REED COLLEGE Portland, Oregon 97202

REACTOR FACILITY

October 9, 2003

Document Control Desk
US Nuclear Regulatory Commission
Washington, DC 20555

Docket 50-288

Enclosed is Reed College Reactor's Annual Report.

This has been another exciting year. We continue to make progress on many of our long term projects. Details are shown in the report.

Please feel free to contact me for additional information.

Regards,

Stephen G. Frantz
Director, Reed College Reactor

A020

3203 SE Woodstock Blvd., Portland, OR 97202-8199 503-777-7222 Fax: 503-777-7274 reactor@reed.edu

# REED RESEARCH REACTOR ANNUAL REPORT

September 1, 2002 -- August 31, 2003

# REED RESEARCH REACTOR ANNUAL REPORT

September 1, 2002 -- August 31, 2003

3203 Southeast Woodstock Blvd.
Portland, Oregon 97202-8199
503-777-7222
fax: 503-777-7274
reactor@reed.edu

Stephen G. Frantz
Director, Reed Reactor Facility
Program Director, Nuclear Science
Consortium of the Willamette Valley

# TABLE OF CONTENTS

# OVERVIEW

This report covers the period from September 1, 2002 to August 31, 2003, and is intended to fulfill the reporting requirements of the U.S. Nuclear Regulatory Commission, the U.S. Department of Energy, and the Oregon Department of Energy including:

- U. S. Nuclear Regulatory Commission, License No. R-112 (Docket 50-288)
- Oregon Office of Energy Rule No. 345-030-010
- U. S. Department of Energy Grant No. DE-FG07-02ID14292
- U. S. Department of Energy Grant No. DE-FG07-01ID14153

We also wish to thank other funding sources and granting agencies including Portland General Electric and Concordia University.

The reactor is a Triga Mark I reactor with zirconium hydride / uranium hydride fuel elements in a circular grid array at the bottom of a 25-foot-deep tank of water and is surrounded by a graphite reflector. The fuel is enriched to 19.9% in uranium-235.

The Reed College Reactor Facility has been a resource for research and educational projects in the Portland area since its establishment in 1968. The main uses of the Reed Reactor Facility are instruction and research, especially in the field of trace-element analysis. In addition to providing student research opportunities, the reactor staff works to educate the surrounding community on the principles of nuclear energy and radiation safety.

There were 1740 individual visits to the Reactor Facility during the year. Most were students in classes at Reed College or area universities, colleges, and high schools. Including tours and research conducted at the facility, the Reed Reactor Facility contributed to the educational programs of 9 colleges and universities in addition to 16 pre-college groups. The reactor was operated 294 times on 136 days. The thermal energy produced was 60.7 megawatt-hours.

The reactor staff consists of a Director, an Associate Director, a contract Health Physicist, Reed College undergraduate students, and some non-students who are licensed by the Nuclear Regulatory Commission as reactor operators or senior reactor operators. The number of licenses varies from year to year. As this report is being written the licensed operating staff consists of 13 women and 17 men.

During the reporting period, 12 reactor operator candidates passed their NRC exams and 4 senior reactor operator candidates passed their NRC exams. During the past ten years 87 people have taken the NRC reactor operator exam and 84 received licenses. During the same period 45 people have taken the senior reactor operation exam and 43 have received senior reactor operation licenses.

There were no radiation exposures to individuals in excess of 1% of the limit during the year. There were no releases of liquid radioactive material from the facility and airborne releases were well within regulatory limits. There were no shipments of radioactive waste.

The facility experienced a small fuel leak this year. We were able to identify the leaking element and remove it from service. Normal operations were resumed.

The Nuclear Regulatory Commission conducted their annual inspection during December 2002. There were no violations or concerns. There was one follow up item. Additionally, the NRC visited the facility in June of 2003 specifically to review our security condition.

# PEOPLE

## Facility Staff

During the period September 1, 2002 to August 31, 2003, the facility staff consisted of:

| | |
|---|---|
| *Reactor Director:* | Stephen Frantz (4/94 – Present) |
| *Associate Director:* | Rachel Barnett (5/03 – Present)<br>Eric Weis (6/01 – 5/03) |
| *Reactor Supervisor:* | Megan Othus (5/02 – Present) |
| *Training Supervisor:* | Lily Cool (5/03 – Present)<br>Rachel Barnett (5/01 – 5/03) |
| *Radiation Safety Officer:* | Kathleen Fisher (1/03 – Present)<br>Stephen Frantz (8/00 – 1/03) |
| *Contract Health Physicist:* | Marshall Parrott (8/91 – Present) |
| *Senior Reactor Operators (SRO):* | Rachel Barnett<br>Jay Bodzin<br>Mat Brener<br>Nick Chaimov<br>Lily Cool<br>Cilicia Dorn-Lopez<br>Ann Erickson<br>Nicki Ford<br>Stephen Frantz<br>Chris Hoefler<br>Steve Katz<br>Ariah Kidder<br>Eric Lawrence<br>Andrea Neuhoff<br>Megan Othus<br>David Rubin<br>Eric Weis |
| *Reactor Operators (RO):* | Carl Anderson<br>Andre Bach<br>Nicholas Blanchard-Wright<br>Alex Bram<br>Katie Bray<br>David de Regt<br>Oren Elrad<br>Derek Galligan<br>Jessica Griffith<br>Jesse Hallett<br>Judy Kim<br>Beverly Lau<br>Kristen Lavavej<br>Peter Rovegno<br>Seth Samuel<br>Dan Spoth<br>Maureen Steckler<br>Nancy VanProoyen<br>Joy Wattawa<br>David Williams<br>Gabriel Ycas<br>Jon Young |

The list of operators includes everyone who held a license during the reporting period. ROs who upgrade their licenses to SRO during the reporting period are listed under SRO. All staff members were Reed College undergraduates except Mr. Frantz, Ms. Barnett, Ms. Fisher, Dr. Parrott, Mr. Weis, Mr. Bodzin, Mr. Bram, and Ms. Dorn-Lopez.

The number of licenses and the gender ratio varies from year to year. As this report is being written there are 13 women with reactor licenses and 17 men with licenses.

## Oversight Committees

The Reed Reactor Facility has two oversight committees: the Radiation Safety Committee and the Reactor Operations Committee. Together they comprise the Reactor Review Committee. The Radiation Safety Committee is concerned with emergency preparedness, health physics, radiation safety, physical security, environmental impact, and the interface between the Reed Reactor Facility, Reed College, and the surrounding community. The Reactor Operations Committee deals with the day-to-day operations of the reactor, reactor maintenance, reactor safety, operator training, and operator requalification. The membership of the committees during the reporting period is shown below:

## Radiation Safety Committee

*Voting Members:*

John Frewing (Chair) *(Oregon Independent College Foundation)*
Wayne Lei *(Environmental Director, Portland General Electric)*
Jack Mahoney *(Neighborhood Resident)*
Tom Meek *(Radiation Protection Manager, Trojan Nuclear Power Plant)*
Kathleen Fisher *(Director, Reed Environmental and Safety)*

*Ex Officio (without vote):*

Peter Steinberger *(Dean of the Faculty, Reed College)*
Stephen Frantz *(Director, Reed Reactor Facility)*
Eric Weis *(Associate Director, Reed Reactor Facility)*
Marshall Parrott *(Contract Health Physicist)*
Megan Othus *(Reactor Supervisor)*
Rachel Barnett *(Reactor Training Supervisor)*

## Reactor Operations Committee

*Voting Members:*

Daniel Gerrity (Chair) *(Chemistry Faculty, Reed College)*
Juliet Brosing *(Physics Faculty, Pacific University)*
Josh Filner *(Medical Student, Oregon Health Science University)*
Steve Reese *(Reactor Director, Oregon State University)*

*Ex Officio (without vote):*

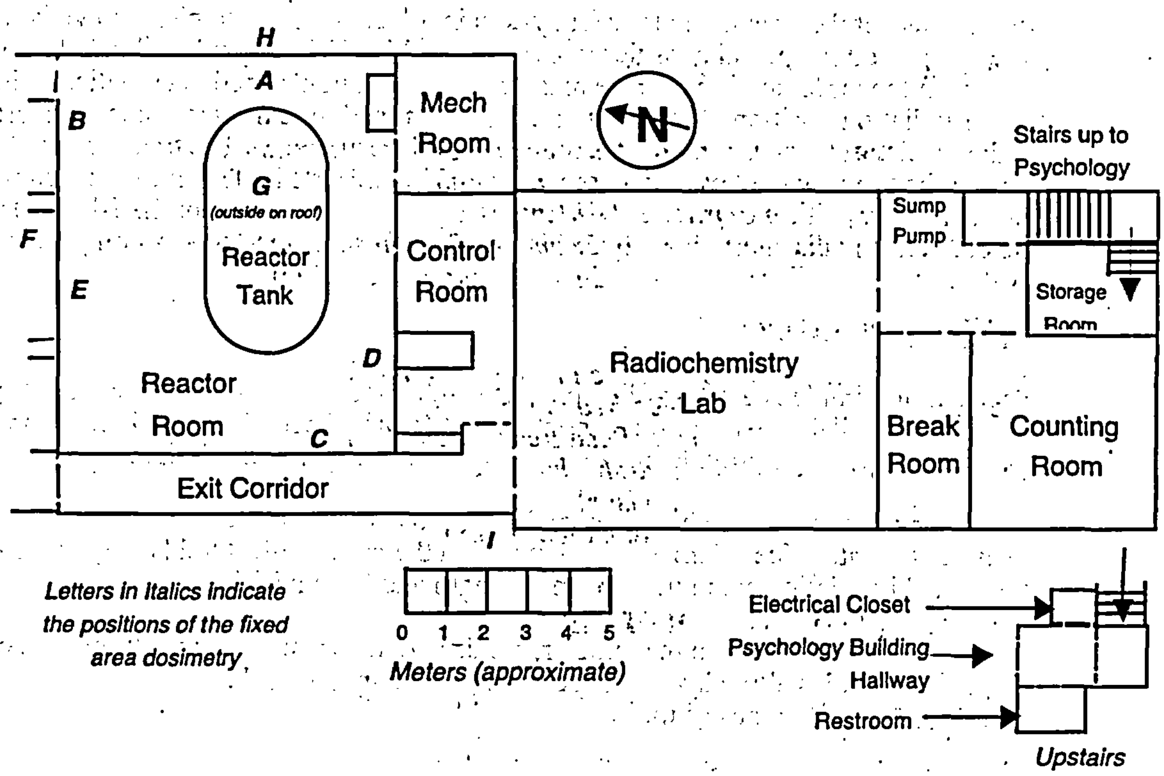
Peter Steinberger *(Dean of the Faculty, Reed College)*
Stephen Frantz *(Director, Reed Reactor Facility)*
Eric Weis *(Associate Director, Reed Reactor Facility)*
Megan Othus *(Reactor Supervisor)*
Rachel Barnett *(Reactor Training Supervisor)*

# FACILITIES

## Reactor Facility Floor Plan

In addition to the reactor, the Reed Reactor Facility has space for a radiochemistry lab. A floor plan appears as Figure 1.

**Figure 1 - Reed Reactor Facility Floor Plan**




The equipment available at the reactor facility includes high purity germanium gamma spectrometers, an X-ray florescence detector, surface barrier detectors, alpha spectrometers, silicon lithium X-ray detectors, a whole body counter, gas flow proportional counters, ion chambers, beta counters, Geiger Muller tubes, neutron detectors, alpha detectors, and thermoluminescent dosimeter readers. These instruments are used for experiments and training in nuclear science and radiation detection. Two hand and shoe monitors are in the reactor bay. A liquid scintillation detector serves the campus radioisotope committee. The reactor facility has several systems for performing irradiations, described below.

## Rotating Specimen Rack Facility

The rotating specimen rack ("lazy susan") is located in a well on top of the graphite reflector surrounding core. The rack consists of a circular array of 40 tubular receptacles; each of which can accommodate two irradiation tubes. Vials holding up to 17 ml (four drams) are used in this system. Samples are loaded in the specimen rack prior to the start-up of the reactor. The rack automatically rotates during irradiation to ensure each sample receives the same neutron flux. Typically, researchers use the rotating rack when long

irradiation times (generally greater than five minutes) are required. The approximate thermal neutron flux in a rotating rack position at full power is 1.7 $x10^{12}$ $n/cm^2s$ with a cadmium ratio of 6. The specimen rack can be used for gamma irradiations (approximately 8 rad/min) when the reactor is shutdown.

## Pneumatic Transfer System

The pneumatic transfer system ("rabbit") consists of an irradiation chamber in the outer F-ring of the core and its associated pump and piping. This allows samples to be transferred in and out of the reactor core very rapidly, while the reactor is at power.

Routine use of the pneumatic transfer system involves placing samples into vials, which in turn are placed in special capsules known as "rabbits." The capsule is loaded into the system in the laboratory next to the reactor and is then transferred pneumatically into the core-irradiation position. At the end of a predetermined time the sample is transferred back to the receiving terminal, where it is removed for measurement. The transfer time from the core to the terminal is about seven seconds, making this method of irradiating samples particularly useful for experiments involving radioisotopes with short half-lives. The flux in the core terminal is approximately $5x10^{12}$ $n/cm^2s$ when the reactor is at full power.

## In-Core Facilities

The central thimble is a water-filled irradiation chamber about 3 cm in diameter. It provides the highest available neutron flux, about $1x10^{13}$ $n/cm^2s$. Special sample holders are used in the central thimble to provide maximum flexibility in experiment design.

A fuel replacement source holder assembly can also be used as an irradiation facility. The chamber fits into a fuel-element position within the core itself. It holds only one specially positioned irradiation container 7.5 cm in length and 2.5 cm in diameter.

Foil-insertion holes, 0.8 cm in diameter, are drilled at various positions through the grid plates. These holes allow inserting special holders containing flux wires into the core, to obtain neutron flux maps of the core.

## In-Pool Facilities

Near core, in-pool irradiation facilities can be arranged for larger samples. Neutron fluxes will be lower than in the lazy susan and will depend on the sample location.

## Beam Facilities

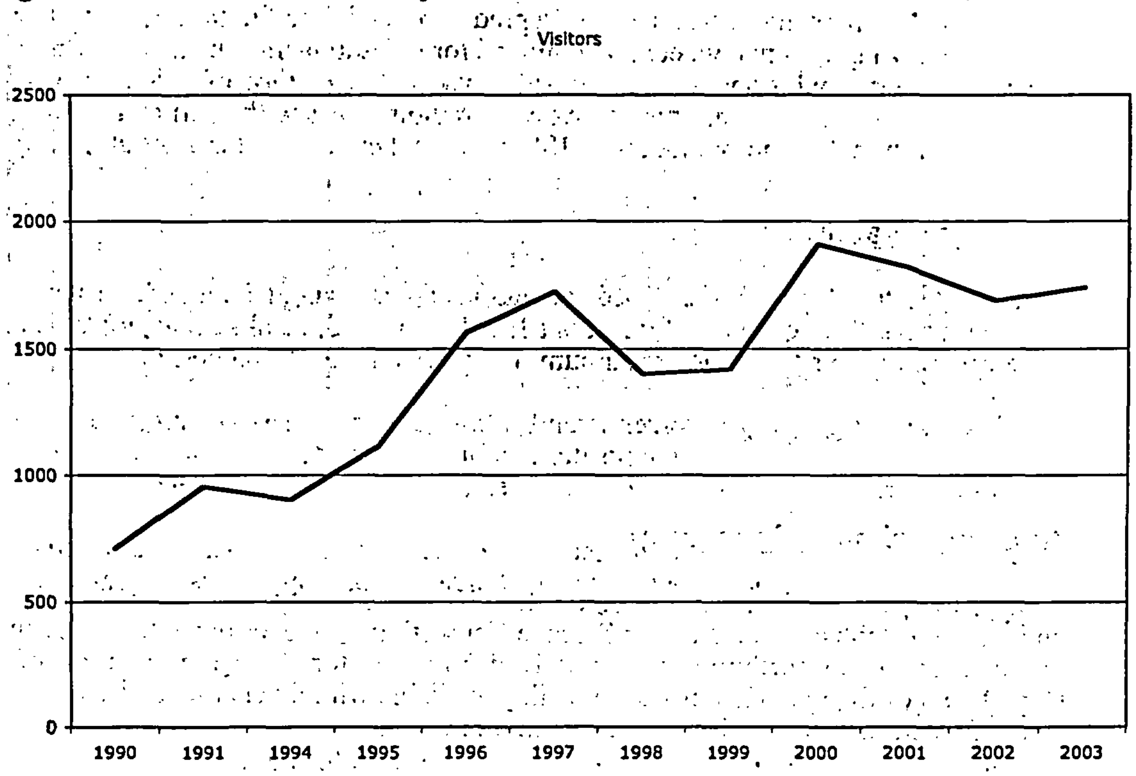
The central thimble can be evacuated with gas, producing a vertical neutron beam. This beam can be used to generate directional neutron flux, or for limited irradiations above the tank. Neutron radiography is also possible. The flux above the beam exit is approximately $1x10^3$ $n/cm^2s$ when the reactor is at full power.

## USERS

### Reactor Visitors

A total of 1740 individuals visited the Reed Reactor Facility during the year, as derived from the visitor log - Entry List B. Individuals who visited more than once are counted for each visit. Visitors include all individuals who are not listed as facility staff. The visitors included 1558 individuals for training or tours, of whom 689 were in programs funded in part by the U.S. DOE Reactor Sharing program. A large percentage of these were students in classes at area colleges and schools as discussed below. A graph of the history of visitor attendance is shown in Figure 1, and a list for the current year is included as Appendix A.

**Figure 2 - Reed Reactor Facility Visitors**



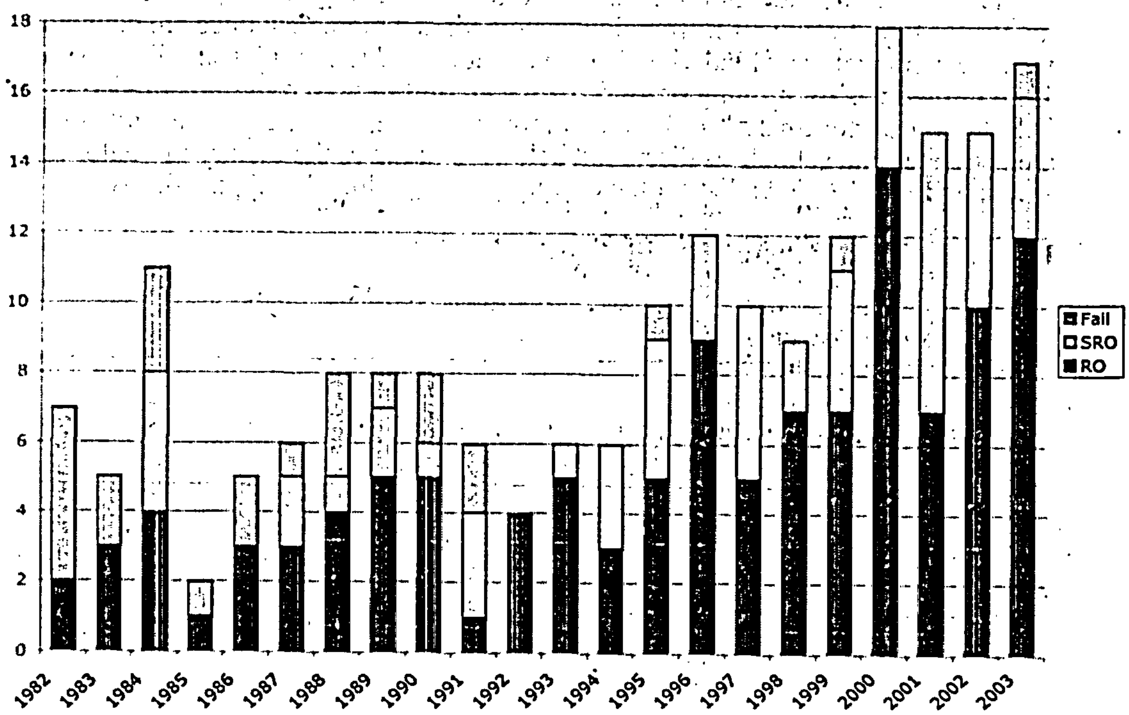

### Reactor Operations Seminar

The Reed Reactor Facility conducts an annual seminar series for students from Reed and other area educational institutions. This non-credit course serves as an introduction to nuclear reactor theory, health physics, and reactor operation. Some of the students continue with in-depth reactor operator training and subsequently apply for a reactor operator license. If successful, the individual may be hired to operate the reactor. In addition, existing reactor operators may take the NRC senior reactor operator exam to upgrade their licenses.

During the reporting period, 12 out of 13 reactor operator candidates passed their NRC exams and 4 out of 5 senior reactor operator candidates passed their NRC exams.

Historically students who fail the NRC exam only fail one section and they are allowed to retake that section later. Figure 3 is a graph of the number of license application each year since 1982 showing how many new RO and SRO licenses were awarded at Reed and how many failed to obtain a license.

**Figure 3 - Reed Reactor Facility License Exam Results**




## Nuclear Science Consortium

In order to better use the resources of the Reed Reactor Facility, several area colleges and universities established the Nuclear Science Consortium of the Willamette Valley in 1970. Funding for the Consortium has been derived from Reactor Use Sharing Grants of the U.S. Department of Energy. This made the facility available without charge to classroom groups and unfunded research projects for consortium members.

The following institutions have participated in facility tours, experiments, and research projects in the reporting period.

COLLEGE TOURS/USERS

- Concordia University
- Lewis and Clark University
- Linfield College
- Linfield School of Nursing
- Pacific University
- Portland Community College
- Portland Community College – Rock Creek
- Portland State University
- Warner Pacific College
- Willamette University

HIGH SCHOOL & MIDDLE SCHOOL TOURS/USERS

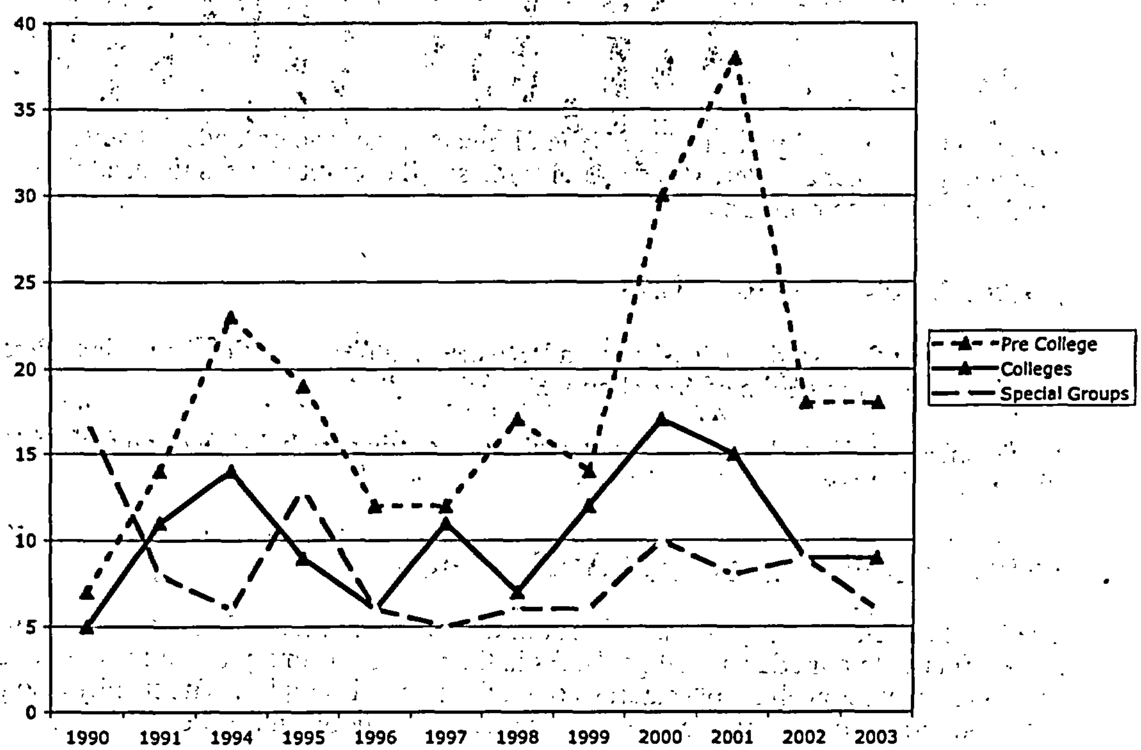
- C.S. Lewis Academy
- Cleveland High School
- David Douglas High School
- Franklin High School
- Hood River High School
- Jefferson High School
- Jesuit High School
- Kennedy High School
- Lincoln High School
- Milwaukee High School
- New Covenant Academy
- Oregon Episcopal School
- Rex Putnam High School
- Roosevelt High School
- Southridge High School
- St. Francis Academy
- Sunset High School
- Trillium Charter School

SPECIAL GROUPS

- Advocates for Women in Science, Engineering, and Mathematics
- Apprenticeships in Science and Engineering
- Bring Your Child to Work Day
- Oregon Museum of Science and Industry (OMSI) Camp
- Saturday Academy
- Science Camp

Figure 4 is a graph showing the history of visits by colleges and schools.

**Figure 4 – Schools**




Many reactor tours include hands-on use of facility equipment to conduct experiments in radiation science, health physics, and nuclear physics. A typical lab involves determining the background of a Geiger Muller scalar system and then determining the half-life of a sample of radioactive material. College classes are generally more closely tailored to the individual interests and needs of the Consortium faculty member involved. Experiments include more direct use of the reactor itself by the students, more detailed analysis of materials, and emphasize the incorporation of other classroom activities as much as possible.

Several special programs for gifted children used the reactor for projects. These are designed to enrich their educational program and prepare them for college. Some of the groups who use the reactor target minority and disadvantaged youth who are historically under-represented in science professions.

## High School Student Projects

The Reed Reactor Facility continued to be used in independent science projects initiated by students from several Oregon high schools.

## Pacific University Modern Physics Lab

Each year the Modern Physics Lab at Pacific University spends lab sessions at the reactor. The students do several labs including basic health physics, sub-critical multiplication, and neutron activation analysis.

## Concordia University

The reactor provides training and experiments involving radiation, radioactive material, environmental sampling, and trace element analysis for the Environmental Remediation & Hazardous Material Management Program (ERHMM) at Concordia University

## Scaler Kits

Through the generosity of Portland General Electric, the reactor lends out suitcases containing a geiger counter, a scaler, and some small exempt sources to local high schools for their use in their program.

## Reed Classes

- Chemistry 271 students conducted a lab using neutron activation analysis to determine chemical composition of an unknown.
- Chemistry 101 students conducted a lab to determine the half-life of an activated silver dime.

## Industrial and Commercial Applications

The Reed Reactor Facility is available for industrial or commercial concerns when it does not conflict with our educational goals. As in the past, the primary operations involved neutron activation analysis of materials or environmental samples. The facility also provides radiation protection training to interested parties and schools in the area.

# Reactor Operations

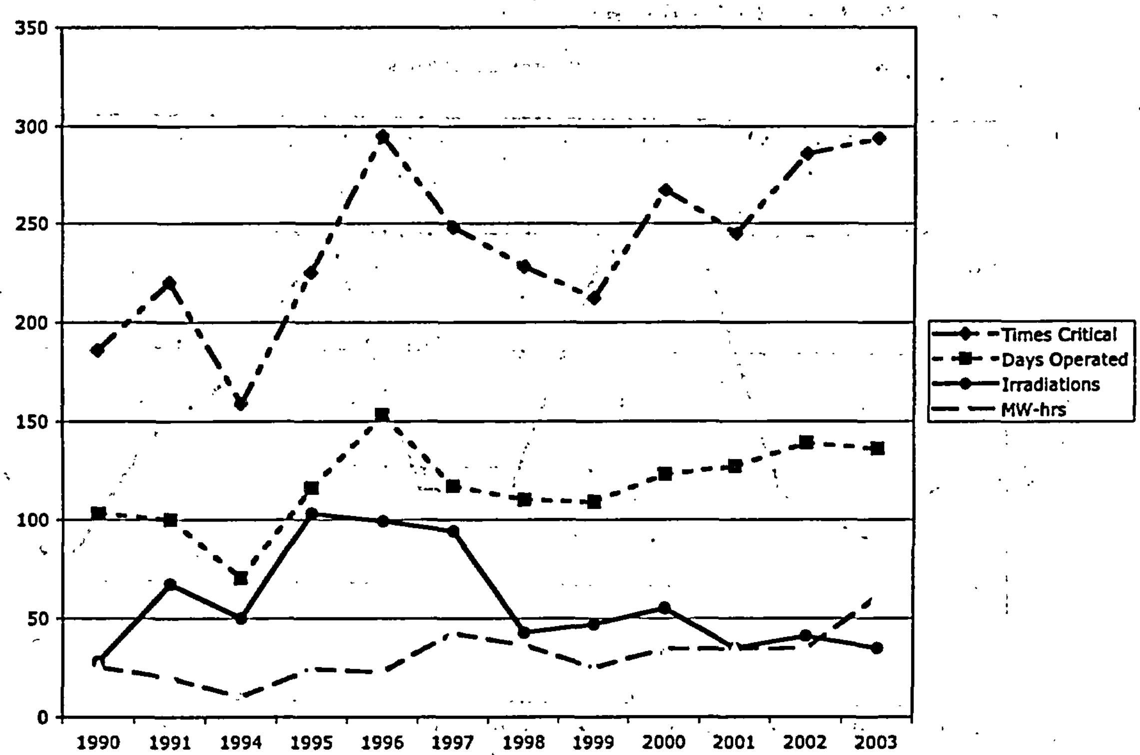
## Operations

During the year the reactor was taken critical 294 times on 136 days. The total energy produced was 60.7 megawatt-hours. Operating history by month appear in Table A. A history of the data is shown in Figure 5. During July the search for the leaking fuel element required operation at full power for several hours each workday.

**Table A - Operating History**

| | Times Critical | Days Operated | MW-hrs |
|---|---|---|---|
| **Sep.** | 21 | 7 | 1.662 |
| **Oct.** | 19 | 9 | 1.73 |
| **Nov.** | 23 | 12 | 4.557 |
| **Dec.** | 8 | 7 | 0.779 |
| **Jan.** | 23 | 10 | 2.829 |
| **Feb.** | 36 | 12 | 2.061 |
| **Mar.** | 32 | 11 | 1.798 |
| **Apr.** | 37 | 14 | 3.546 |
| **May** | 43 | 12 | 2.113 |
| **Jun.** | 16 | 9 | 3.645 |
| **Jul.** | 24 | 22 | 28.561 |
| **Aug.** | 12 | 11 | 7.431 |
| **Total** | 294 | 136 | 60.712 |

**Figure 5 – Operations**



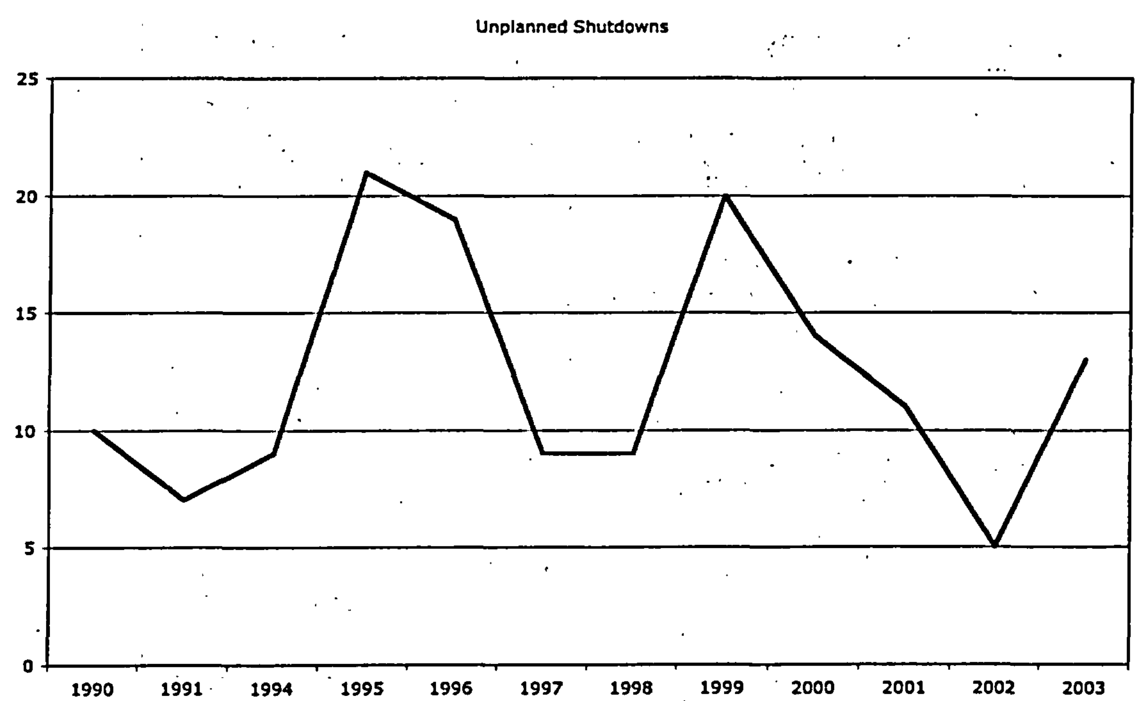
## Unplanned Reactor Shutdowns

There were 13 inadvertent reactor shutdowns (scrams) as shown in Table B; none were unexplained. The number of unplanned reactor shutdowns is consistent our past experience as shown in Figure 6, although it reversed our trend toward fewer unplanned scrams. The major increases were due to electrical transients and in operator error (mostly scramming on the percent power channel while watching the linear channel).

**Table B - Unplanned Reactor Shutdowns**

| Date | Scram Type | Cause Of Scram |
|---|---|---|
| 11/7/02 | Linear | Pushed 25 W range button while at 240 kW |
| 1/24/03 | Percent Power | Operator Error |
| 2/11/03 | Linear | Turned off the Linear channel while trying to turn off the Log channel |
| 2/24/03 | Linear and Percent Power | Automatic rod control malfunction |
| 3/11/03 | Percent Power | Operator Error |
| 4/22/03 | Percent Power | Operator inattention |
| 6/27/03 | Percent Power | Electrical Transient |
| 7/16/03 | Percent Power | Electrical Transient |
| 7/29/03 | Linear and Percent Power | Operator Error |
| 7/29/03 | All | Electrical Transient |
| 8/6/03 | All | Electrical Transient |
| 8/15/03 | All | Temporary loss of electrical power |
| 8/28/03 | Linear and Percent Power | Operator Error |

**Figure 6 – Unplanned Shutdowns**



## Security

There were significant security reviews of the facility, both internal and external. Our physical security barriers and procedures were modified and improved.

## Fuel Leak

The Reed Reactor Facility exhibited characteristics of a fuel leak at 5:09 pm on Friday, June 27, 2003. It was approximately six and a half hours into a long run at 240 kW with pool temperature at 25.3°. There was a very small release–too small to even classify. The highest radiation monitor reading was $7 \times 10^{-8}$ $\mu Ci/cm^3$. We found fission products ($^{138}Cs$ and $^{88}Rb$) in the stack Air Particulate Monitor (APM) filter. On Monday, June 30, 2003, the Reactor Review Committee approved plans for looking for the leaking fuel element. This was accomplished by changing out two elements from the core with elements that were in storage, operating the reactor to look for fission products, and then repeating the process the next day. On August 6, 2003 after following this procedure for 26 days over a six-week period, the leaking element was identified and removed from service. It was element serial number 5488 which had been in position E-4 since initial criticality in 1968. Subsequent inspection on August 7 with the under water camera did not show anything abnormal.

While swapping fuel elements on July 30, 2003, at 9:38 am we dropped one of the fuel elements. There was no release of radioactivity. The element was retrieved and inspected the same day. The lower pin was slightly bent, but otherwise it appeared fine. It was returned to the core and is functioning fine. The root cause of the dropped element appears to be a faulty fuel handing tool. We borrowed a fuel-handling tool from Oregon State University to continue the search for the leaking element. We paln to have General Atomics refurbish our original tool.

## Technical Specification Violation

During the fuel exchange process, we discovered that we had apparently violated our Technical Specifications. Reed Reactor Technical Specification E.3 states: Each standard fuel element shall be visually inspected at least once every ten years. At least 1/5 of all the fuel elements of the core shall be inspected biennially. If indication of apparent deterioration or distortion is found, the fuel element(s) shall be removed from the core.

During the fuel inspections of 2001 and 2003, we did not inspect fuel elements that were not in the core. We normally have four elements that are not in the core, two damaged elements and two spare used elements. Because they were not in the core, these elements were not inspected when they came due.

During our fuel leak investigation this year, one used element was put in the core to replace elements being investigated. Thus, we had one element in the core that had not been inspected during the past ten years. We inspected the two elements as soon as possible after the fuel leak on August 7, 2003. The inspection was normal. We amended our operating procedures to ensure that elements that are not in the core are inspected as scheduled.

# REACTOR MAINTENANCE

## Significant Maintenance

Routine equipment checks are conducted by reactor staff members on a daily, weekly, bimonthly, semiannual (January and July) and annual (January) basis as required by facility procedures. Reed College maintenance personnel assist with routine preventative maintenance to auxiliary equipment. Significant maintenance operations which were not part of a regular schedule are listed in Table D.

**Table D - Significant Maintenance Operations**

| Date | Maintenance |
|---|---|
| 10/30/02 | All electrical outlets near the reactor pool were converted to GFCI outlets. |
| 11/08/02 | Installed new guard rails around the reactor pool |
| 11/19/02 | Replaced belt guards on ventilation fans and air compressor |
| 12/03/02 | Repaired pneumatics for ventilation isolation system |
| 1/13/03 | Installed new water level monitor |
| 1/16/03 | Installed new 24 VDC power supply in console |
| 1/22/03 | Installed new water temperature monitor |
| 1/24/03 | Installed new CAM, APM, GSM (AMS-4) |
| 1/30/03 | Replaced primary filter |
| 4/14/03 | Replaced RAP-1 air pump for CAM |
| 4/24/03 | Adjusted the position indication on the lazy susan |
| 6/26/03 | Replaced primary filter |
| 7/15/03 | Completed installing Honeywell Multitrend |

## Safety Reviews Approved by Reactor Review Committee

Title: **AMS-4 Radiation Monitors**
Date: October 28, 2002
Summary of Proposed Change:

This change replaces the Continuous Air Monitor, the Air Particulate Monitor, and the Gaseous Stack Monitor with new AMS-4 units. The AMS-4 is current state of the art units from ThermoEberline.

The sampling units will be in the loft for the APM and GSM as they are now. The sampling unit for the CAM will be moved to the east wall of the reactor room so that it is near the APM. That way the sampling pump can be up in the loft where the noise will be less troublesome. The units' displays will be mounted in the control room.

Title: **Pool Water Level Monitor**
Date: October 28, 2002
Summary of Proposed Change:

This change would install an Omega electrostatic pool level sensor in the reactor pool to provide a continuous readout of the pool water level. The output of the sensor would feed a new digital display on the console and trip the existing high and low alarms. It would also provide input to the Multitrend Plus V5 Electric Chart Recorder being installed.

This replaces the float-operated alarm currently installed. The new detector measures the capacitance across a water-filled gap, whereas the previous one measured the deflection of a rod connected to a floating ball in the pool. There is no currently installed level detector other than the alarm.

Title: **Period Scram**
Date: October 28, 2002
Summary of Proposed Change:

This change removes the reactor period scram. The scram is not required by Technical Specifications and has been removed on most other Triga reactors. The Safety Analysis Report mentions the period scram but it is not required for reactor safety.

The scram will be removed to eliminate the inadvertent scrams caused by instrument noise. We still intend to enforce the administrative limit on reactor period of 10 seconds.

Title: **Multitrend Recorder**
Date: October 28, 2002
Summary of Proposed Change:

This change connects outputs from various indications on the control console to a Honeywell Multitrend Plus V5 Electronic Data Recorder in the control room. In addition to a graphical display, the recorder can store the data on a zip disk and post the information on the campus network. This replaces our planned use of LabVIEW for these purposes.

This display is not intended to remove any of the installed displays, only to repeat them on the Multitrend for flexible display and data recording. Once the unit's reliability has been established, we will probably use it to replace the physical chart recorder paper and perhaps some of the less important displays.

The unit can accept 16 inputs. Our current plan is to display the CAM, APM, GSM, Linear Power, Log Power, Percent Power, 3 Rod Heights, Pool Level, and 3 Water Temperature values. We might use the available digital inputs for the status of isolation or reactor scram.

Title: **Omega Temperature Monitors**
Date: October 28, 2002
Summary of Proposed Change:

This change replaces the three existing RTD temperature monitors and display with new thermocouples. The three thermocouples will feed a new digital display on the console. The new system should be more accurate and reliable. We may be able to conduct our power calibrations with the installed instruments. Additionally, this will provide a display of pool temperature, which currently only has an alarm. The output of the units can be supplied to the new Multitrend recorder for display and analysis.

Title: **Count Rate Meter**
Date: October 28, 2002
Summary of Proposed Change:

This change removes the original installed count rate meter. This meter is old and near the end of its life. It serves two functions, to indicate power at low levels and to

provide an interlock to prevent rod withdrawal at very low powers. The latter function is required by Technical Specifications. The new Log channel can provide both of these functions and can serve as a replacement for the count rate channel. Newer Triga reactors do not have a count rate channel; they use the log channel.

The intent is to move the rod interlock to the log channel and test it for a period of time. The count rate channel will probably be left installed until we need the space for some other function.

Title: **Console Arrangement and Automatic Rod Control**
Date: April 1, 2003
Summary of Proposed Change:

This change rearranges the switches and displays on the main console and removes automatic rod control. With three exceptions, no actual switches or displays will be changed, just their location. The switches for automatic rod control will be removed, the radiation chart will be removed, and the reactor power chart will probably be removed.

The console has changed considerably in recent years, necessitating cutting new openings and covering over old ones. We plan to procure new pieces of metal for the vertical portions of the console, and have physical plant cut openings for the new displays. We will also move the displays into a more logical arrangement.

The intent is to move the rod position indication from its separate housing on top of the console to the left wing, along with pool level and temperature. The radiation chart will be removed since it has been superceded by the new AMS-4 units and the Multitrend. The reactor power chart has also been superceded by the Multitrend, so the chart functions may no longer be used, although the digital display may be kept. The actual charts for both displays are wearing out. The AMS-4 display and the Multitrend will display the three radiation monitors. The three reactor power channels have their own displays and the Multitrend will display the power.

The console will be modified to provide room for the Multitrend on the right wing.

As part of the modification, automatic rod control will be removed. It does not work well with our new reactor power instruments, and is not necessary. It is the source of many of our inadvertent scrams. When above 1 kilowatt, the reactor maintains its power constant with Prompt Negative Temperature Coefficient. Below that power, the reactor operator can maintain power constant in manual. The operator completes a status stamp every hour that verifies the power.

Once the changes are made, and the count rate channel is no longer needed (pending NRC approval of a previous Tech Spec change) we can also remove major portions of the internal console, including high voltage supply and the left and right swinging doors. The center door houses the reactor scrams and will be left in place.

Following the modification and before any operation above 5 watts, a Console Checkout will be performed per SOP-73. At the same time SOP-73 will be updated for the new instruments and set up.

# Radiation Protection

## Personnel Dosimetry

During the period July 1, 2002 to June 30, 2003 personnel dosimeters were issued to 48 Reed students and staff, and to one contractor. Since dosimeters are changed on a calendar quarter schedule, this period is the closest to the reporting period. Individuals were issued beta-gamma sensitive ring badges and whole-body badges. The Director and Associate Director were issued beta-gamma-neutron sensitive dosimetry.

During the year the largest reading on a whole body dosimeter was 11 mrem deep dose equivalent. The largest reading on a ring dosimeter was 30 mrem shallow dose equivalent. Both of these were on a staff member (not a student). No one exceeded a quarter of a percent of his or her federal limits.

## Fixed Area Dosimetry

Radiation levels are continually monitored to provide an indication of the average radiation levels in the reactor bay and dose outside the facility. The locations of these dosimeters are shown on Figure 1. All dosimeters monitor beta and gamma radiation. Locations A and C also measure neutron dose.

The deep dose equivalent radiation measured by fixed dosimeters during the period July 1, 2002 to June 30, 2003 are shown in Table E. Since dosimeters are changed on a calendar quarter schedule, this period is the closest to the reporting period. There are radioactive material sample storage locations along the north wall: a radioactive source storage safe and a lead enclosed sample box where samples are placed immediately upon removal from the reactor. The neutron howitzer is stored on the east wall.

**Table E - Area Radiation Dosimeters**
(doses are in mRem per calendar quarter)

| Location | | Height (m) | Radiation Detected | Jul 1 - Sep 30 | Oct 1 - Dec 31 | Jan 1 - Mar 31 | Apr 1 - Jun 30 | Total |
|---|---|---|---|---|---|---|---|---|
| A | East Wall | 1.5 | $\beta, \gamma, n$ | 153 | 168 | 168 | 237 | **726** |
| B | North Wall | 1.6 | $\beta, \gamma$ | 15 | 169 | 18 | 25 | **227** |
| C | West Wall | 1.0 | $\beta, \gamma$ n | 7 | 21 | 7 | 10 | **45** |
| D | South Wall | 1.6 | $\beta, \gamma$ | 7 | 15 | 26 | 37 | **85** |
| E | North Wall | 2.3 | $\beta, \gamma$ | 19 | 4 | 105 | 27 | **155** |
| F | North Outside | 2.8 | $\beta, \gamma$ | 7 | 6 | 57 | 12 | **82** |
| G | Roof Outside | 0.4 | $\beta, \gamma$ | 1 | 0 | 4 | 1 | **6** |
| H | East Outside | 1.5 | $\beta, \gamma$ | 0 | 0 | 0 | 0 | **0** |
| I | South Outside | 0.4 | $\beta, \gamma$ | 0 | 0 | 0 | 0 | **0** |

## Gaseous Releases

The only routine release of gaseous radioactivity is from $^{41}Ar$ (1.83 hour half-life) and $^{16}N$ (7.13 second half-life). These come from activation of pool water and air dissolved in the pool water and in the irradiation facilities. For calendar year 2002, the average gaseous activity at the site boundary was $2.24 \times 10^{-10}$ $\mu$Ci/ml, which would deliver a dose to a member of the public of approximately 1.12 mrem, well below regulatory guidelines and constraints. During the fuel leak in July 2003, the calculated dose to a member of the public was approximately 0.1 mrem.

## Liquid Waste Releases

No liquid radioactive waste was released from the Reed Reactor Facility during this report period.

## Solid Waste Disposal

There were no shipments of radioactive waste from the facility during this reporting period.

## Environmental Sampling

Soil samples taken from the area surrounding the facility showed no activity above background. Water samples taken from the facility's secondary cooling system showed no activity above background.

# Appendix A - Visitors

| Date | Institution | Purpose | # | U-Share |
|---|---|---|---|---|
| 9/1/02 | Reed | Tour | 2 | |
| 9/8/02 | Reed | Tour | 1 | |
| 9/16/02 | Reed | Maintenance | 1 | |
| 9/22/02 | Reed | Tour | 6 | |
| 9/10/02 | Reed | Tour | 2 | |
| 9/16/02 | United Fire | Maintenance | 1 | |
| 9/18/02 | Reed | Training | 12 | |
| 9/19/02 | Reed | Training | 18 | |
| 9/24/02 | Reed | Maintenance | 3 | |
| 9/25/02 | Reed | Training | 9 | |
| 9/27/02 | Reed | Maintenance | 1 | |
| 10/2/02 | Reed | Training | 5 | |
| 10/3/02 | Reed | Training | 13 | |
| 10/4/02 | Reed | Tour | 1 | |
| 10/7/02 | Reed | Tour | 1 | |
| 10/7/02 | Reed | Maintenance | 1 | |
| 10/8/02 | Paulson-Nissen Crane | Maintenance | 1 | |
| 10/9/02 | Hood River High School | Tour | 46 | Yes |
| 10/9/02 | OSU | Tour | 1 | Yes |
| 10/9/02 | Reed | Maintenance | 1 | |
| 10/9/02 | Milwaukee High School | Tour | 2 | Yes |
| 10/9/02 | Reed | Training | 7 | |
| 10/9/02 | Reed | Maintenance | 2 | |
| 10/10/02 | Reed | Training | 7 | |
| 10/11/02 | Cleveland HS | Tour | 34 | Yes |
| 10/13/02 | Reed | Tour | 4 | |
| 10/14/02 | Reed | Tour | 6 | |
| 10/14/02 | Reed | Training | 4 | |
| 10/15/02 | Reed | Maintenance | 1 | |
| 10/16/02 | Reed | Training | 9 | |
| 10/17/02 | Reed | Training | 6 | |
| 10/19/02 | Reed | Training | 6 | |
| 10/23/02 | Reed | Maintenance | 1 | |
| 10/23/02 | Reed | Training | 1 | |
| 10/25/02 | United Fire | Maintenance | 1 | |
| 10/28/02 | Taco Del Mar | Tour | 3 | |
| 10/29/02 | Taco Del Mar | Tour | 1 | |
| 10/30/02 | Oregon Electrical Group | Maintenance | 1 | |
| 10/30/02 | Reed | Maintenance | 1 | |
| 10/30/02 | Reed | Training | 7 | |
| 10/31/02 | Reed | Tour | 6 | |
| 10/31/02 | Reed | Training | 10 | |
| 11/1/02 | Reed | Training | 2 | |
| 11/1/02 | Reed | Tour | 9 | |
| 11/4/02 | Oregon Electrical Group | Maintenance | 1 | |
| 11/4/02 | Reed | Thesis | 2 | |

| Date | Institution | Purpose | # | U-Share |
|---|---|---|---|---|
| 11/6/02 | Reed | Thesis | 1 | |
| 11/6/02 | Reed | Training | 7 | |
| 11/7/02 | Reed | Training | 14 | |
| 11/8/02 | Reed | Thesis | 1 | |
| 11/8/02 | Reed | Tour | 45 | |
| 11/8/02 | Reed | Training | 2 | |
| 11/9/02 | UIUC Alum | Tour | 1 | Yes |
| 11/11/02 | Reed | Training | 1 | |
| 11/13/02 | Reed | Training | 5 | |
| 11/14/02 | Reed | Training | 14 | |
| 11/15/02 | Reed | Thesis | 1 | |
| 11/15/02 | Reed | Training | 1 | |
| 11/17/02 | United Fire | Maintenance | 1 | |
| 11/18/02 | Metal Ent. | Maintenance | 2 | |
| 11/18/02 | Reed | Thesis | 1 | |
| 11/19/02 | Metal Ent. | Maintenance | 1 | |
| 11/19/02 | United Fire | Maintenance | 1 | |
| 11/19/02 | Reed | Tour | 1 | |
| 11/20/02 | Reed | Training | 5 | |
| 11/21/02 | State Radiation Protection | Inspection | 2 | |
| 11/21/02 | Reed | Maintenance | 1 | |
| 11/21/02 | Sunset High School | Tour | 24 | Yes |
| 11/22/02 | Sunset High School | Tour | 22 | Yes |
| 11/22/02 | Reed | Thesis | 3 | |
| 11/25/02 | School Counselors | Tour | 24 | Yes |
| 11/26/02 | United Fire | Maintenance | 1 | |
| 11/27/02 | Reed | Training | 3 | |
| 12/4/02 | Reed | Training | 3 | |
| 12/5/02 | Reed | Training | 2 | |
| 12/9/02 | Reed | Training | 4 | |
| 12/11/02 | Reed | Training | 1 | |
| 12/12/02 | Reed | Training | 2 | |
| 12/12/02 | Rex Putnam High School | Tour | 21 | Yes |
| 12/17/02 | NRC | Inspection | 1 | Yes |
| 12/17/02 | Reed | Tour | 4 | |
| 12/18/02 | United Fire | Maintenance | 1 | |
| 12/19/02 | United Fire | Maintenance | 2 | |
| 1/2/03 | Reed | Maintenance | 1 | |
| 1/13/03 | Reed | Training | 22 | |
| 1/14/03 | Reed | Training | 18 | |
| 1/15/03 | Reed | Training | 24 | |
| 1/16/03 | Reed | Training | 21 | |
| 1/17/03 | Reed | Training | 14 | |
| 1/20/03 | Reed | Training | 15 | |
| 1/22/03 | Reed | Tour | 3 | |
| 1/22/03 | Reed | Training | 14 | |
| 1/23/03 | Reed | Training | 14 | |
| 1/24/03 | Kennedy High School | Tour | 17 | Yes |

| Date | Institution | Purpose | # | U-Share |
|---|---|---|---|---|
| 1/24/03 | Reed | Training | 3 | |
| 1/25/03 | Reed | Training | 1 | |
| 1/26/03 | Reed | Training | 2 | |
| 1/26/03 | Reed | Tour | 1 | |
| 1/27/03 | Reed | Training | 1 | |
| 1/28/03 | Reed | Tour | 3 | |
| 1/29/03 | Portland Fire Bureau | Training | 13 | |
| 1/29/03 | Reed | Training | 10 | |
| 1/30/03 | Portland Fire Bureau | Training | 12 | |
| 1/30/03 | Reed | Training | 6 | |
| 1/31/03 | C.S. Lewis Academy | Tour | 13 | Yes |
| 1/31/03 | Portland Fire Bureau | Training | 11 | |
| 1/31/03 | United Fire | Maintenance | 1 | |
| 1/31/03 | Reed | Training | 1 | |
| 2/3/03 | Reed | Training | 5 | |
| 2/3/03 | New Covenant Academy | Tour | 27 | Yes |
| 2/5/03 | Reed | Training | 6 | |
| 2/6/03 | Reed | Training | 5 | |
| 2/7/03 | Reed | Training | 2 | |
| 2/8/03 | Reed | Training | 2 | |
| 2/8/03 | Reed | Tour | 3 | |
| 2/11/03 | Reed | Training | 3 | |
| 2/12/03 | Reed | Thesis | 1 | |
| 2/12/03 | Reed | Training | 2 | |
| 2/13/03 | Reed | Training | 5 | |
| 2/14/03 | Reed | Training | 1 | |
| 2/20/03 | United Fire | Maintenance | 1 | |
| 2/14/03 | St. Francis Academy | Tour | 33 | Yes |
| 2/14/03 | Reed | Training | 2 | |
| 2/14/03 | Reed | Tour | 5 | |
| 2/18/03 | Saturday Academy | Tour | 11 | Yes |
| 2/19/03 | Reed | Training | 4 | |
| 2/20/03 | Reed | Training | 2 | |
| 2/21/03 | Reed | Training | 1 | |
| 2/24/03 | United Fire | Maintenance | 2 | |
| 2/24/03 | Reed | Training | 4 | |
| 2/25/03 | Reed | Training | 5 | |
| 2/26/03 | Warner Pacific College | Tour | 13 | Yes |
| 2/26/03 | Reed | Training | 6 | |
| 2/27/03 | Reed | Training | 9 | |
| 3/2/03 | Reed | Training | 1 | |
| 3/3/03 | Reed | Chem 102 Lab | 13 | |
| 3/4/03 | Reed | Training | 6 | |
| 3/4/03 | Reed | Chem 102 Lab | 21 | |
| 3/5/03 | Reed | Chem 102 Lab | 17 | |
| 3/5/03 | Reed | Training | 8 | |
| 3/6/03 | Reed | Training | 10 | |
| 3/6/03 | Reed | Chem 102 Lab | 18 | |

| Date | Institution | Purpose | # | U-Share |
|---|---|---|---|---|
| 3/7/03 | Reed | Training | 2 | |
| 3/7/03 | Reed | Chem 102 Lab | 22 | |
| 3/7/02 | Roosevelt High School | Tour | 33 | Yes |
| 3/10/02 | Reed | Training | 2 | |
| 3/11/02 | Reed | Training | 6 | |
| 3/12/03 | Reed | Training | 9 | |
| 3/13/03 | Reed | Training | 6 | |
| 3/13/03 | Portland State University | Tour | 9 | Yes |
| 3/19/03 | Reed | Training | 3 | |
| 3/19/03 | Lincoln High School | Tour | 26 | Yes |
| 3/24/03 | Reed | Training | 3 | |
| 3/25/03 | Reed | Training | 5 | |
| 3/25/03 | United Fire | Maintenance | 1 | |
| 3/26/03 | Reed | Training | 3 | |
| 3/27/03 | Reed | Training | 4 | |
| 3/31/03 | Reed | Training | 1 | |
| 4/1/03 | Reed | Training | 3 | |
| 4/2/03 | Reed | Training | 3 | |
| 4/3/03 | Reed | Training | 3 | |
| 4/7/03 | Southridge High School | Tour | 24 | Yes |
| 4/7/03 | Reed | Training | 4 | |
| 4/8/03 | Concordia University | Tour | 12 | Yes |
| 4/8/03 | Reed | Training | 1 | |
| 4/8/03 | Reed | Tour | 8 | |
| 4/9/03 | Reed | Training | 4 | |
| 4/10/03 | Reed | Training | 10 | |
| 4/10/03 | Reed | Tour | 10 | |
| 4/11/03 | Reed | Training | 2 | |
| 4/11/03 | Reed | Tour | 13 | |
| 4/14/03 | Reed | Training | 1 | |
| 4/14/03 | Advocates for Women in Science, Engineering, and Mathematics | Tour | 11 | Yes |
| 4/15/03 | Reed | Training | 4 | |
| 4/15/03 | Jefferson High School | Tour | 53 | Yes |
| 4/16/03 | Reed | Tour | 13 | |
| 4/16/03 | Reed | Training | 4 | |
| 4/17/03 | Reed | Training | 2 | |
| 4/17/03 | United Fire | Maintenance | 1 | |
| 4/21/03 | Reed | Training | 1 | |
| 4/22/03 | David Douglas High School | Tour | 51 | Yes |
| 4/22/03 | Reed | Training | 4 | |
| 4/23/03 | Reed | Training | 3 | |
| 4/24/03 | Reed | Training | 2 | |
| 4/24/03 | Lewis & Clark College | Tour | 8 | Yes |
| 4/24/03 | Reed | Tour | 20 | |
| 4/25/03 | Reed | Maintenance | 1 | |
| 4/25/03 | Willamette University | Tour | 2 | Yes |
| 4/25/03 | Portland State University | Tour | 2 | Yes |

| Date | Institution | Purpose | # | U-Share |
|---|---|---|---|---|
| 4/25/03 | Reed | Training | 3 | |
| 4/26/03 | Reed | Tour | 3 | |
| 4/28/03 | Reed | Training | 4 | |
| 4/29/03 | Reed | Maintenance | 1 | |
| 4/29/03 | Reed | Training | 1 | |
| 4/30/03 | Reed | Training | 2 | |
| 5/1/03 | Reed | Tour | 4 | |
| 5/5/03 | NRC | NRC Exam | 1 | |
| 5/6/03 | NRC | NRC Exam | 2 | |
| 5/7/03 | NRC | NRC Exam | 4 | |
| 5/8/03 | NRC | NRC Exam | 4 | |
| 5/9/03 | Pacific University | Tour | 23 | Yes |
| 5/12/03 | Linfield College | Tour | 25 | Yes |
| 5/14/03 | Linfield College | Tour | 23 | Yes |
| 5/14/03 | Reed | Tour | 1 | |
| 5/15/03 | Reed | Tour | 2 | |
| 5/16/03 | Linfield College | Tour | 14 | Yes |
| 5/20/03 | David Douglas High School | Tour | 9 | Yes |
| 5/20/03 | Reed | Tour | 4 | |
| 5/22/03 | United Fire | Maintenance | 1 | |
| 5/27/03 | PCC Rock Creek | Tour | 17 | Yes |
| 5/28/03 | Franklin High School | Tour | 13 | Yes |
| 5/29/03 | Portland Community College | Tour | 19 | Yes |
| 6/3/03 | Reed | RSO Class | 15 | |
| 6/4/03 | United Fire | Maintenance | 1 | |
| 6/5/03 | Reed | RSO Class | 9 | |
| 6/7/03 | Reed | Tour | 16 | |
| 6/9/03 | Trillium Charter School | Tour | 6 | Yes |
| 6/10/03 | Portland Police | Training | 2 | |
| 6/12/03 | Reed | Tour | 1 | |
| 6/18/03 | NRC | Inspection | 2 | |
| 6/19/03 | Summer Science Camp | Tour | 7 | Yes |
| 6/20/03 | Portland Police | Training | 6 | |
| 6/25/03 | Reed | Maintenance | 1 | |
| 7/1/03 | ASE (Summer Intern) | Training | 1 | |
| 7/1/03 | United Fire | Maintenance | 1 | |
| 7/2/03 | ASE (Summer Intern) | Training | 1 | |
| 7/3/03 | ASE (Summer Intern) | Training | 1 | |
| 7/7/03 | ASE (Summer Intern) | Training | 1 | |
| 7/8/03 | ASE (Summer Intern) | Training | 1 | |
| 7/9/03 | ASE (Summer Intern) | Training | 1 | |
| 7/10/03 | ASE (Summer Intern) | Training | 1 | |
| 7/14/03 | ASE (Summer Intern) | Training | 1 | |
| 7/15/03 | ASE (Summer Intern) | Training | 1 | |
| 7/16/03 | ASE (Summer Intern) | Training | 1 | |
| 7/17/03 | ASE (Summer Intern) | Training | 1 | |
| 7/17/03 | Saturday Academy | Tour | 12 | Yes |
| 7/17/03 | Reed | Environmental Health | 2 | |

| Date | Institution | Purpose | # | U-Share |
|---|---|---|---|---|
| 7/18/03 | ASE (Summer Intern) | Training | 1 | |
| 7/21/03 | ASE (Summer Intern) | Training | 1 | |
| 7/22/03 | ASE (Summer Intern) | Training | 1 | |
| 7/23/03 | ASE (Summer Intern) | Training | 1 | |
| 7/24/03 | ASE (Summer Intern) | Training | 1 | |
| 7/25/03 | ASE (Summer Intern) | Training | 1 | |
| 7/28/03 | ASE (Summer Intern) | Training | 1 | |
| 7/30/03 | ASE (Summer Intern) | Training | 1 | |
| 7/30/03 | Reed | Maintenance | 1 | |
| 7/31/03 | ASE (Summer Intern) | Training | 1 | |
| 8/1/03 | ASE (Summer Intern) | Training | 1 | |
| 8/1/03 | Oregon State University | Tour | 1 | |
| 8/4/03 | Reed | Maintenance | 2 | |
| 8/18/03 | MRP | Maintenance | 2 | |
| 8/18/03 | Reed | Maintenance | 1 | |
| 8/18/03 | ASE (Summer Intern) | Training | 1 | |
| 8/19/03 | Reed | Safety Inspection | 2 | |
| 8/19/03 | ASE (Summer Intern) | Training | 1 | |
| 8/19/03 | United Fire | Maintenance | 1 | |
| 8/20/03 | ASE (Summer Intern) | Training | 1 | |
| 8/25/03 | Reed Orientation | Tour | 2 | |
| 8/27/03 | Reed Orientation | Tour | 18 | |
| 8/28/03 | Reed Orientation | Tour | 20 | |
| 8/28/03 | Friend | Tour | 1 | |
| 8/29/03 | ASE (Summer Intern) | Training | 1 | |
| 8/30/03 | Reed Orientation | Tour | 7 | |