESCO Corporation
1419	Krane	Oregon State University	Nuclear Structure of N=90 Isotones	Study of N=90 isotone structure (Sm-152, Gd-154, Dy-156) from decays of Eu-152, Eu-152m, Eu-154, Tb-154, and Ho-156. Samples will be counted at LBNL.	OSU Physics Department
1464	Slavens	USDOE Albany Research Center	Instrument Calibration	Instrument calibration.	USDOE Albany Research Center
1465	Singer	University of Wisconsin	Ar-40/Ar-39 Dating of Young Geologic Materials	Irradiation of geological materials such as volcanic rocks from sea floor, etc. for Ar-40/Ar-39 dating.	University of Wisconsin
1468	Hu	University of California at Berkeley	Chemistry 146 Experiment	NAA Laboratory experiment.	University of California at Berkeley
1470	Shatswell	SIGA Technologies, Inc.	Instrument Calibration	Instrument calibration.	Siga Pharmaceuticals
1492	Stiger	Federal Aviation Administration	Instrument Calibration	Instrument calibration.	Federal Aviation Administration
1503	Teaching and Tours	Non-Educational Tours	Non-Educational Tours	Tours for guests, university functions, student recruitment.	NA
1504	Teaching and Tours	Oregon State University - Educational Tours	OSU Nuclear Engineering & Radiation Health Physics Department	OSTR tour and reactor lab.	NA
1505	Teaching and Tours	Oregon State University - Educational Tours	OSU Chemistry Department	OSTR tour, teaching labs, and/or half-life experiment.	NA

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
1519	Dunkl	University of Goettingen	Fission Track Analysis of Apatites	Fission track dating method on apatites: use of fission tracks from decay of U-238 and U-235 to deterimine the coling age of apatites.	University of Tuebingen
1523	Zattin	Universita' Degli Studi di Padova	Fission track analysis of Apatites	Fission track dating method on apatites by fission track analysis.	NA
1527	Teaching and Tours	Oregon State University - Educational Tours	Odyssey Orientation Class	OSTR tour.	NA
1528	Teaching and Tours	Oregon State University - Educational Tours	Upward Bound	OSTR tour.	NA
1529	Teaching and Tours	Oregon State University - Educational Tours	OSU Connect	OSTR tour.	NA
1530	Teaching and Tours	Newport School District	Newport School District	OSTR tour.	NA

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

Project	Users	Organization Name	Project Title	Description	Funding
1531	Teaching and Tours	Central Oregon Community College	Central Oregon Community College Engineering	OSTR tour for Engineering	NA
1535	Teaching and Tours	Corvallis School District	Corvallis School District	OSTR tour.	NA
1537	Teaching and Tours	Oregon State University - Educational Tours	Naval Science Department	OSTR tour.	NA
1538	Teaching and Tours	Oregon State University - Educational Tours	OSU Speech Department	OSTR tour.	NA
1542	Teaching and Tours	Oregon State University - Educational Tours	Engineering Sciences Classes	OSTR tour.	NA
1543	Bailey	Veterinary Diagnostic Imaging & Cytopathology	Instrument Calibration	Instrument calibration.	Veterinary Diagnostic Imaging & Cytopathology
1544	Teaching and Tours	West Albany High School	West Albany High School	OSTR tour and half-life experiment.	NA
1545	Teaching and Tours	Oregon State University - Educational Tours	OSU Educational Tours	OSTR tour.	NA
1548	Teaching and Tours	Willamette Valley Community School	Willamette Valley Community School	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
1583	Teaching and Tours	Neahkahnie High School	Neahkahnie High School	OSTR tour.	NA
1584	Teaching and Tours	Reed College	Reed College Staff & Trainees	OSTR tour for Reed College Staff & Trainees	NA
1611	Teaching and Tours	Grants Pass High School	Grants Pass High School	OSTR tour.	NA

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
1613	Teaching and Tours	Silver Falls School District	Silver Falls School District	OSTR tour.	NA
1614	Teaching and Tours	Marist High School	Marist High School	OSTR tour and half-life experiment.	NA
1617	Spikings	University of Geneva	Ar-Ar geochronology and Fission Track dating	Argon dating of Chilean granites.	University of Geneva
1621	Foster	University of Florida	Irradiation for Ar/Ar Analysis	Ar/Ar analysis of geological samples.	University of Florida
1622	Reese	Oregon State University	Flux Measurements of OSTR	Measurement of neutron flux in various irradiation facilities.	NA
1623	Blythe	Occidental College	Fission Track Analysis	Fission track Thermochronology of geological samples	Occidental College
1653	Teaching and Tours	Madison High School	Madison High School Senior Science Class	OSTR tour for Senior Science Class	NA
1655	Teaching and Tours	Future Farmers of America	OSTR Tour	OSTR tour	NA
1657	Teaching and Tours	Richland High School	Richland High School	OSTR tour.	NA
1660	Reese	Oregon State University	Isotope and Container Testing	Testing of containers and source material	NA
1667	Teaching and Tours	Yamhill-Carlton High School	Teaching and Tour		NA
1673	Teaching and Tours	Heal College	Heal College Physics Department	OSTR tour.	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
1684	Fodor	North Carolina State University	Geochemical Investigation	NAA to determine rare earth composition.	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
1687	Teaching and Tours	Inavale Grade School	Reactor Tour	General reactor tour	NA
1690	Teaching and Tours	Wilson High School	Reactor Tour	D300 Reactor Tour	NA
1691	Teaching and Tours	Lost River High School	Reactor Tour	D300 Reactor Tour	NA
1692	Choi	Arch Chemicals Inc.	Screening Tests of Wood Decay	This is to build up basic knowledge on the efficacy of a copper based preservative in preventing decay of wood inhabiting basidiomycetes.	Arch Chemical Inc.
1695	Teaching and Tours	Transitional Learning	Reactor Tour	Reactor Tour in D300 only	NA
1696	Sayer	Marquess & Associates Inc.	Instrument Calibration	Instrument calibration	Marquess & Associates Inc.
1699	Teaching and Tours	Philomath High School	Reactor Tour	Tour of NAA and gas chromatograph capabilities in the Radiation Center	NA
1700	Frantz	Reed College	Instrument calibration	Instrument calibration	Reed College
1714		Lebanon Community Hospital	Instrument Calibration		Lebanon Community Hospital
1717	Baldwin	Syracuse University	Ar/Ar Dating	Ar/Ar Dating	Syracuse University
1718	Armstrong	California State University at Fullerton	Fission Track Dating	Fission track age dating of apatite grains .	Department of Geological Sciences
1719	Teaching and Tours	Portland Community College	Upward Bound	OSTR Tour for Upward Bound	NA
1720	Teaching and Tours	Saturday Academy	OSTR Tour	OSTR Tour	NA
1726	Teaching and Tours	Oregon State University - Educational Tours	Academic Learning Services	Cohort Class 199	NA
1730	Reese	Oregon State University	Neutron Radiography	Neutron Radiography using the real-time and film imaging methods	NA
1739	Teaching and Tours	Daly Middle School	Reactor Tour	Reactor Tour	NA

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

Project	Users	Organization Name	Project Title	Description	Funding
1743	Teaching and Tours	West Salem High School	Reactor Tour	Reactor Tour	NA
1745	Girdner	US National Parks Service	C14 Measurements	LSC analysis of samples for C14 measurements.	US National Parks Service
1747	Teaching and Tours	East Linn Christian Academy	Reactor Tour	Reactor Tour for Chemistry Class	NA
1758	Teaching and Tours	Oregon State University - Educational Tours	Kids Spirit	OSTR tour	NA
1763	Svojtka	Academy of Sciences of the Czech Republic	Fission Track	Fission Track	Academy of Sciences of the Czech Republic
1765	Beaver	Weyerhaeuser	Instrument Calibration	Calibration of radiological instruments.	Weyerhaeuser Foster
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
1771	Otjen	Oregon State Fire Marshal	Instrument calibration	Calibration of radiological response kits	Oregon State Fire Marshall
1777	Storey	Quaternary Dating Laboratory	Quaternary Dating	Production of Ar-39 from K-39 to determine radiometric ages of geological materials.	Quaternary Dating Laboratory
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.
1779	Teaching and Tours	Lebanon High School	Teaching and tours	OSTR tour.	NA
1781	Balogh	Roswell Park Cancer Institute	INAA of Au nanocomposites.	INAA to determine biodistribution Au nanocomposites in mouse tissue samples.	Department of Defense, Roswell Park Cancer Institu
1783	Amrhein	Amrhein Associates, Inc	Instrument Calibration	Instrument calibration	Amrhein Associates, Inc.
1786	Teaching and Tours	Oregon State University - Educational Tours	Anthropology Department	Anth 430/530 NAA class with Minc	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
1790	Teaching and Tours	Oregon State University - Educational Tours	OSTR Tour	OSTR Tour	NA
1791	Teaching and Tours	Oregon State University - Educational Tours	OSTR Tour	RX Tour	NA
1794	O'Kain	Knife River	Instrument Calibration	Instrument calibration	Tangent Construction
1795	Zubek	Eugene Sand & Gravel, Inc.	Instrument Calibration	Instrument calibration	Eugene Sand & Gravel, Inc.
1796	Hardy	CH2M Hill, Inc.	Instrument Calibration	Instrument calibration	CH2M Hill, Inc.
1797	Teaching and Tours	Oregon State University - Educational Tours	OSTR Tour	OSTR Tour	NA
1806	Davis	Oregon State University	INAA of Chert	Trace-element analysis of geological and artifactual chert from the Lower Salmon River Canyon of Idaho to establish provenance.	OSU Anthropology
1816	Kounov	Geologisch-Palaontologisches Institut	Fission Track Analysis	Geochronology analysis using fission track dating.	Geologisch-Palaontologisches Institut
1817	Costigan	City of Gresham	Instrument Calibration	Calibration of instruments	City of Gresham
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
1824	Kounov	University of Basel	Fission Track Analysis	Low temperature thermochronology is being used to answer questions relating in general to tectonics and basin analysis. The current project covers studies in Madagascar, southern India, Sri Lanka where they are trying to understand what happened to the	Geologisches Institut, ETH Zentrum
1826	Teaching and Tours	North Eugene High School		OSTR Tour and 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
1827	Teaching and Tours	Stayton High School	OSTR Tour and half-life experiment	OSTR Tour and half-life experiment	NA
1828	Teaching and Tours	Lincoln High School	OSTR Tour and half-life experiment	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
1837	Sterbentz	Idaho National Laboratory	Zirconium Reactivity Measurement	Measurement of reactivity worth of Zr slabs doped with gadolinium.	Idaho National Laboratory
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
1843	Fletcher	Empiricos LLC	Instrument Calibration	Instrument calibration	Empiricos LLC
1847	Higley	Oregon State University	Ultra-trace uptake studies for allometric studies	NAA of ultra-trace elements in plant samples for application in allometric studies	NERHP CRESP Grant
1848	Hartman	University of Michigan	Development of Prompt Gamma Neutron Activation Analysis at the OSTR	Development of a PGNAA beam line on beam port #4.	NA
1849	Converse	Sonoma State University	INAA of Bricks from Historic Fort Vancouver	Trace-element analysis of bricks from historic Fort Vancouver to determine provenance.	NA
1852	McGuire	Oregon State University	Antimicrobial activity of silanized silica microspheres with covalently attached PEO-PPO-PEO	co-polymer and nisin association. The project is aimed at finding effective methods for coating surfaces to enhance protein repellant activity and antimicrobial activity using nisin.	Chemical,Biological & Env Engineering
1853	Ivestor	Grande Ronde Hospital	Instrument Calibration	Instrument calibration	Grande Ronde Hospital
1854	Loveland	Oregon State University	Radiation Stability of Targets	To determine material loss of thin U238 tagets.	OSU Chemistry / Loveland DOE
1855	Anczkiewicz	Polish Academy of Sciences	Fission Track Services	Verification of AFT data for illite-mechte data	Polish Academy of Sciences
1856	Becker	University of Michigan	INAA of samples from PML site.	Activation of soils and concrete from Phoenix Memorial Lab and FNR site.	NA
1858	Arbogast	Gene Tools, LLC	Instrument Calibration	Calibration of instruments	Gene Tools, LLC

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
1859	Morris	A. M. Todd Company Inc.	Gamma Irradiation for Crop Mutation Breeding	Treat different plant tissues including cuttings, rhizomes, and callus at different gamma irradiation dosages in order to obtain useful mutants with beneficial characteristics.	A.M. Todd Company Inc.
1860	Minc	Oregon State University	INAA of Archaeological Ceramics	Trace-element analysis of archaeological ceramics.	NA
1861	Page	Lund University	Lund University Geochronology	Ar/Ar Geochronology	Lund University
1862	Reese	Oregon State University	Coolant Temperature Measurements	Measurement of the primary coolant temperatures in the primary tank.	NA
1863	Chew	Trinity College	Fission Track dating of Peruvian Andes and East African Rift	Use of fission track to determine U content of samples from the Peruvian Andes and the East African Rift.	Trinity College, Ireland
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
1866	Smith	Pacific Northwest National Laboratory	Irradiation of Uranium Foil	Gather data with detection and spectroscopic equipment on fission products produced by an irradiated uranium foil	Pacific Northwest National Laboratory
1867	Paulenova	Oregon State University	Uranium Coating Studies	Surface dynamics and morphology at nanometer and micrometer scale of uranium and backing materials irradiated by thermal neutrons.	NA
1868	Teaching and Tours	Springfield High School	OSTR Tour and half-life experiment	OSTR Tour and half-life experiment	NA
1869	Spence	Richard Spence	INAA of Trace Metals	Trace-element analyis of metal samples for precious metals.	Richard Spence
1870	Slavens	USDOE Albany Research Center	Sample Identification	Determination of radioisotopic composition from various unknown samples	USDOE Albany Research Center
1871	Arp	Oregon State University	Isolation of Soil Archaeal Ammonia Oxidizers	Recent discovery of autotrophic ammonia oxidizing archaea and their ubiquity in aquatic and terrestrial environments suggests that they have a major role in global biogeochemical cycles. We are trying to isolate ammonia oxidizing archaea from soil in a ho	OSU Botany & Plant Pathology

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
1872	Hartman	University of Michigan	Evaluation of Borohydride Compounds Using PGNAA	Utilization of PGNAA to evaluate the material content of various borohydride compounds.	University of Michigan
1873	Hines	Washington State University	Fission Chamber Refurbishment	Refurbishment of a fission chamber for transfer and use at Washington State University	Washington State University
1874	Williams	Oregon State University	Chemoprotection by dietary agents in vivo against a xenograft of human T-cell leukemia	Diindolylmethane (DIM), the primary acid condensation product of indole-3-carbinol (I3C), has been shown to be an effective chemoprotective agent in vitro against a human T-cell lymphoblastic leukemia cell line, CCRF-CEM. This project will test the abili	OSU Linus Pauling Institute
1875	Hosmer	102nd Oregon Civil Support Unit	Instrument Calibration	Calibration of instruments	102nd Oregon Civil Support Unit
1876	Reese	Oregon State University	Utilization of the Prompt Gamma Neutron Activation Analysis Facility	Development and utilization of the Prompt Gamma Neutron Activation Analaysis Facility for use as a user facility	NA
1877	Iwaniec	Oregon State University	Skeletal Response to Leptin	Leptin, the protein product of the ob gene, acts on multiple organs, including bone. We will test the hypothesis that leptin has peripheral-mediated as well as hypothalamic-mediated actions on bone. In this experiment, will assess the skeletal effect of	Department of Nutrition and Exercise Sciences
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
1879	Gregory	Oregon Biomedical Engineering Institute	AHA/AHADD		Oregon Biomedical Engineering Institute
1880	Merrill	Oregon State University	Selenium, Thioredoxin Reductase and Cancer	Determine whether deletion of the geme encoding thioredoxin reductase in liver 1)increases or decreases the rate of liver cancer, 2)impacts the cancer-preventive activity of dietary selenium, 3)effects the pathways by wich cells protect themselves from oxicative stress and cancer	OSU Biochemistry & Biophysics
1881	Tanguay	Oregon State University	Nanoparticle Uptake in Zebrafish Embryos	INAA to determine the uptake of various metals (Ag, Cu, Co) in nanocomposite from by zebrafish embryos	OSU Environmental & Molecular Toxicology
1882	Bray	Wayne State University	INAA of Archaeological Ceramics from South America	Trace-element analysis of Inca-perios ceramics for provenance determination	Wayne 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

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
1884	Contreras	Oregon State University	Mutation breeding of Prunus laurocerasus	Cherrylaurel is desired as a screening plant for its attractive foliage and dense growth; however, its prolific fruit loads contribute to litter and have begun to invade natural areas. The current project is designed to identify the LD50 rate of gamma irradiation so that large seed lots may be irradiated in order to develop novel phenotypes that exhibit reduced fertility or sterility	OSU Horticulture
1885	Mireles	Umpqua Research Company	Water Sample Analysis	Analyze water samples using the LSC to determine if tritium is the same in all samples	Umpqua Research Company
1886	Coutand	Dalhousie University	Fission Track Irradiation	Fission track irradiations of apatite samples	Dalhousie University
1887	Farsoni	Oregon State University	Xenon Gas Production	Production of xenon gas	OSU NERHP
1888	Misner	Pacific Northwest National Laboratory	Detection of short-lived fission products	Utilization fo the PGNAA fast shutter to observe short-lived fission products	Pacific Northwest National Laboratory
1889	Paulenova	Oregon State University	Hydrolysis and Radiolysis of synergistic extractants	The goal of this project is to determine the effects of hydrolysis and radiolysis on the extraction ability of a diamide and chlorinated cobalt dicarbollide (CCD). CCD and the diamide are synergistic extractants and will be together in solution for hydrolysis and radiolysis experiments. Effects will be measured with IR spectroscopy and extraction distribution ratios	NA
1890	Price	Boeing	Neutron Radiography of Electronic Components	Utilizazation of neutron radiography to examine various electronic componentents to detect manufacturing defects	Boeing
1891	Reese	Oregon State University	Development of a Neutron Depth Profiling Instrument	Development and use of a Neutron Depth Profiling instrument in conjunction with PGNAA facility	NA
1892	Vildirim	University of Cincinnati	INAA of Koru ore deposits	Geology of Pb-Zn deposits in Koru area of Canakkale, Turkey	Istanbul Technical University
1893	Mueller	University of Oregon	Soil Sterilization	Sterilization of soils to remove microorganisns (i.e., fungi) without altering abiotic conditions	University of Oregon
1894	Greene	University of Chicago	INAA of Late Bronze-Age Ceramics, Armenia	Trace-element analyses of ceramics from Tsaghkahovit, Armenia, to determine provenance	University of Chicago
1895	Filip	Academy of Sciences of the Czech Republic	Bojemian Massif	Fission-track dating	Academy of Sciences of the Czech Republic

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
1896	Hamby	Oregon State University	Beta Source Creation Through Activation	Activation of various materials for beta radiation sources used in the development of beta spectroscopy instrumentation	OSU NERHP
1897	Loveland	Oregon State University	Testing of Stern Gerlach apparatus	Prepare 86Rb tracer to test Stern Gerlach apparatus.	NA
1898	Fayon	University of Minnesota	Fission Track Services	Use of fission tracks to determine location of 235U, 232Th in natural rocks and minerals.	University of Minnesota
1899	Loveland	Oregon State University	Target Production	Production of actinide targets for used in neutron beams	NA
1900	Keiluweit	Oregon State University	Manganese chemistry and lignin decomposition	We used an artificial soil media (clay minerals, glass beads, manganese oxides) for our experiments. This artificial soil needs to be sterile for our experiments to succeed.	OSU Crop and Soil Science
1901	Emberling	Oriental Institute of Chicago	The Uruk Expansion	INAA of ceramics from Mesopotamia and adjacent areas.	OSU Radiation Center, Minc
1902	Groom	University College of London	Tepe Yanik	INAA of ancient ceramics from Tepe Yanik, Iran.	OSU Radiation Center, Minc
1903	Napier	Pacific Northwest National Laboratory	INAA of Fruits and Soils	Trace-element analysis to determine values for food-chain pathway.	Pacific Northwest National Laboratory
1904	Minc	Oregon State University	INAA of Archaeological Ceramics from Ecuador	Trace-element analyses of ceramics from Ecuador for provenance determination.	NA
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
1906	Torgeson	Yaquina River Constructors	Instrument Calibration	Instrument calibration.	Yaquina River Constructors
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
1908	Colwell	Oregon State University	Sterilization of Basalt Core using Gamma Irradiation	Six (6) basalt cores approximately 6" in height and approximately 2" in diameter will be sterilized using a Co-60 source in order to prepare the cores for microbial incubation experiments. Each core will be individually wrapped in aluminum foil and duplic	OSU COAS
1909	Hamby	Oregon State University	Use of Batteries as Acitivation Detectors	Use of Li-ion batteries as activation detectors by looking at activation of metals in the the battery.	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
1910	Maynard	U.S. EPA	Soil Manganese Redox Cycling in Suboxic Zones: Effects on Soil Carbon Stability	Suboxic soil environments contain a disproportionately higher concentration of highly reactive free radicals relative to the surrounding soil matrix, which may have significant implications for soil organic matter cycling and stabilization. This project e	U.S. EPA
1911	Alden	University of Michigan	INAA of Ancient Iranian Ceramics	Trace-element analysis of ceramic from ancient Iran to monitor trade.	National Science Foundation
1912	Thornton	University of Pennsylvania	INAA of Ancient Iranian Ceramics	Trace-element analyses of archaeological ceramics from Iran.	National Science Foundation
1913	Reese	Oregon State University	Fission Yield Determination Using Gamma Spectroscopy	Use of neutron activation to determine fission yields for various fissile and fertile materials using gamma spectroscopy	NA
1914	Barfod	Scottish Universities Environmental Research Centre	Ar/Ar Age Dating	Ar/Ar age dating.	Scottish Universities Research and Reactor Centre
1915	Peoples	Bartlett Nuclear	QA of Contamination Surveys	Use of gas flow proportional counter to measure gross alpha/beta on contamination survey swipes as part of an independent QA procedure	Bartlett Nuclear
1917	Hosmer	102nd Oregon Civil Support Unit	Sample counting	Counting different media with different instruments to determine isotopic composition.	NA
1918	Jander	Oregon State University	Radiation effects on Magnetic Tunnelling Junction devices	This project is to study the changes of the structural and electrical properties of Magnetic Tunneling junction exposing in gamma radiation.	Electrical Engineering and Computer Science
1919	Baker	Lake District Hospital	Instrument Calibration	Instrument Calibration	Lake District Hospital
1921	Fear	City of Salem	Instrument Calibration	Instrument Calibration	City of Salem
1922	Hallmark	Coos County Public Health	Instrument Calibration	Instrument Calibration	Coos County Public Health
1923	McAllister	NETL	Instrument Calibration	Instrument Calibration	NETL
1924	Hartman	University of Michigan	Lithium Content Determination using PGNAA	Use of PGNAA to determine lithium content in various chemical combinations	NA
1925	Macnab	Allied Waste	Instrument Calibration	Instrument Calibration	Allied Waste
1926	Hartman	University of Michigan	PGNAA Utilization	Use of PGNAA to determine elemental composition of various materials.	NA
1928	Schleifer	Mushka Dairy	Dairy/Vegetation Radionuclide Detection	Determination if contamination of dairy/vegetation from radionuclides exists.	NA
1929	Farsoni	Oregon State University	Source Activation	Irradiation of different materials to make sources for detection experiments.	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
1930	Brown	University of Glasgow	Fission Track Irradiation	Use of fission tracks to determine location of 235U, 232Th in natural rocks and minerals.	University of Glasgow
1931	Emori	Nunhems USA, Inc.	Pollen Sterilization	Irradiation by gamma radiation will make sterile pollen which can be used on female flowers to produce fruit with haploid embryos in some of the seed.	Nunhems USA Inc.
1932	Yilma	Oregon State University	Induced mutation and in vitro techniques as a method to screen drought tolerance in potatoes	Gamma rays and chemical mutagens will be used to induce variation in shoot –tips culture of selected potato varieties for further evaluation.	OSU Crop and Soil Science

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

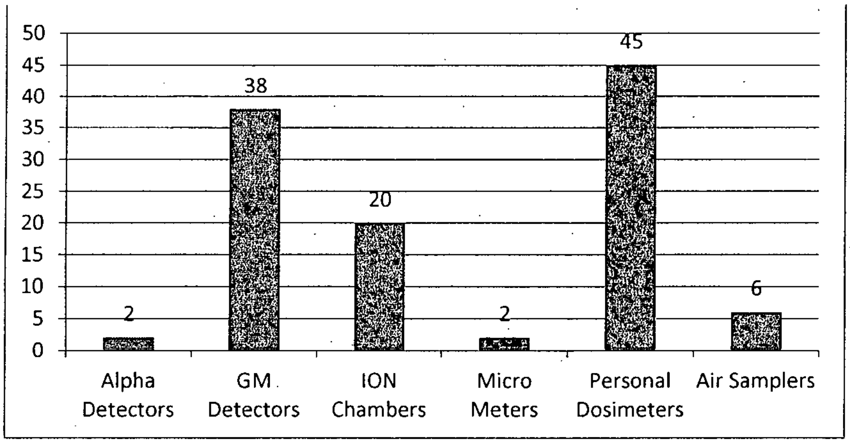


Table VI.3
Summary of Radiological Instrumentation Calibrated to Support OSU Departments

OSUDepartment	Number of Calibrations
Animal Science	2
Biochem/Biophysics	4
Botany	6
Center for Gene Research	2
Chemistry	1
Civil and Construction Engineering	2
COAS	3
Environmental & Molecular Toxicology	4
Environmental Engineering	1
Horticulture	1
Linus Pauling Institute	2
Microbiology	3
Nutrition & Exercise Science	3
Pharmacy	3
Physics	5
Radiation Safety Office	32
Veterinary Medicine	10
Total	84

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

Agency	Number of Calibrations
Allied Waste	1
Amrhein Associates, Inc.	2
CH2MHill	2
City of Salem	2
Coos County	1
ESCO Corporation	7
FAA	3
Fire Marshall	101
Gene Tools	3
Grand Ronde Hospital	5
Health Division	92
Knife River	1
Lake District Hospital	5
Lebanon Community Hospital	3
Marquess & Associates	1
NETL	5
Occupational Health Lab	7
ODOE/ Hazmat	22
ODOT	9
Oregon Health Sciences University	40
Reed Reactor Facility	1
Rouge Community College	1
Samaritan Hospital	12
University of Oregon	1
USDA	2
VDIC	2
Weyerhaeuser	1
Yaquina River	1
Total	*333*

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Minc L., CH225H Honors General Chemistry (2 labs in February, 2011; total of 45 students).

Minc L., CH462 Experimental Chemistry II (3 labs in January, 2011; total of 18 students).

Minc L., NE116 Intro. to Nuclear Engineering & Radiation Health Physics (6 labs in February, 2011; total of 60 students).

Minc L., The Society for American Archaeology Meetings in Apri 2012 in Memphis, TN.

Mundil R., Kimbrough D.L., Irmis R.B., Denyszyn S.W., and Renne P.R., 2010, Time Scale Calibration Benefitting from the Mattinson Technique (CA-TIMS) Applied to Volcanic Zircons. Geological Society of America Annual Meeting, Denver.

Napier B., Fellows R., Minc L. Transfer Factors for Contaminant Uptake by Tree Fruits, 56th Annual Meeting of the Health Physics Society, Palm Beach, FL, 30 June 2011. Health Physics 101(1), p. S92.

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Precek M., Paulenova A.; Radiolytic behavior of neptunium in nitric acid in the presence of HNO2 scavengers, 240th American Chemical Society National Meeting, August 22-26, 2010, Boston, MA, USA.

Precek M., Mincher B., Paulenova A.; Interactions of Nitrous Acid with Neptunium in Nitric Acid Solutions, oral at 66th Northwest Regional Meeting (NORM) of the American Chemical Society, June 26 - 29, 2011 Portland, Oregon, USA.

Precek M., Mincher B., Paulenova A.; Interactions of Nitrous Acid with Neptunium in Nitric Acid Solutions, 35th Actinide Separations Conference, May 23- 26, 2011, Charlotte, North Carolina, USA.

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Roden-Tice, Mary K. and Tremblay A., 2011. Potential Fault Reactivation in the Ottawa-Bonnechere Graben based on Apatite Fission-Track Analysis. Joint Annual Meeting of GAC-MAC, Ottawa, Canada, May 25-27, 2011.

Sobel E. R., Schoenbohm L., Chen J., Thiede R. Stockli D., Sudo M. and Strecker M.R., 2010, Strike-slip fault deceleration constrained by thermochronology: Implications for the timing of Pamir - Tien Shan collision, 12th International Conference on Thermochronology, Thermo2010, Glasgow, 18-20 August, 2010, p. 207.

Sobel E.R., Schoenbohm L., Chen J., Thiede R., Stockli D., Sudo M., and Strecker M.R., 2011, Late Miocene - Pliocene deceleration of dextral slip between Pamir and Tarim: Implications for Pamir orogenesis, EGU General Assembly, Volume 13: Geophysical Research Abstracts, p. EGU2011-7033.

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Tanguay R., Duke University: "Fishing to Define the Nanoparticle Properties that Dictate Biological Responses" April 22, 2010.

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Tanguay R., Environmental Protection Agency STAR Nano Grantee Meeting: "Refinements of the use of Zebrafish for Nanomaterial-Biological Interaction Assessments." Portland, OR. November 9, 2010.

Tanguay R., Greener Nano Conference 11: "High Content Evaluations of the Nano/Bio Interface: A Path to Greener Nanomaterials." Cupertino, California. May 2, 2011.Tanguay R., Greener Nano Conference 11: "Using Biological Assays to Determine Nanomaterials 'Greenness'." Cupertino, California. May 1, 2011.

Tanguay R., Material Sciences Society Annual Meeting, Plenary Speaker: "Optimizing in Vivo Assessment of Nanomaterial-Biological Interaction to Guide Safer Material Design." Boston, MA. November 29, 2010.

Tanguay R., Participation Center for the Alternatives to Animal Testing (CAAT) Nanotechnology and Nanomaterials, "Developing High Throughput in Vivo Assess to Identify Nanomaterial Hazards." Mt Washington Conference Center, Baltimore, MD October 11-13,2010.

Tanguay R., Presentation scheduled at the American Geophysical Union meeting in San Francisco in Dec 2011.

Tanguay R., "Refining Parameters to Improve the Zebrafish Model for Nanomaterial-Biological Interaction Assessments". U.S. EPA Nanotechnology Grantee Meeting. November 9, 2010, Portland, OR.

Tanguay R., The Microproducts Breakthrough Institute (MBI): "High-Throughput/High Content Screening to Enable Greener Nanotechnology." Corvallis, Oregon. June 9, 2011.

Tanguay R., "Silver Nanoparticles Induce Size-Independent Biological Responses in Embryonic Zebrafish". Society of Environmental Toxicology and Chemistry. November 8 – 11, 2010, Portland, OR.

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Tanguay R., University of Wisconsin-Milwaukee: High-Content/High-Throughput Zebrafish Assays to Define Nanoparticle Bioactivity." Milwaukee, Wisconsin. May 26, 2011.

Thomson S.N. Klepeis K.A., Hervé F. & Calderón M. (2011). Late Oligocene erosion of Cordillera Darwin (southernmost South America) associated with rift margin uplift and opening of the west Scotia Sea. 11th International Symposium on Antarctic Earth Sciences, Edinburgh, UK.

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Tissot C., Paine J., Shaw C., Bytwerk D., Higley K., and Whitlow J. The Concentration Ratio of 36Cl in Artemia Salina. s9 Fifty-sixth annual meeting of the Health Physics Society: 26 - 30 June 2011 Palm Beach, Florida: Abstracts of Papers Presented at the Meeting Health Physics. 101(1):A3-A4,S1-S99, July 2011. doi: 10.1097/01.HP.0000400068.68697.fd.

Toraman E., Teyssier C., Whitney D.L., Fayon A.K., Reiners P.W & Thomson S.N. (2011). Ending orogeny: Timing and patterns of exhumation of the Shuswap Metamorphic Core Complex. Cooperative Institute for Dynamic Earth Research (CIDER) Summer Program "Dynamics of Mountain Building", UC Berkeley, USA.

Weirich J. R., Isachsen C.E., and Swindle T.D.(2011) Ar-Ar age of the L chondrite NWA 091: More evidence that multiple isochrons reveal a link to fossil meteorites. Lunar Planet. Sci. Conf. XLII, Abstract #1910.

Willner A.P., Gerdes A., Massonne H.-J., Schmidt A., Sudo M., Thomson S.N. & Vujovich G. (2010). Pressure-temperature-time evolution of a collisional belt (Guarguaráz Complex, Mendoza Province, W-Argentina): Evidence for the accretion of the Chilenia microplate. AGU 2010 Meeting of the Americas, Foz do Iguaçu, Brazil.

Wilson K.E., Leng M.J., Edgar R.K., Deino A.L., Kingston J.D., Maslin M.A., and Mackay A.W., 2010, Millennial-scale cyclicity in the Pliocene: Evidence from the East African Rift Valley. American Geophysical Union, Fall Meeting, San Francisco.

Students

Abdulsalam Alhawsawi, Degree: MS in RHP (completed);Thesis Title: " Study of Compton Suppression Capability in a Triple-Layer Phoswich Detector."

Alejandro Bande (PhD expected in 2013): Constraining deformation history of the Talas-Fergana strike-slip fault and kinematically-linked thrust faults, Kyrgyz Republic. Advisor: Dr. E. Sobel.

Al Zaharani Abdullah B., MS "Examination of Uranium Uptake by Root Vegetables and Consequences for Human Consumption."

Andy Sinclair. Chain length effects on nisin adsorption and elution at polyethylene oxide brush layers. 2011 (BIOE). Advisor: Joe McGuire.

Anke Deeken (PhD expected in 2011): Long-term erosion and exhumation rates across different climatic zones in the Indian NW Himalaya. Advisor: Prof. M. Strecker.

Bemnet Alemayehu- Degree: PhD in RHP (in progress), Thesis Title: "A Well-Type Phoswich Detector for Radioxenon Measurements."

Benedetta Andreucci: "Termocronologia dei Carpazi esterni (Polonia meridionale)". PhD project at the University of Padova. Advisor: Prof. Massimiliano Zattin.

C. Black; The Investigation of Dipicolinic Acid Diamide Derivatives for the Separation of Actinides and Lanthanides using Solid Phase Extraction Chromatography, M.S. Thesis, May 2011.

Clare Tochilin (University of Arizona) – Advisor: Peter Reiners, George Gehrels, Stuart Thomson, MS Thesis Title: Detrital apatite and zircon triple dating (U-Pb, Fission Track, and (U-Th)/He) frpm offshore East Antarctica.

Clay Painter (University of Arizona) – Advisor: Barbara Carrapa, MS Thesis Title: Thermochronology of Upper Cretaceous and Paleocene deposits in the central Cordilleran foreland basin.

Converse, Kristin, M.A. Anthropology (Sonoma St.), Outside Member Title: "Like Nuggets from a Gold Mine": Searching for Bricks and Their Makers in the Oregon Country. Advisor: Margaret Purser.

Corrie D. Black, M.S. NE-RHP, GCR Title: The investigation of dipicolinic acid diamide derivatives for the separation of actinides and lanthanides using solid phase extraction chromatography. Advisor: A. Paulenova.

Davis, Christina, in progress for 2012, "Cretaceous exhumation and rifting in the Byrd Glacier outlet of the Transantarctic Mountains, Antarctica, from apatite fission track analyses". B.A. Thesis, Occidental College, Advisor: Ann E Blythe.

Dorrell, Nick J., M.S. NE-RHP, Outside Member Title: Retrospective thermal neutron fluence determination using lithium-ion mobile telephone batteries. Advisor: D. Hamby.

E. Wade; The Effects of Radiolysis and Hydolysis on the Stability of Extraction Systems for Minor Actinides, M.S. Thesis, November 2010.

Euan Macaulay (PhD expected in 2012): Has late Cenozoic climate change lead to enhanced erosion in the Kyrgyz and Chinese Tien Shan? Advisor: Dr. E. Sobel.

Fariq Shazanee (University of Arizona) – Advisor: Barbara Carrapa, Undergraduate Senior Thesis Title: Multi-geochronology analyses of Pamirs river detritus: insights into Pamir-Tibet connections.

Franziska D.H. Wilke (2010). Quantifying crystalline exhumation in the Himalaya. PhD Thesis, University of Potsdam. http://opus.kobv.de/ubp/volltexte/2010/4313/ Advisor: Prof. P. O'Brien.

Franziska D.H. Wilke, PhD 2010. Quantifying crystalline exhumation in the Himalaya. Dissertation Universität Potsdam, pp. 98. Urn:nbn:de:kobv:517-opus-43138.

Giorgio Di Fiore: "Thermal modelling of the Simplon and Brenner regions". PhD project at the University of Bologna. Advisro: Prof. William Cavazza.

Gombosi, D., (PhD, SUNY Albany: advisor: S. Baldwin), Argon diffusion in Lunar Impact glasses and the development of the electron microprobe zircon fission track dating technique. In progress).

Heather Lavalleur, MS in Microbiology, expected in Dec 2011

Izykowski, T.M., 2011. (BSc, Union College, Advisor: Garver) Detrital zircon fission track ages of the Paleocene Orca Group of Eastern Prince William Sound, near Cordova, Alaska; unpublished BSc Thesis, Union College, Schenectady NY, 112 p.

J. R. Weirich (2011) Improvements to Ar-Ar dating of extraterrestrial materials. PhD thesis, University of Arizona, Department of Planetary Sciences. Advisor, T. D. Swindle.

Jonathan Gaylor, Ar/Ar dating and the integrated Cretaceous time scale; advisor: Xavier Quidelleur; Université Paris-Sud (France), PhD-student.

Julia Ricci, K/Ar and 40Ar/39Ar dating of the Viluy devonien traps (Siberia) and their relationship with the Frasnien-Fammenien crisis; advisors: Xavier Quidelleur and Vincent Courtillot; Université Paris-Sud (France), MS-student.

Julie Auxier. Quantification of fibrinogen adsorption to nisin-loaded polyethylene oxide layers. 2011 (BIOE). Advisor:Joe McGuire.

Katherine Tadehara. Molecular origins of surfactant stabilization of a human recombinant Factor VIII. 2011 (CHE). Advisor: Joe McGuire.

Kiya Wilson, BS Earth Science (Honors), 2011.

Kristin and Bryan presented a joint poster at the local Sigma Xi Research Symposium in April 2011.

Lisa Truong – PhD Candidate, Advisor: Robert Tanguay Thesis Title: Surface functionalities influences developmental toxicity in embryonic zebrafish.

Mason Keck, B.S. in physics (degree expected June 2012) Allison Gicking, B.S. in physics (degree expected June 2012) Howard Dearmon, B. S. in physics (degree expected June 2012).

Maud Moulin, The Karoo traps and the mass-extinction of the lower Jurassic: eruptive dynamics and environment perturbations; advisors: Vincent Courtillot and Frédéric Fluteau; IPG Paris (France), PhD-student (graduated on july 1, 2011).

Milde, E.R., 2011, (BSc, Union College, Advisor: Garver) Fission track ages of detrital zircon for the Campanian-Maastrictian Valdez Group of the Chugach terrane, Richardson Highway, Valdez, Southeast Alaska; unpublished BSc Thesis, Union College, Schenectady NY, 78 p.

Nicholas A. Jarboe, PhD (2010) "The Steens Basalt of the Oregon Plateau: A geomagnetic polarity reversal and the age of the Columbia River basalt group". Robert S. Coe, advisor (Univ. California, Santa Cruz.

Roxana Safipour (University of Arizona) – Advisor: Peter DeCelles, Barbara Carrapa, MS Thesis Title: Shortening in the Central Andes at the transition to flat slab subduction.

Sara Callegaro, PhD (expected 2011) "Petrology and Origin of the Central Atlantic Magmatic Province". Andrea Marzoli, advisor (Univ. Padua, Italy).

Sarah Ashley Bromley, MS Geology, 2011.

William S. Cassata, PhD (expected 2011) "Argon diffusion in feldspars". Paul Renne, advisor ((Univ. California, Berkeley.

Williams, Manual P., M.S. NE-RHP, GCR Title: How clean is coal: coal power plant ash pond regulations compared to nuclear reactor decommissioning standards. Advisor: K. Kigley.

Xiuxi Wang: "Tianshui-Huicheng Basin's response to the Cenozoic tectonic evolution of Northeast Tibetan Plateau and the relation with the uplift of west Qinling". PhD project of the Lanzhou University (China).

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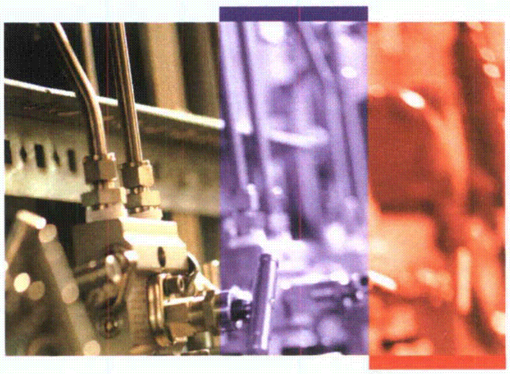

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