**The Sharing of the Penn State Breazeale Reactor
with
Other Educational Institutions**

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PENN STATE REACTOR SHARING PROGRAM

Introduction

The Penn State Radiation Science and Engineering Center (RSEC) integrates the Breazeale Reactor and its affiliated laboratories and facilities on the University Park Campus. Penn State has the only nuclear reactor in Pennsylvania dedicated to research and education. Its faculty have pioneered industrial and research applications of radiation and radioisotopes. In addition, the center and its affiliated faculty have access to the multidisciplinary resources and expertise available within Penn State, one of the nation's leading research universities.

The goals of the Penn State Radiation Science and Engineering Center are:

- To incorporate radiation science and engineering services and facilities into a cohesive infrastructure
- To provide state-of-the-art academic instruction and laboratory experiences
- To provide facilities and assistance for academic research
- To provide technical, engineering, and other support services to RSEC users
- To generate new techniques, applications, and services for researchers in diverse disciplines
- To serve the needs of academia and industry through RSEC services, faculty affiliations, and facilities that are not readily available elsewhere.

Reactor Availability

Over the past year, 64 Penn State University faculty and staff, 33 graduate students and 6 undergraduate students used the RSEC facility for research. Along with research, the reactor was utilized for Reactor Technology Laboratory courses and other undergraduate and graduate courses offered by the Department. The facility was also used by the Chemistry department, Industrial Engineering, Mechanical Engineering, Metals Science and Engineering, Mineral Science and Engineering, Physics, and Geosciences. These activities, along with 1992-1993 reactor sharing participation, utilized the reactor an average of 5.8 hours per shift. This allows ample time in the reactor schedule for students from other colleges and universities and high school groups to use the reactor and related facilities for additional research and educational projects.

Regional Assessment

Since the Penn State Breazeale Reactor is the only university research reactor facility in Pennsylvania, the minimum region that it serves can be considered the entire state. In Pennsylvania there are approximately 200 institutions of higher education and over 500 school districts that are potential users of the Radiation Science and Engineering Center. The University is in the geographic center of Pennsylvania making the location of the reactor facility a convenient distance from all of Pennsylvania's colleges, universities, and secondary schools. The RSEC has also been accessed by educational institutions in other states.

Interest of User Institutions

The faculty and staff of the RSEC have a strong reputation for providing quality research and educational experiences. Many educational institutions have used the RSEC and related facilities for experiments and educational programs. These users continue to return to the RSEC on a regular basis. Each year additional research projects and educational programs are added; this increases the use of the RSEC by other institutions through the Reactor Sharing Program. The goal of the 1994-1995 Penn State Reactor Sharing Program will be to maintain participation at the secondary level and continue to increase participation at the higher education level.

Five different universities utilized the RSEC facilities for research and education projects. The services included several different types of technical support and facilities. Neutron activation analysis was performed for a master thesis research project on metal concentrations in peat for a graduate student at Villanova University. The University of Connecticut and University of Wisconsin utilized the gamma irradiation facility for their research projects on the Mussaenda plant and alkali halide crystals. Faculty and students from Lock Haven State University and Juniata College performed experiments at the facility.

Twenty-eight secondary science teachers participated in the Nuclear Concepts and Technological Issues Institute, a three-week program at Penn State. The Breazeale Reactor was used to produce short-lived radionuclides for experiments and to demonstrate neutron activation analysis and neutron radiography. The "Approach to Critical" experiment used the reactor to demonstrate subcritical multiplication and reactor control principles.

Twenty-four science teachers participated in a full day workshop at the RSEC as part of a seven day course on Nuclear Energy. In addition, partial day programs of information along with a tour of the facility was provided to 95 teachers as part of their workshop or professional meeting experience.

A total of 529 students and instructors from 23 High Schools came to the RSEC for experiments and instruction. In addition, sixty-four high school students from across Pennsylvania participated in the "Radioisotopes in Agricultural Research" section of the Pennsylvania Governor's School for Agricultural Sciences. The Atoms scholars program was conducted by the Nuclear Engineering department to provide rural students the opportunity to learn about nuclear science. A total of twenty-seven students participated in this program. The facility was used in special conferences for 100 high school students and teachers including several programs geared to encourage minority students to pursue engineering careers.

In summary, the Reactor Sharing program at Penn State enabled a total of nearly 1,000 students and instructors to conduct research, perform educational experiments and learn more about the uses and operations of a research reactor. For a detailed listing see Attachment A, University Reactor Sharing Program Annual Report - Fiscal Year 1992-1993.

Although instructional programs will vary depending upon the needs of the user institutions, a typical program would include one to two days of activities. The content in past programs has been: Day 1, familiarization with the reactor facility, followed by a critical experiment, a neutron activation analysis experiment and a demonstration of neutron radiography. Those already familiar with the facility bring samples for irradiation and analysis, and are given an update on research capabilities. An example of the depth and detail presented in each experiment can be gained by reviewing the description of the approach to critical and neutron activation analysis experiments, Attachment B.

Related facilities include the Neutron Beam Laboratory, Angular Correlations Laboratory, Radionuclear Applications Laboratory, Cobalt-60 Irradiation Facility, Nuclear Materials Engineering Laboratory and the Low-Level Radiation Monitoring Laboratory. A more detailed description of the Penn State Radiation Science and Engineering Center and related facilities is included in Attachment C.

Research and Educational Programs Recognized

Penn State's research and educational programs for university and pre-college participants have been recognized on a national and international level. The University Reactor Sharing Program is an essential component in the conduct and success of such programs. Candace Davison, Nuclear Education Specialist was invited to present papers and conduct workshops concerning the programs and activities at Penn State. These included:

August 1992 - ACS conference, Washington, D.C. special session on pre-college nuclear science education - Session Co-chair and Paper "Pre-College Nuclear Science Programs at Penn State".

April 1993 - AAPT, Western PA Chapter at Indiana University of Pennsylvania

April 1993 - ASCE, ANS, High-Level Radioactive Waste Management Conference, Las Vegas, Nevada

Goals for 1994-1995 Reactor Sharing Program

The proposed University Reactor Sharing Program for the 1994-1995 year will be to continue to provide quality education and research opportunities to user institutions. The response to the research and educational opportunities provided to other universities and high school students through the reactor sharing program is expressed in the enclosed letters (Attachment D). While there is much anecdotal evidence concerning the positive impact of the reactor sharing experience, there is not much actual documentation. One example is from a person who visited the reactor while in high school, became a physics teacher and wanted to provide this same learning experience to his students. Continued funding through the Reactor Sharing program is essential in providing such opportunities. Efforts will continue to increase visibility and utilization by outside colleges and universities and maintain the current utilization for other educational institutions.

University: The Pennsylvania State University
 Program Director: Marcus H. Voth, Candace Davison
 Grant Number: DE-FC02-80ER10728 Amendment 20

Location: University Park, PA 16802
 Telephone Number: (814) 865-6351
 Reactor Type/Power Level: TRIGA Mark III
 1 MW-Maximum Steady State Power
 Reactor Sharing Support 1994-1995 \$22,000

Participating Institution	Principal Investigator	Number of Student/Faculty	Description of Project/Program
1. HIGHER EDUCATION			
A. RESEARCH PROJECTS			
Indiana University of Pennsylvania	Dr. Frank Fazio T. Daubenspeck	1 (F)	NAA for comparison of materials
Juniata College	Dr. Norm Siems PSU Health Physics	1 (F)	Use of counting equipment for leak testing of calibration sources and neutron source.
B. EDUCATIONAL EXPERIMENTS			
Lock Haven State University Indiana University of Pa	C. Davison T. Daubenspeck D. Hughes J. Lebedzik	4 UG 9 Students & Faculty	The students performed experiments to understand reactor operation and control or applications of radiation. These included the Approach to Critical Experiment, Negative Temperature Coefficient and Neutron Activation Analysis.
C. TEACHER WORKSHOPS			
Exploring the Nuclear Option	C. Davison	24 Teachers (PC)	A full day program as part of a course on Nuclear Energy Basics. The teachers performed several experiments at the facility and learned about reactor operation basics.
ENTER 2000	C. Davison	40 Teachers (PC)	A partial day program of information along with a tour of the facility.

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Participating Institution	Principal Investigator	Number of Student/Faculty	Description of Project/Program
2. SECONDARY EDUCATION			
A. RESEARCH/DEMONSTRATION PROJECTS (Pre-College Students and Teachers)			
	C. Davison T. Daubenspeck J. Lebedzik	Over 100 Teachers and/or Individual Students	A variety of experiments were conducted to determine the effects of radiation. For example; seeds, fruit flies and crystals were irradiated and the effects demonstrated or studied. Radon concentrations were detected and calculated, TLD and shielding, etc.
B. EDUCATIONAL EXPERIMENTS			
PA Governor's School (U-9 and gifted HS intern in Engineering Technology		64 (PCS) 57 (PCS) 20 (PCS)	These programs enabled the students to perform a variety of experiments utilizing the Penn State Breazeale Reactor and related facilities.
Secondary Schools			
Berlin Brothers HS Bermudian Springs HS Berwick HS Bradford HS Camp Hill HS Carlisle HS Carmichaels HS Council Rocks HS Cumberland Valley HS Dallastown HS Daniel Boone HS East Stroudsburg HS Eastern Lebanon HS Franklin HS Germanstown Friends HS Glendale HS Greensburg Salem HS Harbortreeck HS Harmony HS Harrisburg Academy Jersey Shore HS	C. Davison L. Lunetta C. Norman J. Moncil	784 (PCS) Students & Teachers	Those who came to the RSEC received instruction on the basics of radiation and nuclear energy along with a tour of the facility. Most groups conducted experiments such as the approach to critical experiment or saw a demonstration with the reactor. Most groups also did one of the other experiments listed below. Gamma Ray Spectroscopy Neutron Activation and Complex Decay of Silver Barium-137m Decay or Silver Decay Neutron Activation Analysis Relative Stopping Powers for α , β , and γ in materials Neutron radiography demonstration

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Participating Institution	Principal Investigator	Number of Student/Faculty	Description of Project/Program
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EDUCATIONAL EXPERIMENTS (cont.)

Secondary Schools (cont.)

Lewistown HS
 Loyalsock Twp HS
 Marion Center HS
 Muncy HS
 Northern Bedford HS
 Peters Township HS
 Portage HS
 Redland HS
 Ridgway HS
 St. Mary's HS
 Somerset HS
 State College HS
 State College Delta Program
 Twin Valley HS
 Westmont Hilltop HS
 Williamson HS

(PCS) Students
& TeachersC. Davison
L. Lunetta
C. Norman
J. Moncil

Those who came to the RSEC received instruction on the basics of radiation and nuclear energy along with a tour of the facility. Most groups conducted experiments such as the approach to critical experiment or saw a demonstration with the reactor. Most groups also did one of the other experiments listed below.

Gamma Ray Spectroscopy
 Neutron Activation and Complex Decay of Silver
 Barium-137m Decay or Silver Decay
 Neutron Activation Analysis
 Relative Stopping Powers for α , β , and γ in materials
 Neutron radiography demonstration

C. INSTRUCTION and TOURS

(PCS)

SPECIAL CONFERENCES

BEST program
 Jr Science Symposium
 Upward Bound
 Women in Engineering
 VEC-Tour & MEP

A partial day program of information along with a tour of the facility. These programs were mostly for minority or disadvantaged high school students.

24 Students
 41 Students
 14 Students
 37 Students
 110 Students

Notation:

F - Faculty

S - Students

UG - Undergraduate

PC - Pre-College

PCS - Pre-College Students