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UMASS Lowell

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RADIATION LABORATORY

50-223

August 30, 2001

U.S. Nuclear Regulatory Commission
ATTN: Mr. Marvin Mendonca, REXB
Mail Stop 012-D3
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

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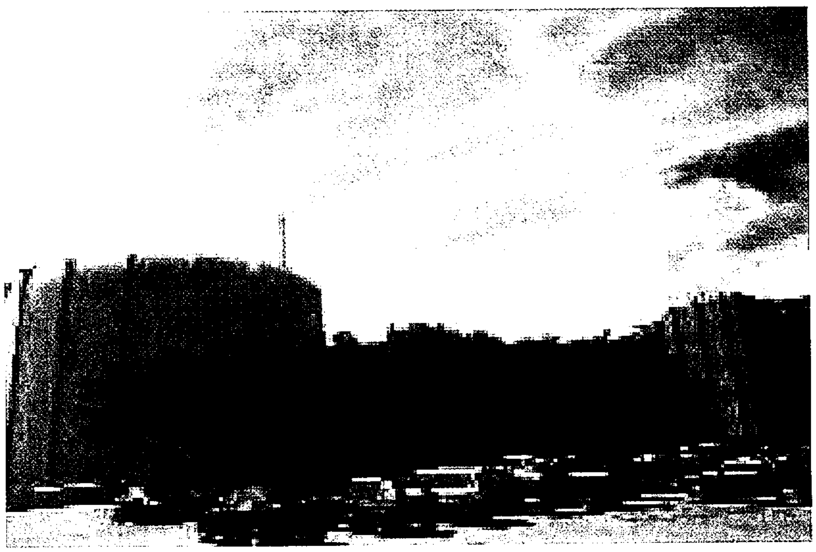
University of Massachusetts Lowell Research Reactor (UMLRR)



1999-2000 OPERATING REPORT

NRC Docket No. 50-223

NRC License No. R-125

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CONTENTS

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.

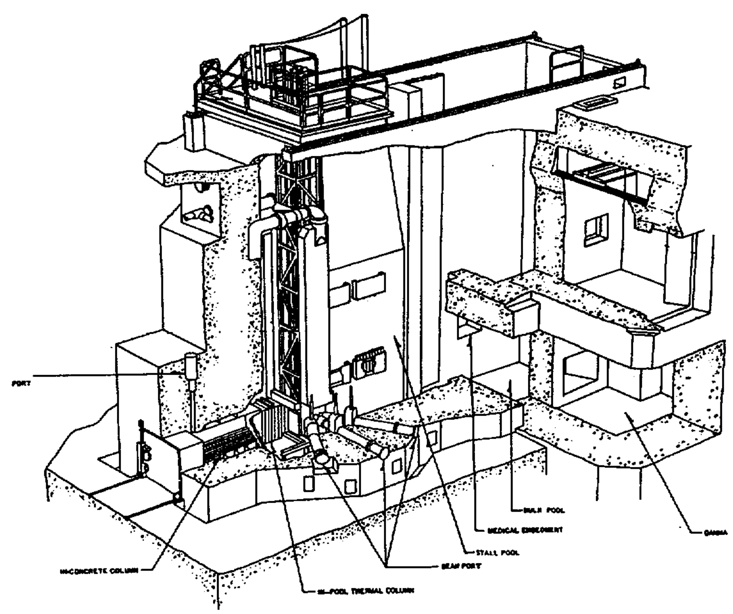
The name of the Nuclear Center was officially changed to the "Pinanski Building" in the spring of 1980. The purpose was to reflect the change in emphasis of work at the center from strictly nuclear studies. At that time, the University of Lowell Reactor became part of a newly established Radiation Laboratory.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

Research

The UMLRR has participated in neutron activation analysis for quality assurance testing of medical radiation oncology devices for brachytherapy treatment of prostate cancer, and arterial stents used to prevent restenosis (reclosure of the artery) after angioplasty. Specialized radioisotopes were produced for several medical research projects. 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. 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

In addition, the summer Reactor Operations and Systems Experience (ROSE) program was provided again 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

Three major facility changes have occurred during the reporting period. The reactor was converted from HEU fuel to LEU fuel in August 2000. The conversion required a change to the UMLRR License Technical Specifications approved by the Nuclear Regulatory Commission in 1997. A full report of the LEU fuel conversion was submitted to NRC in April 2001.

In January 2001, the process of removing three beam-tubes on one side of the reactor core was undertaken. Under a contract with Intersil Corporation (now Fairchild Semiconductor) a fast neutron irradiation facility was designed, constructed, and installed at the location of the removed beam-tubes. The change was made under the provision of 10CFR 50.59 and is further described in Section G of this report.

In March of 2001, the reactor control room process control cabinet (described in the UMLRR FSAR) was removed and the process of installing computer-based process control upgrade was undertaken. Under a grant from the Department of Energy, the upgraded process controls system was designed and installed using the same digital control technology applied to the area radiation monitoring system upgrade made in 1999. The change was made under the provision of 10CFR 50.59 and is further described in Section G of this report.

As of the end of this reporting period, both facility changes are ongoing, resulting in the reactor having not operated in several months.

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. Several draft revisions are ongoing for various operations, calibration, and surveillance procedures related to the facility changes. These will be reviewed and approved in accordance with UMLRR administrative procedures when all changes are complete.

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.

6. Staff Changes

The Chief Reactor Operator (CRO) and a full-time senior reactor operator (SRO) were released during the reporting period. A new full-time CRO and a full-time operator trainee have been hired. As of June 30, the reactor staff consists of two full-time SROs and two part-time SROs. In addition, one full-time non-staff Asst.-Professor and teaching-assistant graduate student are maintaining SRO licenses. Remaining staff consists of part-time undergraduate and graduate student assistants.

7. Operations Summary

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

HEU Operating Hours		LEU Operating Hours	
Critical hours	37.78	Critical hours	123.96
Full power hours	30.35	Full power hours	83.37
Megawatt hours	30.91	Megawatt hours	87.05
Total Hours		**Utilization (HEU and LEU)**	
Critical hours	161.74	Sample hours	146.22
Full power hours	113.72	Samples	85
Megawatt hours	117.96	Training hours	70.46

D. ENERGY GENERATED

HEU

Total energy generated (MWD)	1.26
Total cumulative energy output (MWD)	288.23

LEU

Total energy generated (MWD)	3.63
Total cumulative energy output (MWD)	3.63

E. INADVERTENT AND EMERGENCY SHUTDOWNS

There were 8 inadvertent shutdowns. One occurred due to a faulty airlock interlock. Two occurred due to brief utility electrical power losses. Two occurred due to automatic period scrams during control blade calibration procedures at low power (<10kW). Two shutdowns occurred from start-up counter malfunctions. One shutdown occurred from control blade disengagement from a faulty drive mechanism.

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

F. MAJOR MAINTENANCE

During the process of removing three beam tubes and installing the fast neutron irradiator, a repair of the pool liner in the stall-pool section of the reactor pool was undertaken. This section of the reactor pool has been leaking for several years. The leaking had progressed to a level of several gallons per hour. Water from the leak would accumulate mainly in the sub-basement of the reactor containment building, where it would be pumped to the waste sump for eventual disposal. The repair involved the use of a nuclear-grade Kevlar enhanced epoxy coating (BioDur 561). The coating was applied by UMLRR staff to selected areas of the stall pool liner. These areas included weld seams along the pool floor, around the beam tube flanges, around the thermal column support footings, and on several areas of visually observed pitting. After re-filling the stall pool, no further evidence of leaking has been observed for several months. The sub-basement is checked monthly as part of a routine surveillance activity.

Several minor maintenance activities included: clean-up demineralizer pump shaft bearing and seal replacement, a drive mechanism ball-nut replacement, ventilation valve solenoid and quick release valve replacement, start-up counter connector and seal replacement, and pool divider gate seal replacement.

G. FACILITY CHANGES RELATED TO 10CFR50.59

LEU Fuel

An NRC order to affect the conversion of the UMLRR reactor core to low-enrichment uranium (LEU) fuel was issued on July 31, 1997. The conversion to LEU fuel prompted the review and approval of safety analyses by the NRC, with the subsequent change to the UMLRR License Technical Specifications. With Department of Energy funding for fuel manufacture and UMLRR support, the LEU conversion process began in August 2000 and was completed several weeks later.

Fast Neutron Irradiator (FNI)

A new ex-core irradiator required removal of the three existing beam tubes on one side of the reactor core. The beam tube removal provided about 3 ft of working space between the pool liner and the side of the core box. Within this space, a large support structure (Fig.1) was positioned to house most of the elements associated with the FNI (sample holder, shield blocks, and flux shaping filter). The support structure is configured as an 11x9 grid with a 3.06" square center-to-center spacing. A 10 CFR50.59 safety evaluation reviewed the effects and potential effects on the design bases of the reactor as a result of removing three beam tubes adjacent to the reactor and installing the fast neutron irradiation (FNI) facility next to the core. The evaluation concluded the installation and operation of the FNI does not require Technical Specifications revision and meets the criteria specified in 10 CFR 50.59.

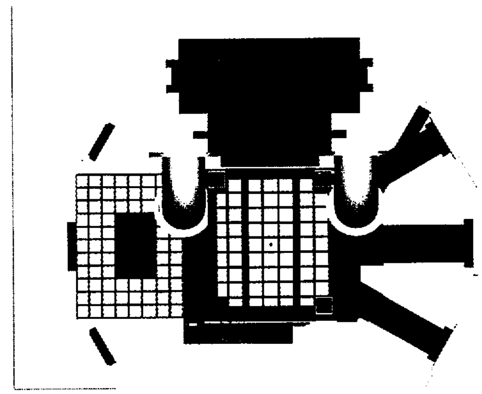


Fig. 1 Top view of UMLRR with FNI grid present on left side of core grid.

Process Control Cabinet Upgrade

The original UMLRR process control cabinet (PCC) served as an assembly point for the location of a core flow indicator, fourteen motor pushbutton indicating controls, primary and secondary cooling system flow square root converters, a power supply, a ventilation valve position indicator panel, and two circuit breakers.

Manual control of reactor cooling systems, water conditioning systems, containment building ventilation system, and the monitoring of these systems was accomplished via the PCC located in the control room. The PCC also housed chart recorders for the primary and secondary system flow, three primary system temperature points, and three water conductivity points. Various chronic age-related failures and the difficulty of finding replacement parts initiated an upgrade for most of the PCC components.

Commercially available, reliable, and economic control technology was chosen to replace the old process control cabinet with a new process control system (PCS). This system is similar to an upgrade for the radiation monitoring control panel currently being used. The system analog and digital input and output devices are fully compatible with existing motor controls and sensing instruments used throughout the UMLRR. 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 PCS upgrade does not require Technical Specifications revision and meets the criteria specified in 10 CFR 50.59. The PCS has been fully documented. When complete, the system will be thoroughly tested and all affected instrumentation will be calibrated using existing procedures, modified as necessary. Procedures requiring revisions will be reviewed according to UMLRR administrative guidelines, as will the results of all tests, before normal operations resume.

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, 2000 to June 30, 2001.

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-one individuals were monitored by "Luxel" whole badges during the year. Selective employees were also monitored with TLD ring badges. Whole body dose equivalents for the 12 months ranged from less than one to 405 mrem. The annual ALARA goal established by the Radiation Safety Committee is less than 500 mrem per employee.

In February 2001, the installation of a fast neutron irradiator (Intersil Project) required the removal of three beam tubes. Over 80% of the annual person rems (0.1 of 1.3) was received during this project. ALARA goals for the project were met through careful planning and utilizing the pool water for shielding.

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.

The radiation levels in the vicinity of the beam tubes during their removal (Intersil Project) ranged from 100 mR/hr to 2 R/hr.

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.

There was one incident where contamination was tracked outside of controlled areas. This resulted from an unexpected leak from an oxidized thullium sample that was being irradiated. The contamination was restricted to the floor of the third level of the reactor. Personnel exposure were minimal.

K. NATURE AND AMOUNT OF RADIOACTIVE WASTES

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 3.2 mCi was released over the 12 month period. The principle isotopes released was H-3. Small amounts of activation products such as Co-60, Mn-54 and Zn-65 were also released.

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 2000	1.23
August 2000	.03
September 2000	.23
October 2000	1.24
November 2000	0.70
December 2000	0.93
January 2001	0.13
February 2001	-
March 2001	0.11
April 2001	-
May 2001	-
June 2001	-
TOTAL	4.6

This release represents a 12 month dose of 0.1 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.