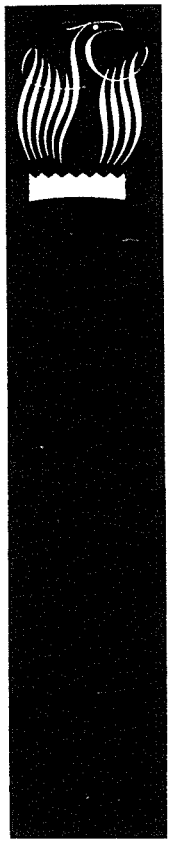
QUARTERLY REVIEW

WINTER 1992

MICHIGAN MEMORIAL PHOENIX PROJECT
THE UNIVERSITY OF MICHIGAN

NUCLEAR REACTOR LABORATORY
FORD NUCLEAR REACTOR
PHOENIX MEMORIAL LABORATORY



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Third Year, No. 15

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The Nuclear Reactor Laboratory Quarterly Review is published and distributed to University of Michigan faculty and staff members to inform them of the unique research capabilities of the Nuclear Reactor Laboratory and to make them aware of the types of research in progress.

The Michigan Memorial Phoenix Project was founded on May 1, 1948, as a memorial to the 585 University of Michigan alumni, students, faculty, and staff members who died in World War II. The Project's charter is to explore ways and means by which atomic energy can be a beneficent influence in the life of man. Research support and services provided by the Nuclear Reactor Laboratory and a research grant program are the means by which the Project fulfills its charter.

NEW RESEARCH

FORD NUCLEAR REACTOR

University of Michigan

Chemistry

Mr. Chris Espinosa, an undergraduate student working for Professor Henry Griffin, is investigating chemical properties of individual elements with short lived tracers. Mr. Espinosa is irradiating small amounts of elements and compounds in solid and liquid form to give ≤ 5 μCi of tracer.

Nuclear Engineering

Mr. Ram Venkataraman, under the direction of Professor Ronald F. Fleming, is irradiating titanium and iron foils in the reactor heavy water tank. The foils are irradiated for approximately forty hours and then are counted after an appropriate waiting period to determine reaction rates. The purpose of the work is to evaluate the heavy water tank neutron flux spectrum.

Physics

Karim Ashktorab, a doctoral candidate working under the direction of Professor Joachim Janecke, is examining the nickel-63 beta energy spectrum. The nickel-63 sources for this project are produced in the Ford Nuclear Reactor by neutron activation. The irradiation is performed in the reactor heavy water tank to minimize production of undesirable nickel isotopes. Hafnium and palladium foils also are being irradiated to provide palladium-109 and hafnium-180 beta sources for calibration purposes.

School of Public Health

Jeff Birkmeier is a graduate student working for Professor James Martin of the School of Public Health and Professor K. Rengan from Eastern Michigan University. Mr. Birkmeier is developing a methodology for assessing airborne concentration of radioiodines in the field following a nuclear accident. Radioiodines are considered the most important isotopes contributing to human exposure. Mr. Birkmeier is examining retention efficiencies of particulate filters and silver zeolite cartridges for a typical mix and yield of uranium-235 fission products. A set of correction curves will be developed to equate the response of a Geiger-Mueller pancake probe in the field to I^{131} air concentrations. Time after release and geometry will be taken into account.

University of California - Santa Barbara

Microhardness discs are being irradiated for Professor Eugene Lucas of the Chemical and Nuclear Engineering Department. An attempt is being made to correlate hardness and nil-

ductility transition temperature in reactor vessel steels.

General Motors Research Laboratories

Dr. Donald T. Morelli is investigating a shift in thermal conductivity that has been observed in polycrystalline diamond when graphite is present. Diamond has one of the highest thermal conductivities of known materials and is used as heat sink for semiconductors subjected to adverse temperature environments such as in automotive engine compartments. The diamond conducts away damaging heat that is generated in the semiconductor chips.

Sheets of polycrystalline diamond are produced by a vapor deposition process. The sheets are cut to size and attached to semiconductor chips. During carbon vapor deposition, various amounts of graphite are produced along with the diamond. The graphite, which is intimately incorporated into the diamond, has been observed to degrade thermal conductivity rendering the diamond less effective at removing heat.

Dr. Morelli is artificially creating graphite in four chips of vapor deposited diamond with high energy, fast neutrons from the University of Michigan's Ford Nuclear Reactor. Atoms of carbon are sometimes displaced from their crystal lattice positions when fast neutrons collide with the diamond. The overall result is a breaking of diamond type carbon bonds and the creation of graphite type bonds. The diamond chips will be removed after various levels of fast neutron exposure and studied at General Motors Research Laboratories for the effect graphite concentration has on thermal conductivity.

NEUTRON ACTIVATION ANALYSIS

University of Michigan

Chemical Engineering

Mr. Peter Gautier is working with Professor Robert Kadlec on a study of wetland utilization for community waste water treatment. The project is examining the ability of wetlands to be used as alternative methods for the treatment of secondary waste water. First started in 1978, the project is examining the short and long term environmental effects of the experimental Houghton Lake Wetland Treatment system. Mr. Gautier, working on one facet of the project, is using neutron activation analysis to perform a follow-up to a 1980 study of trace metal concentrations in various wetland plant species.

Chemistry

Professor Paul Rasmussen is examining the ability of experimental chelating compounds to extract environmentally hazardous metal ions and simulated nuclear waste ions from industrial waste streams. The compounds being studied are tetracyanobiimidazole, imidazole diacid, and related model compounds. Neutron activation analysis is being used to help determine the chelation effectiveness of the compounds. Professor Rasmussen's work is being funded in part by a grant from the Michigan Memorial Phoenix Project.

Geological Sciences

Mr. Jeffrey Mauk is researching the Geology of the White Pine Mine for his Ph.D. thesis. The White Pine Mine in northern Michigan was a source of native (metallic) copper. Neutron activation analysis is being used by Mr. Mauk to test for trace metal concentration differences in copper deposited during two distinct episodes of mineralization. If statistically significant differences are found, neutron activation analysis will be used to further characterize the geology of the mine. Mr. Mauk's advisor is Professor Philip A. Meyers.

Professor Enriqueta Barrera is studying ocean sediment core samples for evidence of the events that gave rise to the Cretaceous-Tertiary boundary in geological history. There is speculation that a cataclysmic geologic event occurred approximately 57 million years ago. The event, possibly massive volcanic eruptions, caused a major disruption to the inter-related ocean current and weather patterns. Ocean sediment samples give some evidence of a large change in ocean circulation. This has been seen in isotopic analyses of carbon and oxygen which show excursions in the isotopic ratios for the period. In addition, a higher than typical clay fraction in the sediments points to possible volcanic activity. Professor Barrera is analyzing sediment in a core drilling collected from the southern Indian Ocean near Antarctica. Neutron activation analysis is being used to obtain information about trace element concentration in the samples. Anomalous levels of certain elements such as strontium and iridium could indicate a volcanic source.

Medical School - Pathology

Mr. Anthony Opipari, a graduate student in the Pathology Department is using neutron activation analysis to determine if and to what extent zinc or other metal ions may be bound to the protein A20. A20, a DNA binding protein discovered at the Pathology Department, has the novel ability to impart to cells a resistance to killing by tumor necrosis factor. When tumor necrosis factor is applied to living cells, some are killed and some are left unharmed. The A20 protein may explain this behavior. Mr. Opipari's Ph.D. thesis title is "Characterization of a Novel Tumor Necrosis Factor Induced Protein." Mr. Opipari's faculty advisor is Professor Vishva Dixit.

Nuclear Engineering

Ms. Yuni Dewaraja, a doctoral candidate working under the direction of Professor Ronald F. Fleming, is developing the technique of imaging neutron activation analysis. The elements in an activated sample are identified by gamma-ray spectroscopy, and their distribution within the sample is determined by electron imaging. This program is funded through an NSF small business inovative research grant (SBIRG) with Charles Evans and Associates of Redwood City, California.

Miami University

Professor William Green of the School of Interdisciplinary Studies has been involved in a long term program studying Antarctic lakes. Professor Green is utilizing neutron activation

analysis to detect trace elements in sediment samples collected from seven different Antarctic lakes and from some local lakes. The results will be used to characterize the lakes' histories and to provide comparative information relative to other fresh water lakes.

COBALT-60 IRRADIATOR

University of Michigan

Physics

Professor David Gidley is gamma irradiating polymer samples to modify the lifetime of positrons in the samples. Positron lifetime is dependent on the density and size of voids in the polymer. Gamma irradiation should break bonds, reduce the polymer chain length, and thus generate more voids. Various gamma doses and dose rates are being studied.

Michigan State University

Dr. Jeanette Norton is sterilizing soil with a five megarad dose from the cobalt-60 irradiator. She then adds phanerochaete chrysosporium to the sterile soil to observe its growth. Phanerochaete chrysosporium is a lignin degrading basidiomycete capable of utilizing a wide range of environmental pollutants in pure culture. However, the ability of this fungus to grow and compete in the soil environment is relatively uncharacterized. The proposed experiment will compare the growth of phanerochaete chrysosporium in sterile soils with its growth in competition with the native soil microflora.

Ohio State University

Michelle Wander is sterilizing soil samples for her Ph.D. thesis work. She will be adding ^{13}C-labeled substrates to the sterile soil and to non-sterile soil followed by a three month incubation period. The soil will then be assayed using ^{13}C-NMR on whole soils and on various soil fractions. Ms. Wander is studying the effects of rotational management on soil organic matter characteristics. Her advisor is Professor Samuel Traina of the Agronomy Department.

Novi High School

Various garden seeds were irradiated up to three megarads as part of a science project.

Thomas Jefferson University

Dr. Michael Gibbons and associates are irradiating aids infected (HIV+) bone and tendon grafts at one, two, and four megarad doses with cobalt-60 gamma rays. The grafts will then be recultured for the aids virus (HIV) to determine the efficiency of gamma radiation on tissue sterilization.

Environmental Research Institute of Michigan (ERIM)

Pat Hamilton is cobalt-60 irradiating various items to be used in space. Initially, the items will be irradiated at doses up to 0.8 megarads. Materials tests will be conducted on the items to look for damage caused by doses equivalent to those they will receive in space. Mr. Hamilton works for the Environmental

Research Institute of Michigan (ERIM) Space Automation and Robotics Center (SPARC). SPARC's function is to assist companies in developing private commercial space ventures. ERIM accomplishes this by recruiting researchers from around the country who have the qualifications needed for research requested by the private companies. SPARC also enlists the help of interested companies for financial support and in supplying materials for the systems being researched.

Pat Hamilton is working on developing a system for allowing a service module, Commercial Experiment Transporter (Comet 2), to dock with another module, Comet 1, already in space. Comet 1 is to be sent into space in December, 1992, to deploy a satellite and perform various experiments. After the experiments and deployment, it will continue orbiting earth for approximately 2 years at which time Comet 2 is to be sent into space. Comet 2 will deploy its payload and perform sattelite resupply and servicing experiments, after which it will attempt to dock with Comet 1 using the Global Positioning System (GPS) to test the Autonomous Rendezvous and Docking (ARD) program and a refueling system for future carriers. Following the tests, Comet 1 and Comet 2 will be destroyed upon reentry into the atmosphere. Hopefully, enough will be learned and proven to make it feasible for future carriers to be reused or used for other tasks after fulfilling their original missions.

FEATURE ARTICLE

MINORITY AND FEMALE LABORATORY AND TRAINING PROGRAMS AT THE NUCLEAR REACTOR LABORATORY

Introduction

Nuclear power industry operations staffs are composed predominantly of white males because most of the personnel come from the nuclear submarine and surface branches of the United States Navy. The purpose of the minority and female intern program sponsored by the Nuclear Reactor Laboratory at the University of Michigan is to provide a path for minorities and women to enter the nuclear industry as operators, technicians, and, in the long term, as graduate engineers.

While the training is directed toward operation of a nuclear reactor, it is equally applicable to careers in most other technical fields. It is hoped that some of the interns will remain at the Nuclear Reactor Laboratory as reactor operators, enter college, and obtain college degrees, after which they will enter the nuclear industry as graduate engineers. The Nuclear Reactor Laboratory has one or two openings annually for reactor operators.

The program is aimed at high school students, preferably at the junior level. Students attend classes and laboratories on a work-study basis arranged with their schools two-days-per-week, four-hours-per-day during the academic year.

While the proposed intern program for minorities and women will not meet the needs of the nuclear industry, it is hoped that it will serve as a pilot for similar programs at other universities and at nuclear power plant sites.

Minority Engineering Programs Office,
University of Michigan

The initial problems in setting up an internship were money and finding suitable candidates. Financial support was provided by 1) the Department of Energy through a program entitled "Nuclear Reactor Operator Training for Disadvantaged Americans"; 2) Consumers Power Company; and 3) the Office of the Vice President for Research, University of Michigan.

It was initially intended that candidates would be selected through a summer pre-evaluation program that would be conducted for approximately twenty candidates. The candidates would live on campus and participate in a two-week academic and laboratory course. From those twenty initial candidates, four would be selected for the two-year academic and laboratory curriculum at the Nuclear Reactor Laboratory.

Contact was made with Richard Benjamin, Superintendent of the Ann Arbor Public Schools, who arranged a meeting at the Nuclear Reactor Laboratory with minority leaders from the

community. Among those attending were program directors from the University of Michigan's College of Engineering Minority Engineering Programs Office directed by Derrick Scott. The Minority Engineering Programs Office accepts and screens applications from minority high school students who express an interest in science and engineering and develops a pool of candidates for a variety of special programs in the fall, winter, and summer semesters. As soon as the Nuclear Reactor Laboratory indicated an interest in minority programs, the Minority Engineering Programs Office had candidates ready.

We were concerned that the candidates for the program selected by the Minority Engineering Programs Office would be "too good"; that is, they would most likely be college bound students at the top of their classes. We wanted to reach high school students who had ability, but lacked direction. A number of people from the public school system and from the University pointed out to us that many minority students who are successful in high school have a great deal of difficulty at the University. In the end, we felt that having relatively high achievers in the initial program would most likely ensure its success. Based on the students that have participated to date, the cross section of minority students seems comparable to a cross section of non-minority students. Many will be very successful in college while some will have a tough time. Perhaps in the future we can try to reach that group of students who are intelligent but lack motivation and direction. For now, we hope that the students who are participating in our program will provide an example for other minorities and women with whom they come in contact.

Reactor Laboratory, Winter 1991

A reactor laboratory was set up for the winter of 1991. Students participated in the laboratory on five Saturday mornings from 9 a.m. to 1 p.m. A list of the students with their schools is shown below. Those students who expressed interest in and applied for the two-year intern program are marked with an asterisk.

Student	School
Tekeshia Bailey *	Huron High School
Hyacinth Garrett*	Lincoln High School
Marciela Harris	Inkster High School
Wiletha Horton	Huron High School
Yvo Maldonado	Gabriel Richard High School
Michael Mathis*	Southfield Lathrup High School
Partha Mukhopadhyay	Ypsilanti High School
Torri Oats	Lincoln High School
William Ratcliff*	Huron High School
Manish Sharma	Ypsilanti High School

Summer Apprentice Program, June - August 1991

The University of Michigan Engineering College supports an eight-week summer apprentice program for high school applicants who express interest in Engineering, and in particular in entering the University of Michigan. Eight apprentices, funded by the Minority Engineering Programs Office and the Office of the Vice President for Research, were accepted by the Nuclear

Reactor Laboratory. The students who participated are listed below. Two of the students, one a previous applicant, applied for the two-year internship.

Student	School
Jeremy Dabrowiak	Saline High School
Brande Everett	Detroit Cass Tech
Hyacinth Garrett*	Lincoln High School
Dia Martin	Huron High School
Akomea Poku-KanKam	Pioneer High School
Robert Sundy*	Lincoln High School
Jumaane Williams	Pioneer High School
Kimberly Wilson	First Coast High School, Florida

The apprenticeship was divided into two distinct parts. About half of the time was spent in formal classroom lectures related to reactor theory with supporting experiments performed. The second half involved individual student utilization of neutron activation analysis. The entire group participated in a one-week field trip around the state of Michigan where samples of Great Lakes sediment and water, geological materials, hair, and bullet lead were gathered. Trace element analysis of each was performed by teams of two students. The sediment and water trace element levels were compared to EPA standards and guidelines for drinking water and sediment pollution. Geological samples were analyzed for unusual geological traits in Michigan. Hair and bullet lead were analyzed for use in criminal investigations.

Two-Year Minority and Female Internship

The two-year internship for four selected candidates began in mid-September 1991. The students work on a high school work-study arrangement on Tuesdays and Thursdays from 3 to 7 p.m. The curriculum is fairly rigid,

3 - 4 p.m.	Mathematics
4 - 5 p.m.	Reactor Theory Health Physics and Radiation Protection
5 - 6 p.m.	Reactor Systems Reactor Procedures Reactor License and Technical Specifications

6 - 7 p.m.	Problem Solving Session

because a great deal of material must be covered in a relatively few hours. Experiments and demonstrations are interspersed with each of the reactor related lectures.

One of the candidates is a senior in high school; two are juniors; the other is a sophomore. It is hoped that the senior will be ready to accept an operator position at the Nuclear Reactor Laboratory in the summer of 1992 when an opening is anticipated, and that at least one of the juniors will accept a position the following summer.

Future Programs

If the two-year internship is successful in the sense of providing operators for our reactor, producing entrants into the nuclear industry, and having graduates who go on to college, we hope to repeat the program on a regular two-year rotation. We plan to continue with the fall and winter Saturday morning laboratories, and to accept summer apprentices each year. Service to the University of Michigan is our primary responsibility, and we consider these programs for minorities and women an important service that we can provide.

NUCLEAR REACTOR LABORATORY
Profile of Services

Neutron Irradiation Services

In-core, pneumatic tube, and beamport irradiations with high energy (fast) and low energy (thermal) neutrons. Thermal neutron range: $8x10^6$ to $1.5x10^{13}$ n/cm^2/sec.

Neutron Activation Analysis

Identification of trace quantities of sixty-two elements including most metals and rare earth elements utilizing a technique that is almost non-destructive and requires very small sample volumes.

Gamma Irradiation Services

Gamma irradiations utilizing a large cobalt-60 source to sterilize bone and cartilage for reconstructive surgery and to study radiation effects on materials.

Neutron Radiography

Radiographic imaging of low density materials such as plastic, oil, water, and gasoline contained in heavy materials and porous media that cannot be imaged with ordinary x-rays.

Radioisotope Preparation

Production and distribution of large quantities of investigational drugs containing iodine-123, iodine-125, and iodine-131 to almost 150 hospitals and medical research institutions for diagnosis and therapy of adrenal gland cancer and adrenomedulla diseases.

Radiochemical Production

Preparation of bromine-82 labeled motor oil for use in engine oil economy research programs, and bromine-82 labeled toluene for use in oil refinery flow tests.

Testing Programs

Accelerated neutron and gamma aging of reactor materials; fast neutron damage effects in reactor vessel steels; and quality assurance tests of irradiated materials including neutron attenuation properties, strength, gas evolution, radionuclide content, and changes in physical parameters.

Training

Neutron activation analysis and reactor operations laboratories for university students, advanced high school students, and electric utility engineers and reactor operators.

NUCLEAR REACTOR LABORATORY DIRECTORY

Hours of Operation

Monday-Friday Sept. 1 - April 30 8:00 a.m.-5:00 p.m.
May 1 - Aug. 31 7:30 a.m.- 4:00 p.m.
Facilities can be made available 24 hours a day, if required.

Tours

Monday-Friday 9:00 a.m. - 4:00 p.m.

Tours should be scheduled at least 24 hours in advance.

Telephone Numbers

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Nuclear Reactor Laboratory Location
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