REED COLLEGE Portland, Oregon 97202

REACTOR FACILITY

December 16, 2004

Document Control Desk
US Nuclear Regulatory Commission
Washington, DC 20555

ATTN: Dan Hughes

Docket 50-288

Enclosed is Reed College Reactor's Annual Report.

This has been another good 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

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A001

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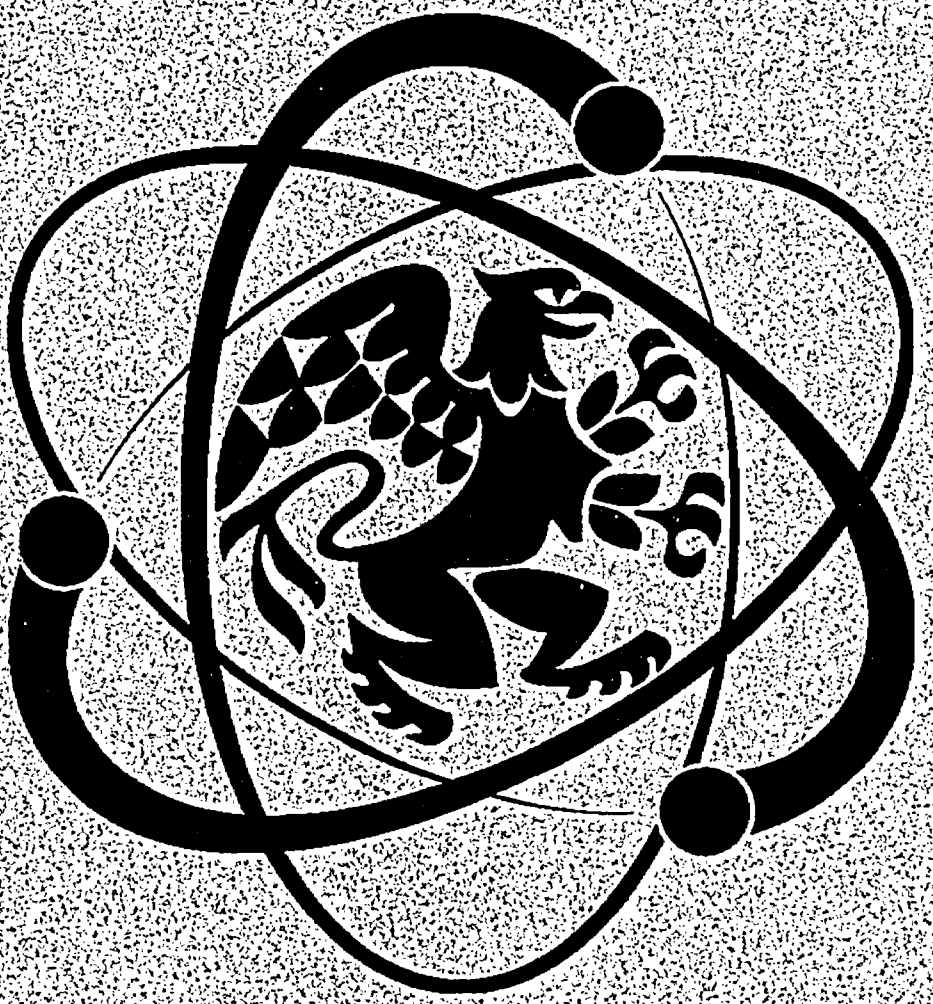
REED RESEARCH REACTOR
ANNUAL REPORT



September 1, 2003 -- August 31, 2004

REED RESEARCH REACTOR ANNUAL REPORT

September 1, 2003 -- August 31, 2004

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OVERVIEW

This report covers the period from September 1, 2003 to August 31, 2004, 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-FG07-02ID14387
- U. S. Department of Energy Grant No. DE-FG07-03ID14467

We specifically wish to thank other funding sources including:

Portland General Electric

Concordia University

Reed College operates 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 Research Reactor has been a resource for research and educational projects in the Portland area since its establishment in 1968. The main uses of the Reed Research Reactor 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 2218 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 Research Reactor contributed to the educational programs of nine colleges and universities in addition to 20 pre-college groups and seven special groups. The reactor was operated 383 times on 139 days. The thermal energy produced was 31.7 megawatt-hours.

The reactor staff consists of a Director, an Associate Director, a contract Health Physicist, Reed College undergraduate students, and a few 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 12 women and 24 men.

During the reporting period, 18 reactor operator candidates passed their NRC exams and 7 senior reactor operator candidates passed their NRC exams. During the past ten years 107 people have taken the NRC reactor operator exam and 103 received licenses. During the same period 52 people have taken the senior reactor operation exam and 50 have received senior reactor operation licenses.

There were no radiation exposures to individuals in excess of 2% 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 was one shipment of three 55-gallon drums of Low Level Radioactive Waste totaling 31.8 mCi. It was sent to the US Ecology Site in Richland, Washington

The Nuclear Regulatory Commission conducted their annual inspection during December 2003. There were no violations or concerns. There were no follow up items.

PEOPLE

Facility Staff

During the period September 1, 2003 to August 31, 2004, the facility staff consisted of:

Reactor Director:	Stephen Frantz (4/94 – Present)	
Associate Director:	Rachel Barnett (5/03 – Present)	
Reactor Supervisor:	Carl Anderson (5/04 – Present) Megan Othus (5/02 – 5/04)	
Training Supervisor:	Jessica Griffith (5/04- Present) Lily Cool (5/03 – 5/04)	
Radiation Safety Officer:	Kathleen Fisher (1/03 – Present) Stephen Frantz (8/00 – 1/03)	
Contract Health Physicist:	Marshall Parrott (8/91 – Present)	
Senior Reactor Operators (SRO):	Carl Anderson Andre Bach Rachel Barnett Jay Bodzin Nick Chaimov Lily Cool David de Regt Cilicia Dorn-Lopez Stephen Frantz	Jessica Griffith Steve Katz Ariah Kidder Beverly Lau Kristen Lavavej Andrea Neuhoff Megan Othus David Rubin Maureen Steckler
Reactor Operators (RO):	Juliana Arrighi Drew Atwater Susan Beaver Will Draper Oren Elrad Tyler Freeman Derek Galligan Ben Greenspan Jesse Hallett Jeremy Harper Vanessa Holfeltz Judy Kim Matt King Toms Kreicbergs	Elliot Naidus Derek Oldridge Peter Rovegno Seth Samuel Zach Schultz Jake Schwartzman Jason Seifter Kayce Spear Craig Wagner Joy Wattawa David Williams Gabriel Ycas Trevor 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. Samuel, Mr. Bodzin, and Ms. Dorn-Lopez.

The number of licenses varies from year to year. As this report is being written there are 12 women with reactor licenses and 24 men with licenses.

Reactor Review Committee

The Reed Research Reactor 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 Research Reactor, 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

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)*

Reactor Operations Committee

Johnny Powell (Chair) *(Physics Faculty, Reed College)*
Maggie Geselbracht *(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) on Both Committees:

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

FACILITIES

Reactor Facility

In addition to the reactor, the Reed College has space for a radiochemistry lab. 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 1.7×10^{12} n/cm^{2}s 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 5×10^{12} n/cm^{2}s 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 1×10^{13} n/cm^{2}s. 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

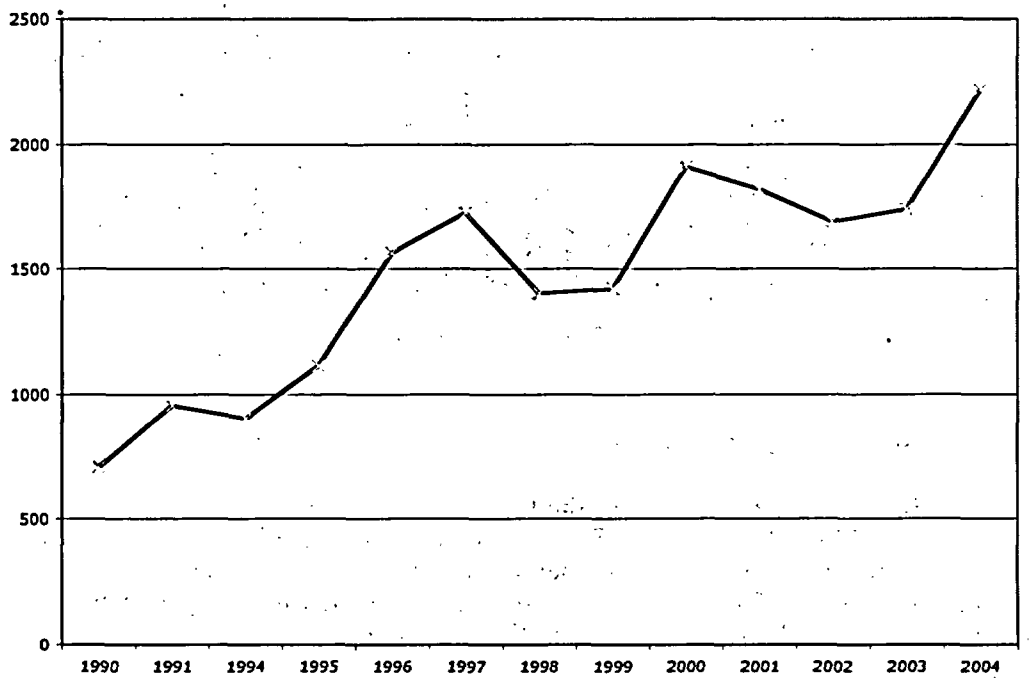
The central thimble can be evacuated with gas, producing a vertical neutron beam. This beam can be used to generate directional neutron flux, or for limited irradiations above the tank. Neutron radiography is also possible. The flux above the beam exit is approximately 1×10^6 n/cm^{2}s when the reactor is at full power.

USERS

Reactor Visitors

A total of 2218 individuals visited the Reed Research Reactor 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 2218 individuals for training or tours, of whom 684 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 1 - Reed Research Reactor Visitors



Reactor Operations Seminar

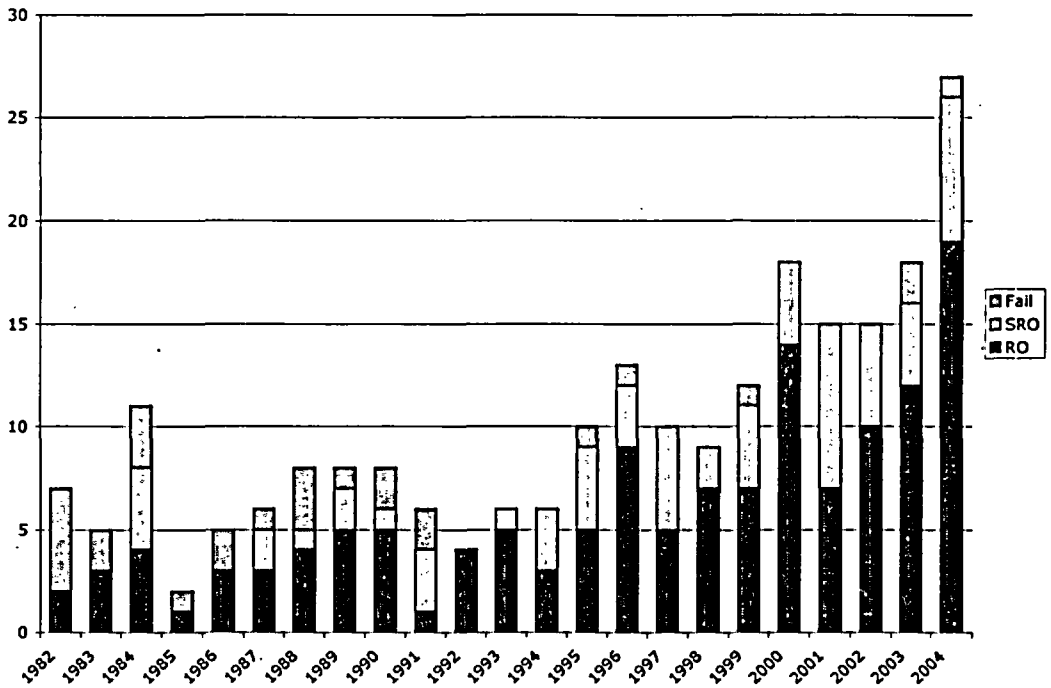
The Reed Research Reactor conducts an annual seminar series for students from Reed and other area educational institutions. This non-credit course serves as an introduction to nuclear reactor theory, health physics, and reactor operation. Some of the students continue with in-depth reactor operator training 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, 18 out of 20 reactor operator candidates passed their NRC exams and 7 out of 7 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 2 is a graph of the number of license application each year

showing how many new RO and SRO licenses were awarded at Reed and how many failed to obtain a license.

Figure 2 - Reed Research Reactor License Exam Results



Nuclear Science Consortium

In order to better use the resources of the Reed Research Reactor, 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

- British Columbia Institute of Technology
- Concordia University
- Lewis and Clark College
- Linfield College
- Northwestern University
- Pacific University
- Portland Community College
- Portland State University
- University of California
- University of Washington
- Warner Pacific College

PRE-COLLEGE TOURS/USERS

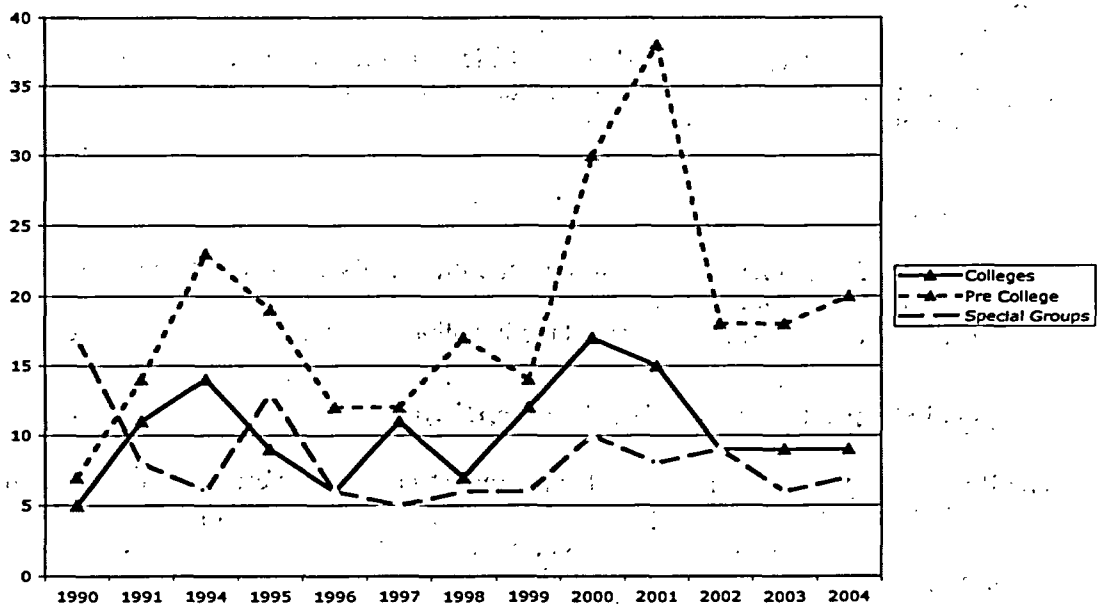
- Advocates for Women in Science, engineering, and Mathematics
- Apprenticeships in Science and Engineering
- Boy Scouts of America (various troops)
- C. S. Lewis Academy
- Catlin Gabel High School
- Cleveland High School
- Conestoga Middle School
- David Douglas High School
- Franklin High School
- Intel International Science and Engineering Fair
- Lincoln High School
- Middle School Symposium
- Oregon Episcopal School
- Pacific Coast Association of Physical Plant Administrators
- Portland Public Schools
- Rex Putnam High School
- Saturday Academy
- Skyview High School
- Southeast High School
- Southridge High School
- St. Mary's Academy

SPECIAL GROUPS

- Foreign Affairs Council
- Forest Charter
- Portland Fire Bureau
- Portland HazMat Team
- Portland Police Bureau
- Rep. Blumenauer Staff

Figure 3 is a graph showing the history of colleges, pre-college groups, and special groups.

Figure 3 – Colleges, Pre-College Groups, and Special Groups



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 use 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 Research Reactor continues to be used in independent science projects initiated by students from several Oregon and Washington State 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) and General Chemistry at Concordia University

Scaler Kits

Through the generosity of Portland General Electric, the reactor lends out kits 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 used neutron activation analysis to determine chemical composition of an unknown.
- Chemistry 101 students determined the half-lives of an activated silver dime.

Industrial and Commercial Applications

The Reed Research Reactor 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

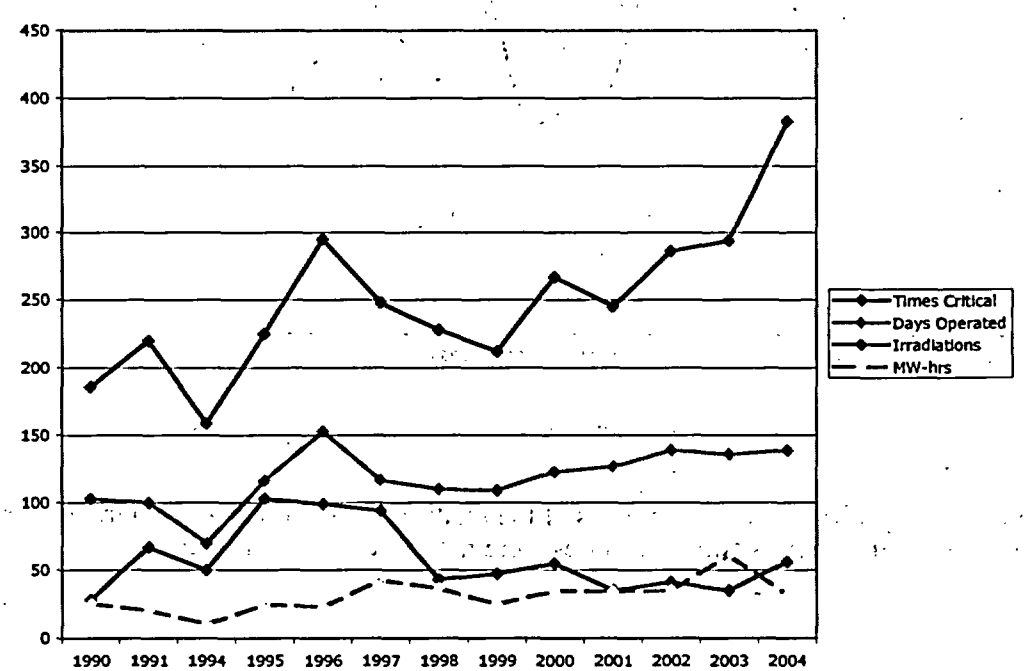
Operations

During the year the reactor was taken critical 294 times on 136 days. The total energy produced was 31.7 megawatt-hours. Operating history by month appears in Table A. A history of the data is shown in Figure 4. During January we conduct our annual maintenance.

Table A - Operating History

	Times Critical	Days Operated	MW-hrs
Sep.	42	10	1.12
Oct.	39	14	2.51
Nov.	22	10	4.61
Dec.	15	8	2.42
Jan.	0	1	0.00
Feb.	65	23	2.44
Mar.	32	12	0.94
Apr.	98	24	8.34
May	39	13	2.76
Jun.	11	9	2.43
Jul.	11	8	1.45
Aug.	9	7	2.64
Total	383	139	31.66

Figure 4 – Operations



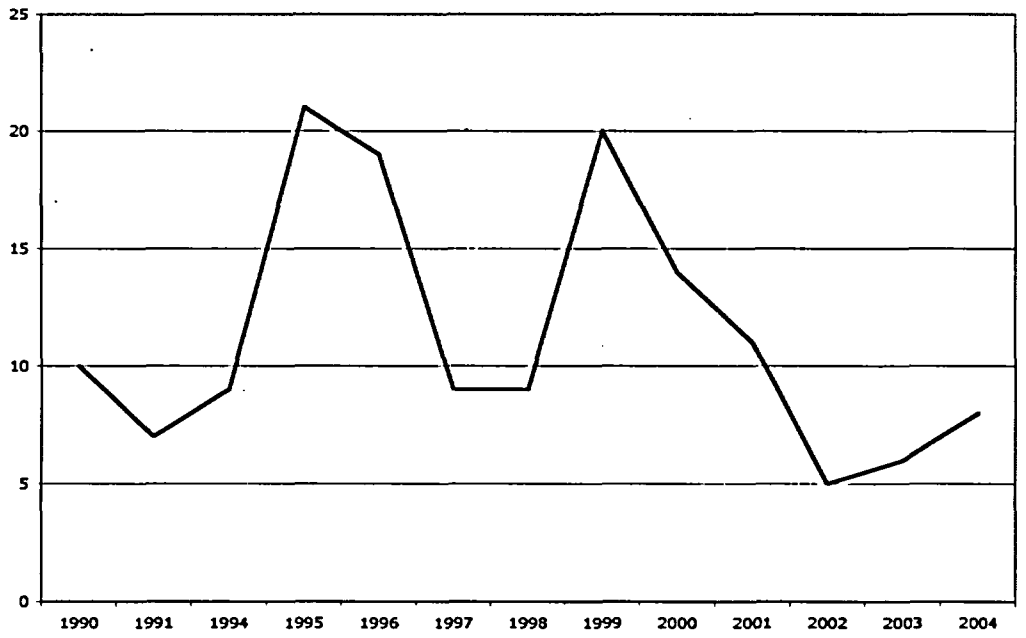
Unplanned Reactor Shutdowns

There were eight 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 5.

Table B - Unplanned Reactor Shutdowns

Date	Scram Type	Cause Of Scram
Sep 24	Percent	Operator Error
Oct 3	Percent/Linear	Operator Error
Feb 5	All	Loss of Power
Feb 5	All	Problems with Safety Rod
Feb 5	Linear	Pressed 25 kW range button at 240 kW
Apr 10	All	Loss of Power due to breaker inadvertently being opened while turning off reactor room lights
Apr 26	All	Electrical transient
Jun 29	None	Loose wire to key switch in console.

Figure 5 – 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.

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 that were not part of a regular schedule are listed in Table D.

Table D - Significant Maintenance Operations

Date	Maintenance
8/20/2004	Bulk water temperature probe placed in service.
10/22/2004	Primary filter replaced.
11/18/2004	Ventilation dampers changed from pneumatic to electromechanical.
1/15/2004	Lazy susan position 28 returned to service.
1/28/2004	Secondary piping froze and broke. Section of pipe replaced.
2/6/2004	Isolation indication connected to Multitrend computer.
2/17/2004	Lazy susan position indication adjusted.
3/11/2004	Secondary caustic pump cleaned.
3/14/2004	Primary demineralizer pressure gauges replaced.
5/5/2004	Multitrend set to backup over network automatically.
5/20/2004	Linear channel repaired.
5/21/2004	Regulating rod motor replaced.
5/26/2004	Pinwheels replaced flags in ventilation system
6/29/2004	Console key switch wire repaired.
7/7/2004	Source interlock moved to log channel.
7/7/2004	APM/GSM mounted on northern west wall of loft.
7/7/2004	CAM mounted on south wall of reactor room.
7/28/2004	Webcam installed.
8/2/2004	Primary filter changed.
8/3/2004	Resistors on regulating rod motor repaired.
8/5/2004	CAM and APM/GSM put on two separate pumps and RAP-1 retired.
8/16/04	Replaced front panels on console. Removed countrate channel display. Removed old chart recorders.

Safety Reviews Approved by Reactor Review Committee

Title: **Replace Ventilation System Actuators**
Date: December 1, 2003
Summary of Proposed Change:

This change replaces all the pneumatic operators for the damper in the ventilation system with electromechanical ones.

The air system that operates the dampers is very old and is failing more often. Physical plant will replace the current actuators with electromechanical ones that are more reliable. It will be controlled by a microprocessor. Also, it will be easier to test and reprogram the system.

The pneumatic system and air compressor will be removed.

Title: **Lazy Susan Cleaning**
Date: December 25, 2003
Summary of Proposed Change:

In last few years it has become increasingly difficult to turn lazy susan (LS) and the clutch has been slipping. Recently removing samples from the LS has resulted in increased contamination levels in the reactor bay. Both of these conditions are most likely caused by the breakdown and activation of lubricating oil in the LS over the past 36 years. The proposed procedure will clean the LS with the solvent Simple Green®, a commercially available, non-toxic, biodegradable degreasing compound.

According the proposed procedure, ten gallons of the solvent will be pumped into the LS while it is vented through a filter. The LS will be operated for two days to dissolve the oil. Then the contaminated solvent will be pumped into a shielded drum. The LS will then be flushed twice with deionized water to remove any remaining solvent or contaminates. The waste will be solidified disposed as low-level radioactive waste.

The LS is an air-filled rack assembly that is isolated from the pool water, so there is no possible interaction between the solvent and the reactor water. Simple Green® is an aqueous-based cleaning compound that is compatible with metals, plastics, and the pool water if any were to get into the pool. It is used as a decontaminant in the nuclear industry. The solvent is not toxic and it will not create a mixed waste problem. The only significant activation products are sodium (15 hour half-life) and potassium (12 hour half-life), although the LS oil will have long-lived cobalt and selenium isotopes. This method was used successfully at the Oregon State University Reactor in October 1990.

The pump and tubing will be on absorbent paper and will be checked frequently for leaks. Radiation monitors will check for air contamination and for high radiation fields. Air from the system will be filtered and monitored. Lab coats, gloves, shoe covers, and goggles will be worn when transferring the solvent. Personal dosimetry is always worn in the reactor room. The drum will be shielded and will not be positioned over the reactor pool. When OSU performed the procedure, the highest measured dose rate was 26 mR/hour. Because of our lower power and power history, we expected lower levels at Reed.

Title: **Shim Rod Controls**
Date: January 26, 2004
Summary of Proposed Change:

The Shim rod is not working correctly. The rod will not move with the button on the console. The normal adjustment of the limit switches and balancing potentiometer did not correct the problem. There appears to be an open in the circuit.

During our investigation of why the shim rod was not working, we switched the control from SHIM 2 to SHIM 1 by moving plugs J9 to J8 in the center door of the console. In this setup the shim rod works properly.

This change leaves the connections on SHIM 1. The rod drop timer connections have been switched to the new indications. The rod position indication and interlocks still work since they do not rely on the plug that was moved. Otherwise, everything is the same.

We have fully checked the rod operating and interlocks. The only change is that the Shim rod can move when another rod up button is pressed (although no two rods may withdrawal at the same time); it used to be that neither rod would move. This is correct by the original design and is in accordance with Technical Specifications and is the way it works at Oregon State University. Inhibiting both rods rather than just one was an artifact of the circuitry and is not required.

Title: **Linear Scram Verification**
Date: March 30, 2004
Summary of Proposed Change:

The Current Adjust on the Linear Power channel is not working properly. This is the method used to check the Linear Power scram. Instead of allowing the operator to adjust the test signal to the Linear Power channel with the potentiometer to test the scram setpoint, it goes to full scale and scrams the reactor. Thus it cannot be used to verify that the scram is below 110% of full power as required by Tech Spec F.5 and Table I. We are required to check this on the startup checklist per Tech Spec F.7. Tech Spec A.2 allows going to 287.5 kW to test the scram, but we don't want to use that technique.

This change will check the Linear Power scram with two other techniques during the startup checklist until the channel is repaired. The Linear Power scram will be tested with the CAL HI position, which is already authorized by SOP 1, Startup Checklist. The Linear Power scram will also be tested by selecting the lowest range on the Linear Power channel, (2.5 mW) and withdrawing control rods to allow subcritical multiplication to increase the power until 110% of the 2.5 mW range is reached. This will cause a scram. At that power the reactor is still subcritical.

Note that the Percent Power scram still works as normal at less than 110% of its scale.

This procedure will replace the Linear Channel portion of SOP 1 step 1.7.6.4.

Linear Channel:

- Reset the console.
- Press the button for the 2.5 mW scale on the Linear Power channel.
- Manually raise the Safety and Reg rods enough to cause power to exceed 2.75 mW. This should cause a Linear Power scram somewhere below 110% of the 2.5 mW scale.
- Verify a scram occurs. Record the scram point on the checklist.
- Verify the four indications outlined above.
- Reset the scrams on the Linear Channel with its button.
- Reset the console.
- Press the button for Auto Range on the Linear Channel
- Press the Linear Channel Select button once to go to the CAL HI position and watch the power indication increase to cause a scram (≈ 108% of the 250 kW scale).
- Verify a scram occurs. Record the CAL HI value on the checklist.
- Verify the four indications outlined above.
- Press the Linear Channel Select button to return Operate.
- Reset the scrams on the Linear Channel with its button.

Title: **Continuous Air Monitor Sampling Location**
Date: June 17, 2004
Summary of Proposed Change:

This changes the sampling location of the Continuous Air Monitor (CAM). The sampling unit will be moved from the west wall of the reactor room to the south wall near the control room door. This will allow accessing and changing the CAM filter through the control room door without actually entering the reactor room in case of high airborne radioactivity. Additionally, one person can do the weekly since s/he can see the CAM display while using the check source.

Changing the sampling location should not affect the sensitivity or representative sampling of the CAM. The current location is along the west wall, at a height of about four feet. The new location will be along the south wall at a height of about two feet. The lower location is required due to the presence of the hand and foot monitors. The lower height will facilitate changing the filter for some staff members.

Title: **Source Interlock Testing Frequency**
Date: July 26, 2004
Summary of Proposed Change:

This proposed change moves the frequency of testing of the source interlock from every startup checklist to the semiannual checklist. The source interlock prevents any rod withdrawal when there is no neutron-induced signal on a nuclear instrument.

Traditionally, the source interlock was tested during every startup. This was done by taking the Count Rate Channel to "Test", verifying that the "Source Interlock" light was illuminated, and that a rod could not be withdrawn. This did not test that the lack of a neutron signal prevented rod motion; it only tested that when the "Source Interlock" light was illuminated, rod withdrawal was prevented. We verified that the "Source Interlock" light was illuminated when the source was removed from the core (thus there were no source induced counts) during the Annual Checklist.

In the summer of 2004 the source interlock was moved from the Count Rate Channel to the Log Channel. The Log Channel does not have a similar test switch. Since the time that the interlock was moved, we have tested the source interlock during every startup checklist by physically removing the 1.64-curie americium-beryllium source from the core. This works, but is labor intensive, involves handling the source by its potentially contaminated cable, and increases the wear and tear on the source holder and the upper core plate. It also increases the probability of dropping the source. Changing the frequency of this test to semiannually will solve these problems.

RADIATION PROTECTION

Personnel Dosimetry

During the period July 1, 2003 to June 30, 2004 personnel dosimeters were issued to 49 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 annual whole body dose was 64 mrem deep dose equivalent. The largest annual extremity dose was 120 mrem shallow dose equivalent. Both of these were staff members (not students). No one exceeded two percent of the 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. 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, 2003 to June 30, 2004 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 particularly radioactive sample was stored in the north storage cage for part of year. The neutron howitzer was stored on the east wall for part of the year.

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

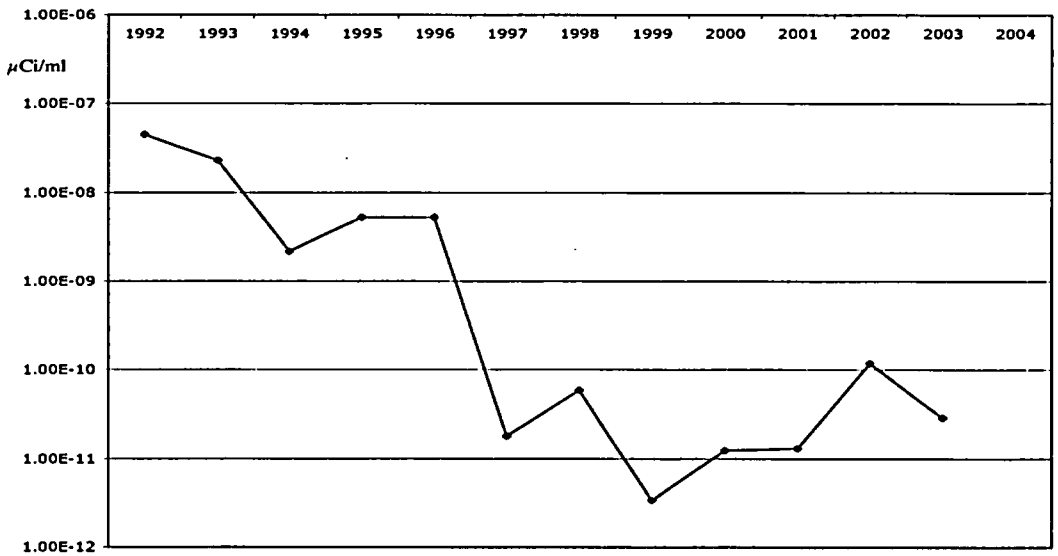
Location		Height (m)	Radiation Detected	Jul 1 - Sep 30	Oct 1 - Dec 31	Jan 1 - Mar 31	Apr 1 - Jun 30	Total
A	East Wall	1.5	β, γ, n	173	110	176	204	663
B	North Wall	1.6	β, γ	52	17	2106	1753	3928
C	West Wall	1.0	β, γ n	0	0	67	82	149
D	South Wall	1.6	β, γ	67	33	36	45	181
E	North Wall	2.3	β, γ	46	20	72	102	240
F	North Outside	2.8	β, γ	25	8	24	48	105
G	Roof Outside	0.4	β, γ	6	0	2	2	10
H	East Outside	1.5	β, γ	0	0	0	0	0
I	South Outside	0.4	β, γ	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 in the pool water and in the irradiation facilities. For calendar year 2003, the average gaseous activity at the

site boundary was 4.4 x 10^{-11} μCi/ml, which would deliver a dose to a member of the public of approximately 0.22 mrem, well below regulatory guidelines and constraints. Figure 6 shows the gaseous releases for each year.

Figure 6 – Gaseous Releases



Liquid Waste Releases

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

Solid Waste Disposal

There was one shipment of radioactive waste from the facility during this reporting period. Three 55-gallon drum of Low Level Radioactive Waste totaling 31.8 mCi was sent to the US Ecology Site in Richland, Washington. Thomas Grey &Associates was the transporter.

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	Number	U-Share
9/3/03	Reed	Tour	2	
9/9/03	United Fire	Maintenance	1	
9/11/03	Reed	Tour	2	
9/13/03	Reed	Tour	1	
9/15/03	Reed	Training	43	
9/16/03	Reed	Tour	1	
9/17/03	Reed	Tour	16	
9/18/03	Reed	Training	27	
9/19/03	Reed	Tour	3	
9/22/03	Reed	Training	11	
9/23/03	Reed	Training	40	
9/24/03	Reed	Training	18	
9/24/03	Reed	Weekly	2	
9/25/03	Reed	Tour	1	
9/25/03	Reed	Training	8	
9/25/03	Reed Physical Plant	Maintenance	1	
9/25/03	Reed Physical Plant	Maintenance	1	
9/25/03	Reed	Training	20	
9/26/03	Reed	Training	14	
9/28/03	PCAPPA	Tour	33	Yes
9/28/03	BCIT	Tour	3	Yes
9/28/03	VCI	Tour	3	Yes
9/28/03	University of California	Tour	1	Yes
9/28/03	Reed	Training/Shutdown	1	
10/1/03	Reed	Training	12	
10/1/03	Reed	Warm body	1	
10/2/03	Reed	Training	11	
10/3/03	Reed	Training	7	
10/4/03	Reed	Tour	1	
10/4/03	Reed	Training	1	
10/6/03	Reed	Startup	1	
10/6/03	Reed	Taking Photos	2	
10/6/03	Reed	TLD Calibration	2	
10/7/03	Pacific University	Tour	11	Yes
10/7/03	United Fire	Maintenance	1	
10/8/03	Reed	Weekly	3	
10/8/03	Reed	Training	15	
10/9/03	Reed	Training	17	
10/10/03	Reed	Tour	1	
10/13/03	Reed	Training	3	
10/14/03	Reed	Tour	1	
10/14/03	Cleveland High School	Tour	27	Yes
10/15/03	Reed	Weekly	1	
10/15/03	Reed	Training	18	
10/16/03	Pacific University	Tour	9	Yes
10/16/03	Reed	Training	10	

Date	Institution	Purpose	Number	U-Share
10/17/03	Reed	Tour	7	
10/22/03	Reed	Training/Maintenance	1	
10/23/03	Reed	Tour	1	
10/28/03	Reed	Training	2	
10/29/03	Reed	Weekly	1	
10/31/03	Reed	Thesis Experiment	4	
11/4/03	Reed	Maintenance	1	
11/5/03	Reed	Training	6	
11/6/03	Reed	Startup	1	
11/6/03	United Fire	Maintenance	1	
11/6/03	St. Mary's Academy	Tour	14	Yes
11/6/03	Reed	Training	7	
11/6/03	Reed	Shutdown	1	
11/7/03	Reed	Startup	3	
11/7/03	Reed	Tour	42	
11/7/03	Reed	Shutdown	1	
11/8/03	Reed	Startup	1	
11/8/03	Reed	Tour	25	
11/10/03	Reed	Tour	2	
11/11/03	Reed	Startup	1	
11/11/03	SE High School	Tour	21	Yes
11/12/03	Reed	Training	4	
11/12/03	Reed	Shutdown	1	
11/13/03	Reed	Training	4	
11/15/03	Reed	Startup	1	
11/15/03	Oregon Episcopal School	Tour	7	Yes
11/15/03	Reed	Training	1	
11/18/03	Oregon Electric Group	Maintenance	1	
11/19/03	Rex Putnam High School	Tour	27	Yes
11/19/03	Oregon Electric Group	Maintenance	1	
11/20/03	Southridge High School	Tour	3	Yes
11/20/03	Conestoga Middle School	Tour	18	Yes
11/20/03	Reed	Tour	3	
11/24/03	Reed	Training	1	
11/24/03	Forest Charter	Tour	25	Yes
11/17/03	Reed	Bimonthly	1	
12/2/03	Reed	Training	6	
12/3/03	NRC	Inspection	1	
12/3/03	Reed	Training	6	
12/4/03	NRC	Inspection	1	
12/4/03	Reed	Class	6	
12/4/03	Reed	Training	4	
12/5/03	Reed	Class	7	
12/5/03	Reed	Training	1	
12/8/03	Reed	Tour	3	
12/9/03	United Fire	Maintenance	1	
12/10/03	C.S. Lewis Academy	Tour	13	Yes
12/10/03	Reed	Training	2	

Date	Institution	Purpose	Number	U-Share
12/12/03	Reed	Startup	1	
12/12/03	Catlin Gabel High School	Tour	9	Yes
12/17/03	Reed	Weekly	1	
12/19/03	Reed	Training	1	
12/22/03	Artic Sheet Metal	Maintenance	2	
12/31/03	Reed	Training	1	
1/9/04	Reed	RWP 6	19	
1/12/04	Reed	Training	14	
1/13/04	Reed	Training	41	
1/14/04	Reed	Training	43	
1/14/04	Reed	Weekly	2	
1/15/04	Reed	Training	33	
1/16/04	Reed	Tour	1	
1/18/04	University of Washington	Tour	2	Yes
1/20/04	Reed	Training	15	
1/20/04	Reed	Bimonthly	1	
1/20/04	Reed	Weekly	1	
1/21/04	Reed	Audit	1	
1/21/04	Reed	Training/E-drill	23	
1/22/04	Reed	Training	1	
1/23/04	Reed	Training	4	
1/23/04	Reed	Tour	1	
1/27/04	Reed	Startup	1	
1/27/04	United Fire	Maintenance	1	
1/27/04	Reed	Training	1	
1/28/04	Reed	Training/Weekly	4	
1/29/04	Reed	Training/Weekly	7	
1/30/04	Reed	Training/Weekly	3	
2/2/04	Reed	Training	4	
2/3/04	Reed	Startup	2	
2/3/04	Reed	Training	3	
2/4/04	Foreign Affairs	Tour	13	Yes
2/4/04	Reed	Tour	1	
2/4/04	Empire Pacific Risk Mgt.	Maintenance	1	
2/4/04	Portland Fire	Tour	8	Yes
2/4/04	Reed	Training	2	
2/5/04	Reed	Startup	1	
2/5/04	Reed	Training	1	
2/5/04	AWSEM	Tour	7	Yes
2/5/04	Reed	Training	3	
2/6/04	Reed	Training	2	
2/6/04	Reed	Shutdown	2	
2/7/04	Reed	Startup	2	
2/9/04	Reed	Startup	1	
2/9/04	Reed	Training	2	
2/10/04	Reed	Startup	1	
2/10/04	Portland Police Bureau	Tour	9	Yes
2/10/04	Reed	Training	3	

Date	Institution	Purpose	Number	U-Share
2/10/04	Reed	Shutdown	1	
2/11/04	Reed	Startup	1	
2/11/04	Reed	Training	2	
2/11/04	United Fire	Maintenance	1	
2/11/04	Reed	Training	5	
2/12/04	Reed	Startup	1	
2/12/04	Reed	Training/Shutdown	6	
2/13/04	Reed	Startup	4	
2/13/04	Reed	Training	3	
2/13/04	Reed	Shutdown	2	
2/14/04	Reed	Training	1	
2/15/04	Reed	Weekly	1	
2/16/04	Reed	Training/Startup	3	
2/17/04	Reed	Training/Startup	25	
2/18/04	Reed	Startup	3	
2/18/04	Reed	Training/Weekly	11	
2/18/04	Reed	Shutdown	1	
2/19/04	Reed	Tour	5	
2/19/04	Reed	Shutdown	1	
2/20/04	Reed	Startup	1	
2/20/04	Reed	Tour	3	
2/20/04	Reed	Shutdown	1	
2/23/04	Reed	Training/Startup	4	
2/24/04	Reed	Training/Weekly	7	
2/25/04	Reed	Training/Startup	7	
2/25/04	Reed	Tour	12	
2/26/04	Reed	Training	5	
2/28/04	Reed	Training	4	
2/28/04	Middle School Symposium	Tour	8	Yes
3/1/04	Reed	Training	3	
3/2/04	Reed	Weekly	1	
3/3/04	Reed	Training	14	
3/4/04	Reed	Training	6	
3/5/04	Reed	Training	2	
3/6/04	Reed	Training	6	
3/7/04	Reed	Training	1	
3/8/04	Reed	Training	2	
3/9/04	Reed	Training	3	
3/9/04	United Fire	Maintenance	1	
3/10/04	Reed	Training	9	
3/11/04	Reed	Training	8	
3/11/04	David Douglas HS	Tour	37	Yes
3/12/04	Reed	Training	1	
3/12/04	David Douglas HS	Tour	32	Yes
3/14/04	Reed	Training	1	
3/16/04	Reed	Training	2	
3/19/04	Saturday Academy	Tour	15	Yes
3/21/04	Reed	Training	4	

Date	Institution	Purpose	Number	U-Share
3/22/04	Reed	Training	1	
3/23/04	Reed	Training	11	
3/23/04	Saturday Academy	Tour	3	Yes
3/24/04	Reed	Training	17	
3/25/04	Reed	Training	17	
3/26/04	Reed	Training	8	
3/28/04	Reed	Training/Startup	7	
3/29/04	Reed	Training	2	
3/29/04	Apprenticeships Science Eng	Tour	1	Yes
3/31/04	Reed	Training	14	
4/1/04	Reed Physical Plant	Maintenance	2	
4/1/04	Reed	Training	6	
4/1/04	Lewis and Clark College	Tour	8	Yes
4/2/04	Reed	Training	2	
4/3/04	Reed	Training	7	
4/4/04	Reed	Training	5	
4/5/04	Reed	Training	1	
4/6/04	Reed	Training	9	
4/6/04	Concordia University	Tour	23	Yes
4/7/04	Southridge High School	Tour	23	Yes
4/7/04	Reed	Training	10	
4/8/04	Reed	Training	26	
4/8/04	United Fire	Maintenance	1	
4/9/04	Reed	Training	7	
4/10/04	Reed	Training	13	
4/11/04	Reed	Training	14	
4/12/04	Reed	Training	5	
4/13/04	Reed	Training	10	
4/14/04	Reed	Training	21	
4/15/04	Reed	Training	8	
4/15/04	Concordia University	Tour	21	Yes
4/15/04	Reed	Training	12	
4/16/04	Prospective Reed Students	Tour	21	
4/16/04	Reed	Training	5	
4/17/04	Reed	Training	4	
4/18/04	Reed	Training	6	
4/19/04	Reed	RAD Tour	17	
4/20/04	Reed	Training	13	
4/21/04	Reed	Training	9	
4/21/04	David Douglas HS	Tour	12	Yes
4/22/04	Reed	Training	7	
4/23/04	Reed	Training	2	
4/23/04	Lewis and Clark College	Tour	2	Yes
4/24/04	Reed	Training	1	
4/25/04	Reed	Training	4	
4/26/04	Reed	Training	3	
4/26/04	Linfield College	Tour	27	Yes
4/27/04	Reed	Training	4	

Date	Institution	Purpose	Number	U-Share
4/27/04	PPS	Tour	16	Yes
4/28/04	Linfield College	Tour	24	Yes
4/28/04	Warner Pacific College	Tour	7	Yes
4/28/04	Reed	Training	2	
4/29/04	Reed	Training	6	
4/30/04	Reed	Training	3	
5/2/04	Reed	Training	4	
5/3/04	NRC/trainees	NRC Exam	3	
5/4/04	NRC/trainees	NRC Exam	11	
5/5/04	NRC/trainees	NRC Exam	8	
5/6/04	NRC/trainees	NRC Exam	14	
5/7/04	NRC/trainees	NRC Exam	7	
5/8/04	Reed	Training	4	
5/8/04	NRC/trainees	NRC Exam	9	
5/9/04	Reed	Training	6	
5/10/04	Reed	Training	3	
5/10/04	ISEF	Tour	21	Yes
5/11/04	Lincoln High School	Tour	14	Yes
5/11/04	ISEF	Tour	24	Yes
5/11/04	Reed	Training	1	
5/13/04	Reed	Training	3	
5/13/04	United Fire	Maintenance	1	
5/14/04	Linfield College	Tour	6	Yes
5/14/04	Portland State University	Tour	1	Yes
5/16/04	Reed	Tour	6	
5/20/04	NRC	Inspection	3	
5/21/04	Portland Police Bureau	Inspection	1	
5/21/04	Reed	Tour	3	
5/21/04	US Crane	Maintenance	1	
5/24/04	Reed	Tour	14	
5/24/04	Reed	Audit	1	
5/25/04	Reed	Audit	1	
5/25/04	Portland Community College	Tour	21	Yes
5/26/04	Reed	Training	2	
5/28/04	United Fire	Maintenance	1	
5/28/04	Reed	Tour	1	
5/30/04	Reed	Tour	2	
6/6/04	Reed	Tour	3	
6/8/04	United Fire	Maintenance	1	
6/8/04	Skyview High School	Tour	2	Yes
6/14/04	Reed	Tour	3	
6/15/04	Boy Scouts	Tour	10	Yes
6/17/04	Reed Reactor Intern	Training	1	
6/18/04	Reed Reactor Intern	Training	1	
6/21/04	Massachusetts Institute Tech	Tour	1	
6/21/04	Reed	Training	2	
6/22/04	RSO Class	Tour	8	
6/24/04	RSO Class	Tour	9	

Date	Institution	Purpose	Number	U-Share
6/24/04	United Fire	Maintenance	1	
6/28/04	Reed Reactor Intern	Training	1	
6/28/04	Northwestern University	Tour	1	Yes
6/29/04	Reed Reactor Intern	Training	1	
6/30/04	Reed Reactor Intern	Training	2	
7/1/04	Boy Scouts	Tour	3	Yes
7/2/04	Reed Reactor Intern	Training	1	
7/6/04	Reed Reactor Intern	Training	1	
7/7/04	Reed Reactor Intern	Training/Weekly	1	
7/7/04	Reed Physical Plant	Maintenance	1	
7/8/04	Reed Reactor Intern	Training	1	
7/9/04	Reed Reactor Intern	Training	1	
7/12/04	Reed Reactor Intern	Training	1	
7/12/04	Saturday Academy	Tour	23	Yes
7/13/04	Reed Reactor Intern	Training	1	
7/14/04	Reed Reactor Intern	Training	1	
7/15/04	Reed Reactor Intern	Training	1	
7/15/04	Reed Physical Plant	Maintenance	1	
7/16/04	Reed Reactor Intern	Training	1	
7/20/04	Reed Reactor Intern	Training	1	
7/20/04	Reed	Tour	4	
7/21/04	Reed Reactor Intern	Training	1	
7/26/04	Reed Reactor Intern	Training	1	
7/26/04	Reed Environ Health Safety	Maintenance	1	
7/28/04	Reed Reactor Intern	Training	1	
7/29/04	Reed Reactor Intern	Training	1	
7/30/04	Reed Reactor Intern	Training	1	
7/30/04	Saturday Academy	Tour	24	Yes
8/2/04	Reed Reactor Intern	Training	1	
8/4/04	Reed Reactor Intern	Training	1	
8/4/04	Reed Physical Plant	Maintenance	1	
8/5/04	Reed Reactor Intern	Training	1	
8/6/04	Reed Reactor Intern	Training	1	
8/8/04	Reed	Tour	5	
8/9/04	Reed Reactor Intern	Training	1	
8/10/04	Reed Reactor Intern	Training	1	
8/10/04	United Fire	Maintenance	1	
8/11/04	Boy Scouts	Tour	12	Yes
8/18/04	Rep. Blumenauer Staff	Tour	2	
8/18/04	Reed Physical Plant	Maintenance	3	
8/18/04	Reed	Weekly	1	
8/25/04	Reed	Tour	45	
8/26/04	MRP Services	Maintenance	1	
8/26/04	Reed	Tour	34	
8/30/04	United Fire	Maintenance	1	