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RADIATION LABORATORY

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U.S. Nuclear Regulatory Commission
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Washington, DC 20555

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

Pursuant to Technical Specification NRC License No. R-125 we are submitting the Annual Report for the University of Massachusetts Lowell Research Reactor.

Sincerely,

Leo M. Bobek,
Reactor Supervisor

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University of Massachusetts Lowell Research Reactor (UMLRR)

2003-2004 OPERATING REPORT

NRC Docket No. 50-223

NRC License No. R-125

UMASS University of Massachusetts Lowell

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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.

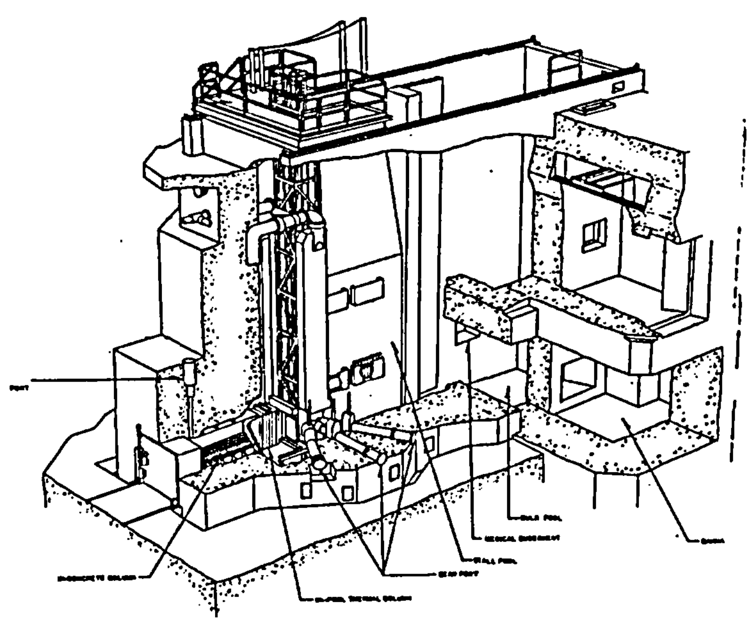
On February 14, 1985, the University of Lowell submitted an application to the Nuclear Regulatory Commission for renewal of the facility operating license R-125 for a period of 30 years. On November 21, 1985, the license renewal was granted as Amendment No. 9 of License R-125 in accordance with the Atomic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

In 1991, the University of Lowell name was changed to University of Massachusetts Lowell. On August 4, 2000, the reactor was converted from high enrichment uranium fuel to low enrichment uranium fuel.

B. FUNCTION

The University of Massachusetts Lowell Radiation Laboratory (UMLRL) is one of 22 research centers at the University. The University departments utilizing the laboratory 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 reactor and Cobalt-60 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.



UMLRR Cutaway View

C. OPERATING EXPERIENCE

1. Experiments and Facility Use

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

Research

DOE and Konarka Technologies

The Radiation Laboratory, along with Konarka Technologies, has received funding from the Department of Energy (DOE) to develop various aspects of a radiation hardened photovoltaic based energy converter. The products developed under these programs will convert nuclear radiation into useful electric power. A primary application of this novel technology will be to operate a secure GPS class transmitter to provide in-situ status of location and integrity for radioactive materials storage and shipments. Both research programs will use the Co-60 facilities and the reactor.

MIT-UML-URI Consortium

Under the DOE Innovations in Nuclear Infrastructure and Education (INIE) program, UML has been funded to develop a digital neutron imaging system (neutron radiography). The present neutron imaging system at UMLRR provides users with industrial neutron radiographic service meeting ASTM standards using film technology. Faculty and staff are now in the process of building and developing a digital neutron radiography system capable of imaging materials and components having a wide range of areal dimensions. The digital imaging will shorten exposure times to provide almost immediate viewing of the radiographic image, provide the flexibility to scan large areas with ease, provide accurate recording of a variety of radiographic details, and permit remote imaging via the internet.

Remote Education

As part of our DOE Reactor Sharing Program, faculty and staff are developing a system for making real-time and archived research reactor data available to educational users via a standard web browser. Virtually any classroom or individual throughout the world will not only be able to access archived UMLRR experimental data, but also observe most of the UMLRR control room instrument readings, in real-time, in a graphical interface for use in classroom lectures, demonstrations, and experiments.

Neutron Activation Analysis (NAA)

Faculty in the Environmental, Earth, & Atmospheric Sciences department apply fission-track geochronology and trace element analysis (NAA) to rock and mineral samples, soil, coal, atmospheric aerosols, human hair, film negatives, and process sludge. The greatest use of the UMLRR for these techniques has been to determine the geochemical, geochronological, isotope geology and petrological characteristics of various locations around the globe, including: Cameroon; Southwest Uganda; the Chilwa and North Nyasa alkaline provinces in Malawi; the Kola Peninsula, Russia; the Monteregian Hills, Quebec; the Arkansas alkaline province; and the petrographic province in the White Mountains of New Hampshire.

Isomer Production

Faculty in the Physics department, in a collaborative project with Argonne National Laboratory, are investigating quantum phenomena in rapidly spinning atomic nuclei. When heavy nuclei with stored energy in a high-spin "isomer" slow down, energy is lost by emitting bursts of gamma-ray photons. The collaborative research by the physics team focuses on isolating, characterizing, and understanding high-spin isomers through detection of the gamma bursts. The UMLRR is being used to produce a known isomer in Lutetium-177 (160-day half-life) via neutron activation of stable lutetium foils. The research may find eventual applications in diverse arenas, from the development of gamma-ray lasers to theories of star formation.

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 are supervised by faculty and staff.

The following UML courses use the reactor facilities 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

In addition, a summer Reactor Operations and Systems Experience (ROSE) program is provided 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 are often provided for local school science classes who observe 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.

2. Facility Changes

Two facility changes have occurred during the reporting period. The first was the completed conversion of the original medical embedment to an enhanced low-dose radiation service facility (ELDRS). This changed was reported in the last annual report and has received ongoing review by the Reactor Safety Subcommittee (RSSC), which approved its use in June of this year. The second facility change was the receipt of additional Cobaly-60 from Nordion in August of 2003. The new Cobalt-60 source activity, in addition to the existing Co-60 source activity, is well within the permissible inventory under the reactor license technical specifications. Neither of these changes required 10CFR 50.59 reviews.

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

The following procedures were revised with substantive changes that required the approval by the RSSC: (1) AP-1 Procedure Control and Distribution, (2) AP-2 Procedure Development. Both procedures were revised to clarify and improve procedure control and development. (3) CO-5 Gamma Cave Operations, (4) CO-6 Hot Cell Operations, (5) CO-7 ELDRS Facility Operations. These three procedures were developed to formalize the use of the Cobalt-60 facilities. (6) AP-4 Daily Opening of Containment. This procedure was changed to reflect new equipment and security requirements. Several other procedures had minor revisions or updates un-substantive in nature. Such changes are kept on file and summarized for the RSSC at each meeting.

5. Results of Surveillance Test and Inspections

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.

6. Staff Changes

As of June 30, the reactor staff consists of four full-time SROs, and two part-time undergraduate student ROs, one part-time SRO, and one part-time mechanical technician. In addition, one full-time non-staff Asst.-Professor and teaching-assistant graduate student are maintaining SRO licenses. Remaining part-time staff consists of student assistants.

7. Operations Summary

Critical hours	238
Megawatt hours	148.15

D. ENERGY GENERATED

Energy generated this period (MWD)	6.17
Cumulative energy to date (MWD)	18.01

E. INADVERTENT AND EMERGENCY SHUTDOWNS

There were 29 inadvertent shutdowns, none of which were emergency related or having safety significance. This number is comparable with last year wherein a number of automatic scrams were due to the sensitivity of recently upgraded systems. None of the scrams had any safety significance, and were more a nuisance to the educational and research uses of the facility. Descriptions of each scram are noted in operator logs and are analyzed by an SRO for any safety significance.

F. MAJOR MAINTENANCE

No major maintenance was performed during the reporting period.

G. FACILITY CHANGES RELATED TO 10CFR50.59

Revised or new procedures (section C-4 of this report) were reviewed and approved in accordance with the UMLRR technical specifications and administrative procedures.

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. 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, 2003 to June 30, 2004.

The Radiation Safety Office has performed an ALARA review for the 2003 calendar year. The table below is a summary of the environmental release pathways (sewer and stack) and the maximum environmental and occupational dosimetric exposures documented through the Landauer® film badge analysis service.

As expected, all environmental releases were below the goals set by the Radiation Safety Office (50 mrem per year) with no detectable activity was released through the UML Research Reactor sewer system. The reactor stack release results for 2003 was significantly lower than average. This was attributed to low reactor usage (4.9 MWD) and did not take into account the removal of three reactor beamports, resulting in a significant over-estimation of the quantity of Argon-41 produced. Since the reported value is therefore a conservative estimate, no further action was taken.

The reactor uses 2 constant air monitors (CAMs) to analyze for particulate airborne activity. CAM Filters are collected each operational day and analyzed via gamma spectroscopy for detectable fission or activation products. From July 2003 to date, no fission products or activation products were determined to be present on a CAM filter sample. The reactor also uses an area stack monitor to measure released gross effluent activity from the reactor stack. A particulate filter roll and iodine filter cartridge on the stack monitor are routinely changed every 4-6 months and checked for fission products or activation products. The reactor radiation monitoring system uses a data logger to maintain all stack effluent data.

I. RADIATION EXPOSURES AND FACILITY SURVEYS

2003 ALARA Data

OCCUPATIONAL EXPOSURES

GROUP	NUMBER	MAXIMUM	GOAL
	BADGED	DOSE	
Reactor	19	168	≤500

ENVIRONMENTAL DOSIMETRY

SOURCE	DOSE EQUIVALENTS	GOAL
	mrem	mrem
Reactor stack	<0.1	≤10
Reactor Sewer	<MDA	<10

1. Personnel Exposures

Personnel exposures were maintained at the lowest reasonable levels with the average annual dose of <10 mrem per year per person. Doses received by individuals concerned either directly or indirectly with operation of the reactor were within allowed limits. The annual ALARA goal established by the Radiation Safety Committee is less than 500 mrem per employee. In addition to the film badge, all reactor personnel are required to wear a pocket ion chamber and record its results in the reactor dosimetry logbook. When applicable, reactor personnel are required to wear a finger badge.

2. Radiation Surveys

The Radiation Safety Office performs monthly radiological surveys of the research reactor during 1 MW operations. 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 postings, shielding, personnel access control, and the addition of audio / visual warning indicators. 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 measurable 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. The swipe/filter counting procedures (RxHp-1) were revised and updated on March 2003. Included were instructions on calculating the detection limits (at a 95% confidence level) for the proportional counter, a change in the daily system check procedure to use a $\pm 3\sigma$ system response to a beta standard, and updated Liquid Scintillation Counter work instructions to reflect the new Radiation Safety Office LSC.

K. NATURE AND AMOUNT OF RADIOACTIVE WASTES

2003 ALARA Data

ENVIRONMENTAL RELEASES

SOURCE	ACTIVITY	DOSE	GOAL
	mCi	mrem	mrem
Sewer Releases	<1.0	<1	≤10
Stack Releases	4.3 E3	<1	≤10

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. No detectable activity was released over the 12 month period covered in this report.

2. Gaseous Wastes

No significant effluent releases have been measured during this period. The estimated site boundary Ar-41 dose to the public in the 2003/2004 period covered in this report was below 0.1 mrem for the year. This estimate is based on the EPA COMPLY Code run at the 4th (and most restrictive) calculation level. The Ar-41 activity still assumes the presence of two sets of reactor beamports. The removal of the southern reactor beamport is estimated to decrease Ar-41 production by half. A future project of the Radiation Safety Office will address this issue.

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) is stored in a designated long lived waste storage area awaiting ultimate disposal at low-level radioactive waste disposal site.

End of Report