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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

A020

University of Massachusetts Lowell Research Reactor (UMLRR)

2002-2003 OPERATING REPORT

NRC Docket No. 50-223

NRC License No. R-125

University of Massachusetts UMASS 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.

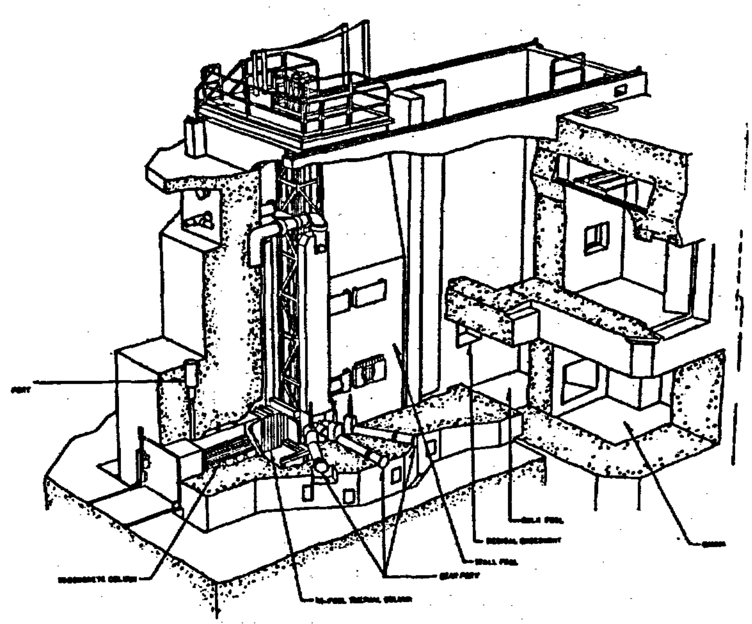
The name of the Nuclear Center was officially changed to the "Pinanski Building" in the spring of 1980. The purpose was to reflect the change in emphasis of work at the center from strictly nuclear studies. At that time, the University of Lowell Reactor became part of a newly established Radiation Laboratory. 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.

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.



UMLRR Cutaway View

C. OPERATING EXPERIENCE

1. Experiments and Facility Use

The major uses of the reactor during this fiscal year were activation analysis, dosimetry calibrations, specialized isotope production, neutron effects studies, teaching, and personnel training. Control room upgrades required the reactor be shutdown during the last two months of the year.

Research

Various radiation effects projects included: radiation induced materials enhancement for commercial and military applications, radiation resistant electronics testing for commercial and military aerospace applications.

Activation techniques were used to study geological composition of rock samples. Dosimetry studies and calibrations utilized N-16 production for high-energy 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 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. Changes in Facility Design

Two changes to facility design occurred during the reporting period. The reactor control blade drive system as described in the UMLRR FSAR 4.1 and 4.4 has been upgraded using the same technology applied to previous control room upgrades described in the 2001 and 2002 Annual Report. The change was made under the provision of 10CFR 50.59 and is further described in Section G of this report.

A second change involves the conversion of the unused bulk pool medical embedment to a low-dose Co-60 gamma facility. The facility is being modified for low-dose, extended radiation testing of electronics. While not yet complete at the time of this report, the facility safety features will be similar to those now used for the bulk pool gamma cave high-dose Co-60 irradiations. When complete, the facility change will be evaluated by the reactor safety committee.

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 reactor safety committee: (1) RO-9 Reactor Checkout; revisions made to conform with control room upgrades, and (2) RO-6 Reactor Operations; with modifications to comply with control room upgrades.

5. <u>Results of Surveillance Test and Inspections</u>

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. <u>Staff Changes</u>

As of June 30, the reactor staff consists of three full-time SROs, and one full-time RO, 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. <u>Operations Summary</u>

Operations Summary data is presented for both the HEU and the LEU fueled reactor. The utilization is broken down as follows:

<u>Reporting Period Hours</u>

Critical hours	208.15
Full power hours	93.61
Megawatt hours	102.881

<u>Reporting Period Utilization</u>

Sample hours	30.81
Samples	68
Training hours	121.33

D. ENERGY GENERATED

Energy generated this period (MWD)	4.29
Cumulative energy to date (MWD)	11.84

E. INADVERTENT AND EMERGENCY SHUTDOWNS

There were 24 inadvertent shutdowns, none of which were emergency related or having safety significance. This number is comparable with last year wherein a number of scrams were due to overly conservative system settings put in place for recently upgraded systems. Thirteen of the inadvertent scrams were due to electronic noise eventually traced to a failing voltage power supply used with new instrumentation installed in the control room. 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. In summary, the number and type of scrams were: Electronic Noise (13), Overly Conservative Trip Setting (6), On-line N-16 Calibration (2), Jostled Pool Height Sensor (1), Area Rad. Monitor Module Failure (1), Truck Door Seal (1)

F. MAJOR MAINTENANCE

No major maintenance was performed during the reporting period. Minor maintenance was performed to replace the aforementioned malfunctioning voltage power supply.

G. FACILITY CHANGES RELATED TO 10CFR50.59

The most recent control room upgrade project completed the upgrade of reactor instrumentation and control systems that began in 1999. This last phase of the I&C upgrades focused on the refurbishment of the 27 yr old reactor start-up and control drive system. The upgrade consisted of:

- Five new drive motors
- New position encoders and limit switches
- Modular I/O for drive-specific control and information display
- Replacement of a malfunctioning, vacuum tube-based, regulating blade servo control system

Commercially available, reliable, and economic control technology was chosen to replace the old electro-mechanical switches and relays with a new drive control system (DCS). This system is similar to upgrades provided for the area radiation monitoring control system and process controls system now being used. The system was designed to maintain the same functionality as described in the UMLRR FSAR, while offering improvements. The major differences are the digital conditioning of signals and software-based logic on some functions. These changes have been reviewed under the provisions of 10CFR 50.59 to evaluate the effects and potential effects on the design bases of the reactor. The evaluation concluded the DCS upgrade does not require Technical Specifications revision and meets the criteria specified in 10 CFR 50.59. The DCS has been documented and thoroughly tested. All affected instrumentation was calibrated using existing procedures, modified as necessary. Procedures that required revisions were reviewed according to UMLRR administrative guidelines.

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, 2002 to June 30, 2003.

The Radiation Safety Office has performed an ALARA review for the 2002 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 (10 mrem per year) with no detectable activity was released through the UML Research Reactor sewer system. The reactor stack release for 2002 was significantly lower than in previous years. This was attributed to low reactor usage (4.3 MWD) and did not take into account the removal of three reactor beamports, which would result in further lowering the estimated Argon-41 production.

Effluents from the reactor stack are collected onto a glass fiber filter and analyzed for deposited activity on a weekly basis. The assistant radiation safety officer (ARSO) collects filter samples, analyzes the samples using a gas flow proportional counter, records the results, and reports the data to the RSO. Typical Minimum Detectable Activity (MDA) achievable is roughly 1 x 10^{-13} μCi/ml. The procedure for air effluent analysis is documented in RxHp-3 Offsite Radiation Monitoring. This work instruction was updated on December 4, 2002 and includes an action level of $2x10^{-11}$ μCi/ml to initiate a gamma spectroscopic analysis of the filter sample in addition to alerting the RSO or UMLRR Director. The $2x10^{-11}$ μCi/ml limit was chosen to be one-tenth the value of the effluent concentration control limit cited in 10CFR20, Appendix B for Cesium-137, a prevalent isotope released in the event of a fission product release. No calibration information was found for the Pinanski roof air pump; therefore the ARSO calibrated the pump in August 2002. In November 2002, the pump seized and was replaced. The new pump was calibrated prior to use. Documentation of the pump calibrations (along with a NIST certificate for the calibrator) is on file with the ARSO. As per the request of the RSO, the ARSO submitted a memo (May 5, 2003) containing the procedures used to calibrate the air pump, his measured data for the calibration, and a copy of the Certification of NIST Traceability for the DryCal DC-Lite primary flow standard.

In September of 2002 upon the present RSO's advice, the ARSO installed a flow indicator in-line with the Pinanski room air sampling system. This indicator will be used to verify air flow through the filter and to track air flow changes over time.

An audit of the UML effluent monitoring program was performed on September 11, 2002. From this audit, a number of improvements were made and documented in a memo written on September 11, 2002 and updated as RxHp-3: Offsite Radiation Monitoring Work Instruction (note that the RxHp-3 tag was later added to the procedure on May 5, 2003 to indicate that this work instruction is a reactor related work instruction). The memo verifies the effectiveness of the present sampling analysis system and estimates the systems minimum detectable activity concentration.

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 January 2002 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. The reactor radiation monitoring system uses a data logger to maintain all stack effluent data.

I. RADIATION EXPOSURES AND FACILITY SURVEYS

2002 ALARA Data

OCCUPATIONAL EXPOSURES

GROUP	NUMBER	MAXIMUM	GOAL
	BADGED	DOSE	
Reactor	19	128	*≤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 20 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 2002, one worker received an annual whole body dose of 128 mrem due to his work preparing the Medical Embedment for its eventual transformation into the ELDRS low dose gamma irradiation facility. All other reactor personnel received an annual whole body dose less than 40 mrem for the 2002 calendar year. 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. On October 11, 2002, the reactor radiological survey form was modified to better identify area radiation survey points, contamination survey points, radiation area postings, and contaminated area postings. In addition, the new survey forms contain information on reactor waste storage and maintenance, radiation source storage, contamination control, personnel dosimetry, area radiological controls, and worker postings. 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. 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

2002 ALARA Data

ENVIRONMENTAL RELEASES

SOURCE	ACTIVITY	DOSE	GOAL
	mCi	mrem	mrem
Sewer Releases	**<1.0**	**<1**	**≤10**
Stack Releases	**3.5 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 2002 ALARA review noted that the estimated site boundary Ar-41 dose to the public in 2002 was below 0.1 mrem for the year. This estimate is based on the EPA COMPLY Code run at the 4^{th} (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