QUARTERLY REVIEW

WINTER 1995

MICHIGAN MEMORIAL PHOENIX PROJECT
THE UNIVERSITY OF MICHIGAN

NUCLEAR REACTOR LABORATORY
FORD NUCLEAR REACTOR
PHOENIX MEMORIAL LABORATORY

North Campus
The University of Michigan
2301 Bonisteel Blvd.
Ann Arbor, Michigan
48109-2100

(313) 764-6220
(313) 764-6223

QUARTERLY REVIEW

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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 provided by 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 is devoted to peaceful, useful, and beneficial applications and implications of nuclear science and technology to the welfare of the human race. Research support and services provided by the Nuclear Reactor Laboratory and a research grant program are the means by which the Project fulfills its mission.

NEW RESEARCH

FORD NUCLEAR REACTOR

University of Michigan

Nuclear Engineering

Shanka Guru irradiated nickel to produce cobalt-58 from a neutron interaction with nickel-58. The cobalt-58 serves as a source of gamma rays at 810.8 keV for a gamma camera test run. Mr. Guru is a doctoral candidate whose advisor is Professor David Wehe. The title of his doctoral thesis is "Fabrication of a Mechanically Collimated High Energy Gamma Camera".

Ayman Hawari irradiated small quantities of chromium and indium for use in calibration of a high purity germanium detector as part of his doctoral work. Chromium-51 releases a 320 keV gamma ray and indium-114m provides two gamma rays at 558 and 725 keV. The title of Mr. Hawari's thesis is "High Accuracy Calibration of HPGe Detectors and Applications". His advisor is Professor Ronald F. Fleming.

School of Public Health

Kenneth Coble, a master's student in radiological health, irradiated a variety of pharmaceutical products including Maalox, Correctol, vitamin and mineral supplements, and baby aspirin. The items were counted on a high purity germanium detector, and the results form part of his thesis work, the title of which is "Airport TNA Explosive Detection and Pharmaceutical Activation". Mr. Coble's advisor is Professor James Martin.

General Motors Research Laboratory

Tetraamine platinum (II) chloride was activated for Dr. Eric Schneider to produce radioactive platinum isotopes. The platinum was used as a tracer in the study of automotive catalysts.

Kaefer Isoliertechnik GmbH

A variety of insulation materials used in the nuclear power industry were irradiated adjacent to the reactor to a gamma dose of 2×10^8 rad with an accompanying thermal and fast neutron dose. After irradiation, the half lives and residual radionuclides in the materials were determined. In addition, pre and post irradiation weight and compressive strength were measured. The purpose of the project was to simulate activation as the result of a loss of coolant accident and to determine the impact on physical parameters. Knowing the amount of activity assists in determining the dose human beings will receive when they enter the reactor containment area following an accident.

NEUTRON ACTIVATION ANALYSIS

University of Michigan

Geological Sciences

Peter A. Knoop and his doctoral program advisor, Professor Robert M. Owen, utilized neutron activation analysis to test the viability of the technique for analyzing manganese nodules found on the ocean floor. Chemical composition of the nodules is used in paleooceanographic studies of ocean composition, circulation, and productivity.

COBALT-60 IRRADIATOR

General Plastics Manufacturing Company

Solid plastic foam blocks were irradiated up to a gamma dose of $2x10^8$ rads gamma. The plastic material's potential use is as a base support for spent fuel storage casks being designed for Consumer's Power Company. A series of mechanical tests were performed on irradiated and unirradiated samples to determine the degradation caused by radiation.

Public Service Electric and Gas

A variety of silicone polymer and molded plastic reactor containment penetration sealants were irradiated up to gamma doses of $5x10^7$ rads. The sealants had been applied to a variety of mechanical devices that would allow standard ASTM tension and adhesion tests to be performed after irradiation. Comparison of test results for irradiated and unirradiated specimens will determine the suitability of the materials for use in a reactor containment environment, particularly under loss of coolant accident conditions.

FEATURE ARTICLE

THE EFFECTS OF GAMMA RADIATION ON THE GROWTH AND DEVELOPMENT OF MICRO-FUNGI

Many different molds or fungi and mold-like organisms are known that will produce substances antagonistic to other living organisms, particularly the bacteria. One of the most important and widely used antibiotics produced from fungi is penicillin; it is formed under certain conditions from the fungus, Penicillium notatum.

Four fungal isolates were irradiated in the Nuclear Reactor Laboratory's cobalt-60 gamma irradiator to nominal doses of 4,000 rad, 35,000 rad, $4x10^5$ rad and $3x10^6$ rad.

1. Penicillium notatum 9178, a monospore fungus that was originally used in surface culture production of penicillin;
2. Penicillium notatum Pushkin taken from soil samples in the Catherine the Great Palace gardens, St. Petersburg Russia;
3. Penicillium roquefortii isolated from a living culture of Roquefort cheese; and
4. Trichophyton ajelloi, a parasitic fungus of the skin, also from the Catherine the Great Palace gardens, St. Petersburg, Russia.

As with all life forms, micro-fungi undergo changes at the cellular level when exposed to radiation. Each fungal species responds somewhat differently according to the species and to the intensity of radiation. A temporary change caused by radiation exposure can be followed by complete recovery from a particular injury or physiological process. A fungus, as a plant or animal, can actually increase certain life processes, such as cell division, following exposure to radiation. Part of the purpose of this research was to observe the effects of known radiation doses on fungi in a laboratory environment and to compare the irradiated fungi with radiation damaged fungi in the vicinity of the Chernobyl reactor in the Ukraine.

Figures 1, 2, 3 and 4 are photographs of the four fungus cultures taken through a microscope at 765 times magnification. The three individual photographs that make up each figure are: (a) an unirradiated control culture; (b) a culture irradiated to approximately $4x10^5$ rad; and (c) a culture irradiated to approximately $3x10^6$ rad. To put these radiation doses in perspective: 500 rads of radiation exposure would be lethal to most human beings; bone and cartilage used in plastic surgery are sterilized by exposure to $2x10^6$ rad.

Figure 1 Penicillium Notatum 9178
Hypha Filaments

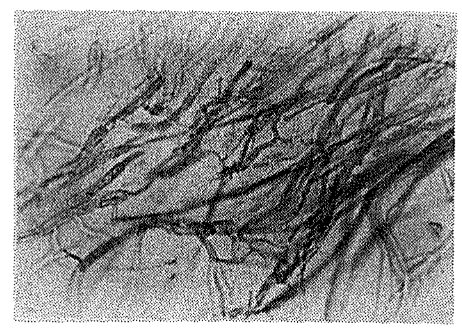
(a) Unirradiated

(b) Gamma Dose: $4x10^5$ Rad

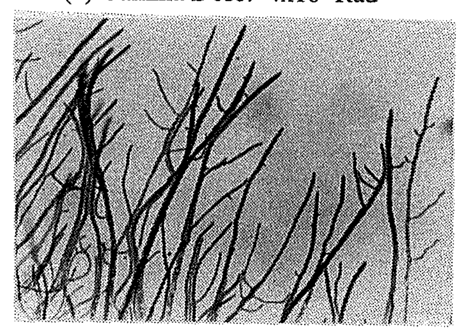
(c) Gamma Dose $3x10^6$ Rad

Figure 2 Penicillium Notatum Pushkin
Hypha Filaments

(a) Unirradiated

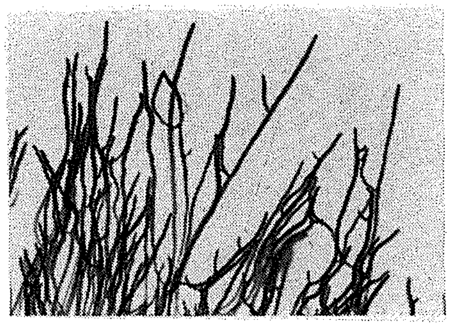


(b) Gamma Dose: $4x10^5$ Rad



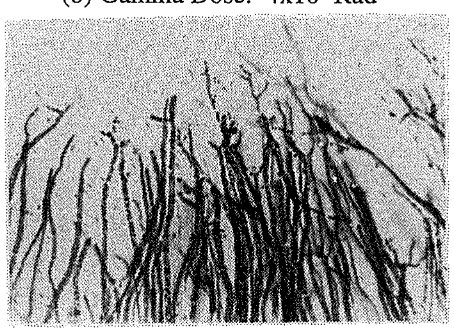
(c) Gamma Dose $3x10^6$ Rad

Figure 3 Penicillium Roquefortii
Hypha Filaments



(a) Unirradiated

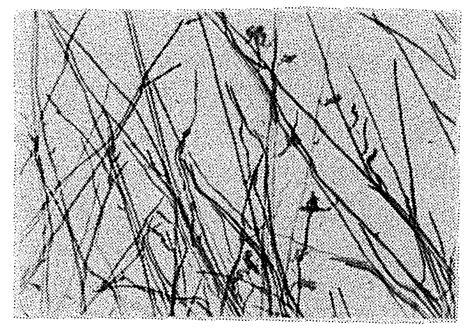
(b) Gamma Dose: $4x10^5$ Rad



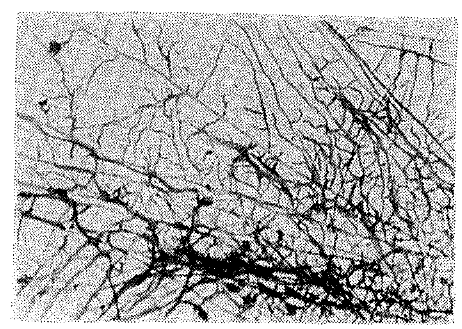
(c) Gamma Dose $3x10^6$ Rad

Figure 4 Trichophyton Ajeolli
Hypha Filaments

(a) Unirradiated



(b) Gamma Dose: $4x10^5$ Rad



(c) Gamma Dose $3x10^6$ Rad

Each photograph shows a portion of fungal mycelium, the mass of web-like structure that makes up the organism. The hypha or finger-like webs shown are typical of fungi. The hypal tips or apices are the points of longitudinal growth of a fungus. All of the fungal colonies were grown in a laboratory under the same conditions. After irradiation, the isolates were allowed to incubate at room temperature for 40 hours before being harvested for observation.

Some general observations can be made about all of the irradiated fungal colonies. Radiation exposure affected the growth patterns of all. The colonies seemed to be most affected by the intermediate gamma dose of $4x10^5$ rad; multiple branching, witches broom appearance, and wavy hyphal walls were present. The fungi irradiated to $3x10^6$ rad remained more similar in appearance to the unirradiated control colonies. Some abnormal coloration was observed. Greater frequency of short, multiple hypha branching with numerous cross walls was observed. Vacuolation of protoplasm, that is, formation of small membrane pockets or sacks filled with protoplasm, was plentiful in the $4x10^5$ rad colonies, but was seen only occasionally in the $3x10^6$ rad colonies.

Post irradiation growth patterns varied somewhat between types of fungi. For example, one week after exposure, the growth walls of both the unirradiated and $3x10^6$ rad colonies of penicillium notatum 9178 had reached the petri dish edge; three weeks were required for the $4x10^5$ rad colony to extend to its petri dish edge. In Penicillium roquefortii, colony growth of the unirradiated samples reached the petri dish edge in two weeks; growth of the irradiated colonies was completely inhibited.

This article was based on the research of Professor P.A. Volz, Mycology Laboratory, Eastern Michigan University; D.J. Najarian and S.P. Wasser, Kholodny Institute of Botany, Academy of Science, Kiev, Ukraine; and R.B. Blackburn, Nuclear Reactor Laboratory, University of Michigan.

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.

Radiopharmaceutical Preparation

Production and distribution of large quantities of investigational drugs containing iodine-123, iodine-125, and iodine-131 to more than 100 hospitals throughout the United States and Canada, as well as to 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; bromine-82 labeled toluene, sodium-24, lanthanum-140 for use in oil refinery flow tests; and other specialized radiochemicals.

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 8:00 a.m.- 5:00 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 48 hours in advance.

Telephone Numbers:

Director

Ronald F. Fleming (313) 764-6213

Manager

Reed Robert Burn (313) 764-6224

Assistant Manager, Operations

Bernard P. Ducamp (313) 764-6222

Assistant Manager, Research Support Activities

Neutron Activation Analysis
Radiation Damage Studies
Radiochemical Production

Philip A. Simpson (313) 764-6221

Senior Research Associate

Neutron Radiography

John T. Lindsay (313) 936-1583

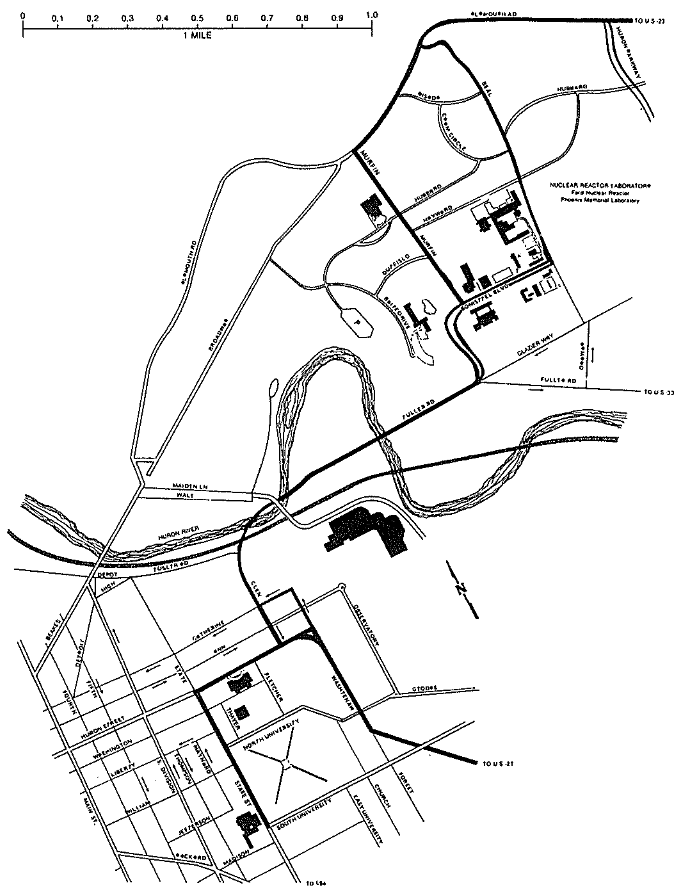
Research Associate II

Cobalt-60 Irradiation
Radioisotope Preparation

Robert B. Blackburn (313) 936-1582

Information and Tours

Kathy Kaminski (313) 764-6220
Zonda Cook (313) 936-1572
FAX (313) 936-1571



Nuclear Reactor Laboratory Location
University of Michigan Central and North Campus

The Regents of The University of Michigan: