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RADIATION LABORATORY

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U.S. Nuclear Regulatory Commission
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Washington, DC 20555-0001

Re: License No. R-125, Docket No. 50-223

Pursuant to the Technical Specifications for license referenced above, we are submitting the Annual Report for the University of Massachusetts Lowell Research Reactor.

Sincerely,

Leo M. Bobek,
Reactor Supervisor

cc: T. Dragoun, Region I

A020

OPERATING REPORT

FOR THE

UNIVERSITY OF MASSACHUSETTS LOWELL

FOR THE PERIOD

JULY 1, 1999 TO JUNE 30, 2000

Docket No. 50-223

License No. R-125

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A. INTRODUCTION

In the late 1950's the decision was made to build a Nuclear Center at what was then Lowell Technological Institute. Its stated aim was to train and educate nuclear scientists, engineers and technicians, to serve as a multi-disciplinary research center for LTI and all New England academic institutes, to serve the Massachusetts business community, and to lead the way in the economic revitalization of the Merrimack Valley. The decision was taken to supply a nuclear reactor and a Van-de-Graaff accelerator as the initial basic equipment.

Construction of the Center was started in the summer of 1966. Classrooms, offices, and the Van-de-Graaff accelerator were in use by 1970. Reactor License R-125 was issued by the Atomic Energy Commission on December 24, 1974, and initial criticality was achieved on January 1975.

The name of the Nuclear Center was officially changed to the "Pinanski Building" in the spring of 1980. The purpose was to reflect the change in emphasis of work at the center from strictly nuclear studies. At that time, the University of Lowell Reactor became part of a newly established Radiation Laboratory. The Laboratory occupies the first floor of the Pinanski Building and performs or coordinates research and educational studies in the fields of physics, radiological sciences, and nuclear engineering. The remaining two floors of the Pinanski Building are presently occupied by various other University departments.

On February 14, 1985, the University of Lowell submitted an application to the Nuclear Regulatory Commission for renewal of the facility operating license R-125 for a period of 30 years. On November 21, 1985, the license renewal was granted as Amendment No. 9 of License R-125 in accordance with the Atomic Energy Act of 1954.

B. FUNCTION

The Radiation Laboratory is one of 22 research centers at the University. More than 200 graduate students have used or are using the Laboratory's services; the comparable number for the faculty is in excess of 25. The University departments utilizing the facility include Biology, Chemistry, Earth Sciences, Physics, Mechanical Engineering, Plastics Engineering, Radiological Sciences, and Chemical/Nuclear Engineering. The University's Amherst campus and Medical Center have active research programs at the Radiation Laboratory. Much research is concerned with safety and efficiency in the nuclear and radiation industries, including pharmaceuticals, medical applications, health affects, public utilities, etc.; however, much research is also done by workers in other fields who use the unique facilities as analytical tools.

In addition, the Laboratory's facilities are used in the course work of various departments of the University. It also provides these services to other campuses of the Massachusetts system, other universities in the New England area, government agencies and to a limited extent, industrial organizations in Massachusetts and the New England area, as well as numerous school science programs in the Merrimack Valley.

C. OPERATING EXPERIENCE

1. Experiments and Facility Use

The major uses of the reactor during this fiscal year were activation analysis, dosimetry studies, calibrations, specialized isotope production, neutron effects, studies, teaching and personnel training.

Research

The UMLRR is currently involved with various biomedical research projects including: analytical testing of medical radiation oncology devices for treating cancer, and the development of stable-isotope biomedical tracer analytical techniques for research and diagnostics. Various radiation effects research projects include: radiation induced materials enhancement for commercial and military applications, radiation resistant electronics testing for commercial, military, and NASA applications, and the

development and testing of spent nuclear fuel storage shipment materials for corporations serving the U.S. and international nuclear power industries.

Activation techniques were used to study geological composition of rock samples. Neutron activation analysis has been used in blood perfusion studies and other biomedical research applications. Dosimetry studies and calibrations utilized N-16 production for high energy gamma fields and reactor facilities for mixed neutron and gamma dosimetry.

Education

Reactor operating time used for teaching purposes included a reactor operations course emphasizing control rod calibrations, critical approaches, period measurement, prompt drops and calorimetric measurement of power and preparation of students and staff members for NRC licensing examinations. Freshman laboratories for reactor principles and activation analysis were conducted for chemical/nuclear engineering students.

Radiological science students utilized the facility for performance of radiation and contamination surveys. Senior students participated in a laboratory that required locating and identifying an unknown isotope of low activity in a mockup power plant environment. The isotope was provided for the students in an isolated area in the reactor pump room during non-operating hours. During the practicum, the students were supervised by faculty and staff.

The following UML courses use the reactor facilities each year as a major or partial component of the curriculum:

96.443 Radiochemistry Laboratory
96.393 Advanced Experimental Physics
96.306 Nuclear Instrumentation
96.201/96.301 Health Physics Internship
99.102 Radiation and Life Laboratory
98.666 Reactor Health Physics
10/24.431 Nuclear Reactor Systems and Operation
10/24.432 Nuclear Systems Design and Analysis
24.507 Reactor Engineering Analysis

87.111 Environmental Science

84.113 General Chemistry

19.518 Engineering Controls and PPE

19.517 Physical Agents

A new summer Reactor Operations and Systems Experience (ROSE) program was initiated for undergraduate engineering students of all disciplines to participate in operator licensing training.

A number of activation and decay experiments were performed for both university and non-university students alike. A very successful program at the UMLRR is the Reactor Sharing Program sponsored by the Department of Energy. This program, which started at the University in 1985, has become extremely popular with area schools, grades 7 through 12. The goal of this program is two-fold: to motivate pre-college students into developing an interest in the sciences, and to promote an understanding of nuclear energy issues while expanding learning opportunities. The program is comprehensive in that it includes lectures, hands-on experiments and tours of the UMLRR. Students and teachers may also participate via interactive two-way cable and satellite television. The lectures cover topics on environmental radiation, the uses of radiation in medicine, and the potential of nuclear energy. Activation and decay experiments were provided for local school science classes involving more than 2,000 students who observed the experiment at the reactor or in their classrooms via interactive cable T.V.

Service

The major outside uses for the reactor facility is neutron and gamma damage studies of electronic components, characterization of neutron detectors, and neutron effects upon materials.

2. Changes in Facility Design

There have been no changes to the facility design during the reporting period.

3. Performance Characteristics

Performance of the reactor and related equipment has been normal during the reporting period.

4. Changes in Operating Procedures Related to Reactor Safety

No changes have been made during the reporting period.

5. Results of Surveillance Test and Inspections

The results of Technical Specification required surveillances have been reviewed by the Reactor Supervisor and Chief Reactor Operator. All surveillance test results were found to be within specified limits and surveillance inspections revealed no abnormalities which would jeopardize the safe operation of the reactor. Each required calibration was also performed. One calibration was not performed in a timely manner. This missed surveillance interval was reported during a routine NRC operations inspection and corrective actions for more precise scheduling and tracking are in development.

6. Staff Changes

A full-time senior reactor operator (SRO) was hired as of June 2000. A part-time research engineer was hired in July 1999 to provide assistance in developing research grants and contracts. This person is licensed as an SRO. A Part-time electronics engineer has been contracted to work as needed for the reactor.

As of June 30, the reactor staff consists of three full-time SROs and three part-time SROs. In addition, three graduate student SROs are available as needed, and one non-staff SRO is maintaining an active license. Remaining staff consists of several undergraduate and graduate student assistants.

7. Operations Summary

The utilization is broken down as follows:

Operating Hours

Critical hours	442.93
Hours at fullpower	323.19
Megawatt hours	339.18

Experimental Utilization

Sample hours	379.32
(includes multiple samples)	
Number of irradiations	379
Number of Training hours	197.4

D. ENERGY GENERATED

Total energy generated (MWD)	23.13
Number of hours reactor was critical	678.11
Total cumulative energy output (MWD)	272.84

E. INADVERTENT AND EMERGENCY SHUTDOWNS

There were 10 inadvertent scrams. Four of these were due to electronic problems associated with compensated ion chamber (CIC) neutron detectors used in the power level monitoring channels. These CICs are approximately 15 years old and replacement options are being investigated. Three scrams occurred due to control panel switch errors. One scram occurred due to an airlock interlock. One scram occurred due to inadvertent contact with a seismic trip detector. One scram occurred due to a brief utility electrical power transient.

None of the inadvertent scrams had any safety significance and all safety systems performed in accordance with the technical specifications.

F. MAJOR MAINTENANCE

The following major maintenance has been undertaken during the reporting period:

The heating, ventilation, and air conditioning system for the reactor containment building was re-built.

The area radiation monitoring (ARM) system has been completely upgraded under funding from the Department of Energy. Full documentation is on file provided for the system. All components have been satisfactory tested and calibrate to meet or exceed original ARM design specifications.

A pneumatic sample tube (one of two) that had been inoperative since 1995 was repaired. A positional sensor aluminum clip had broken loose and became lodged in a pneumatic vent hole within the tube. The clip was removed using an inspection camera and high-velocity vacuum apparatus.

G. FACILITY CHANGES RELATED TO 10CFR50.59

There have been no facility changes to date which pose an unreviewed safety question.

The Department of Energy has funded the re-fueling and conversion of the reactor core to low-enrichment uranium fuel. A revised projected date for LEU fuel receipt is now August 2000. Part of this conversion effort has included support for the complete characterization of the LEU core and reactor irradiation facilities using two-dimensional (DORT), three-dimensional (VENTURE), and MCNP computational methods. This characterization provides traceability to national standards for all future work performed.

Submittals to all NRC requests and answers to questions were completed in July 1997 and an NRC order to effect the change to LEU fuel was issued on July 31, 1997.

H. ENVIRONMENTAL SURVEYS

Surveys of the environs external to the reactor building have continued to show no increase in levels or concentrations of radioactivity as a result of reactor operations. Air particulate samples collected at a continuously monitored site on the roof of the Pinanski Building have shown no reactor produced radioactivity. Thermoluminescent dosimeters

are used to monitor unrestricted areas outside of the Reactor. The results of these measurements show that doses in these areas were indistinguishable from background radiation levels during the period of July 1, 1999 to June 30, 2000.

I. RADIATION EXPOSURES AND FACILITY SURVEYS

1. Personnel Exposures

Personnel exposures were maintained at the lowest reasonable levels. Doses received by individuals concerned either directly or indirectly with operation of the reactor were within allowed limits. Twenty-four individuals were monitored by film badge during the year.

Seven received measurable external deep dose equivalents ranging from 10 to 155 mrem.

2. Radiation Surveys

Radiation levels measured in the reactor building have been typically less than 0.1 mrem/hr in general areas. Experiments have been conducted in which transient levels at specific locations have been in excess of 100 mrem/hr. Doses in these instances have been controlled by use of shielding and/or personnel access control. The pump room remains designated as a high radiation area during reactor operation and access is controlled. Dose equivalent levels in the order of 10 mrem/hr are present adjacent to the closed beam ports during maximum power operation.

3. Contamination Surveys

General area contamination has not been a problem in the reactor building. Contamination has occurred at specific locations where samples are handled and particular experiments have been in progress. Contamination in these areas is controlled by the use of easily replaced plastic-backed absorbent paper on work surfaces, contamination protection for workers, and restricted access.

J. NATURE AND AMOUNT OF RADIOACTIVE WASTES

1. Liquid Wastes

Liquid wastes are stored for decay of the short lived isotopes and then released to the sanitary sewer in accordance with 20 CFR 2003. A total of 17.0 μCi was released over the 12 month period. The principle isotopes released were Co-60, Mn-54, and Zn-65.

2. Gaseous Wastes

Argon-41 continues to be the only significant reactor produced radioactivity identifiable in the gaseous effluent. Following are the monthly stack release data for Ar^{41} for the reporting period:

MONTH	**Ar-41 Released (Curies)**
July 1999	4.7
August 1999	0.6
September 1999	1.1
October 1999	1.2
November 1999	1.5
December 1999	0.1
January 2000	0
February 2000	1.1
March 2000	0.9
April 2000	2.9
May 2000	3.0
June 2000	1.7
TOTAL	18.8

This release represents a 12 month dose of 0.4 mrem to the nearest member of the public using the EPA Comply code.

3. Solid Wastes

Solid wastes, primarily paper, disposable clothing, and gloves, along with other miscellaneous items have been disposed of in appropriate containers. Most of the activity from these wastes consisted of short lived induced radioactivity. These wastes were held for decay and then released if no activity remained. The remaining long lived wasted (<10 cubic feet) was collected and stored in a designated long lived waste storage area awaiting ultimate disposal at low-level radioactive waste disposal site.

On May 17, 2000 .15 cubic feet of dry waste containing 250μCi of Zn-65 was shipped off-site for disposal.