OPERATING REPORT

FOR THE

UNIVERSITY OF LOWELL REACTOR

FOR THE PERIOD

JULY 1, 1978

TO

JUNE 30, 1979

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 institutions, 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 and offices were in use by 1970, and the Van de Graaff accelerator was put into service in that year. Reactor License R-125 was issued by the Nuclear Regulatory Commission on December 24, 1974 and initial criticality achieved January, 1975.

B. Function

The Nuclear Center is a major research focal point of the University. Last year alone, 45 publications* in learned journals or presentations at learned society meetings were the direct result of the Nuclear Center. More than 135 graduate students have used or are using the Center's services; the comparable number for the faculty is in excess of 27. Much research here is correlated with safety and efficiency in the nuclear and radiation industries, including public utilities, pharmaceuticals, medical applications, health effects, etc.; however, much research also is done by workers in other fields who use the unique facilities as analytical tools.

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*45 publications were produced during fiscal 1978 (July 1977 through June 1978). 1979 figures not available.

In addition, the Nuclear Center facilities are used in the course work of various departments of the University. The Nuclear Center also provides these services to other universities in the New England area, government agencies and, to a limited extent, industrial organizations in Massachusetts and the New England area.

C. Operating Experience

1. Staff Changes

Mr. Michael Evans was confirmed by the Board of Trustees as the Chief Reactor Operator in October, 1978. Three reactor operators have resigned and not been replaced. It is expected that two operators will be hired in the near future. Presently, there are four SRO and two RO licensed persons on site.

Dr. Leon Beghian continues to serve as the Director of the Nuclear Center.

2. Experiments

During the report period, the major uses of the reactor were for activation analysis, dosimetry studies and for teaching purposes.

Activation analysis techniques were used to study paint, toys, trees, vegetables, human hair and nails, drugs and cosmetics, geological rocks, resins, coal and charcoal, electronic components, and aerosol collecting filter paper.

The properties of aggregate recoil particles continues to be an active research area as is the efficacy of various filter media.

A major area of research this year has been in the area of neutron dosimetry and Nitrogen-16 dosimetry.

A large amount of reactor time was used in direct support of University courses. Foils and wires were irradiated for flux measurements, various isotopes were produced for activation analysis and other counting classes and labs. Control rod calibrations, an approach to critical, measurements of positive and negative periods and prompt drops, temperature coefficients and calorimetric measurements of power were included in a Reactor Operations course and students in Radiological Sciences measured radioactive effluents, did some foil activations and performed standard surveys.

3. Operations Summary

During the course of the year 1978-1979, the reactor was critical a total of 931 hours. The utilization is broken down as follows:

Operating Hours	931.5
Hours at scheduled power	712.5
Accumulated Megawatt hours	705.2
Experimental Utilization	
Sample Hours	804.3
Number of Irradiations	285
Number of hours for training	151.0

4. Changes in Facility Design

The thermal column graphite stringers were modified to accept foils on an axial plane.

Piping was added to the primary system (at the chemical addition standpipe) to facilitate diversion of a small percentage of flow through a chamber for N-16 dosimetry measurements.

A flow deflector was added to the primary coolant piping where the flow returns to the pool. This deflector reduces control blade flutter for more stable period channel indication. It also allows a more accurate measurement of the differential temperature across the core by preventing channeling of flow over the sensor.

The regulating rod drive brake assembly was redesigned. The original design was a simple spring assembly which needed constant re-adjustment due to wear and spring tension changes. The brake was replaced by a magnetic brake.

A holder was mounted on the reactor bridge to allow for the operational testing of neutron chambers.

The ΔT system was modified by installing an iron-constantan thermo couple in a permanent mount on the core outlet plenum.

5. Performance Characteristics

The reactor has performed well over the past year. A total of 19 scrams occurred during the year. Reasons:

(a)	Operator error	(2)
(b)	Linear Power Channel range switch	(2)
(c)	Loss of power	(1)
(d)	Low line voltage	(4)
(e)	Electronic noise (Safety Channel #2)	(8)
(f)	High flux scram - equipment malfunction	(1)
(g)	Electronic noise period channel	(1)

Radiation surveys at licensed power showed no adverse variation from expected levels, and no fission products were detected outside the reactor core.

The containment building ventilation system operated satisfactorily during this report period. The leak rate of the building was not observed (see procedure changes), Section C.6 below.

6. Changes in Operating Procedures

The Requalification Program was changed to reflect a passing grade of 70% and an examination frequency of two years. These changes were approved by Operator Licensing Branch of the NRC.

The Integrated Containment Leak Rate Test frequency was reduced to every two years after NRC approval of an amendment to our Technical Specifications.

RO-2 (Reloading the Core to a Known Configuration) was rewritten to allow movement of fuel with all blades fully inserted. SP-16 (Rod Drop and Drive Measurements) was amended to clarify the magnet current set points after surveillance testing.

7. Results of Surveillance Tests and Procedures

Surveillance tests and inspections were performed according to schedule. There were no abnormalities discovered which would violate the Technical Specifications or good practice. Furthermore, no trends indicating deterioration of components were seen.

D. Energy Generated

Energy Generated During Report Period (MWD)	Number of Hours Reactor was Critical	Total Cumulative Energy Output (MWD)
29.383	931.5	62.533

E. Emergency Shutdowns

There was one emergency shutdown during the report period due to high flux. A malfunction of the regulating rod brake assembly caused reactor power to increase until the reactor scrammed on a high flux. The brake assembly has been redesigned (See Section 4).

Other reactor scrams are listed in Section 5.

F. Major Maintenance

The Log Count Rate Amplifier in the Start-Up Channel was completely refurbished. All aged components-capacitors, resistors and tubes-were replaced.

One of the compensated ion chambers in a safety channel failed and was replaced with a Reuter-Stokes CIC.

The upper personnel airlock hydraulic motors were overhauled due to hydraulic fluid seal leakage. It is anticipated that this airlock hydraulic system will be completely replaced in the coming year.

G. Changes to the Facility under 10CFR 50.59

All facility changes to date do not pose an unreviewed safety question. The surveillance frequency for containment leak rate testing was reduced to biennial and has been approved by the NRC via license amendment. All procedural changes and changes which presented a situation not covered in the FSAR were submitted to the Reactor Safety Subcommittee for prior approval. All procedural changes have been listed in C.6. All other changes made throughout the year are listed under Changes in Facility Design or Major Maintenance.

H. Environmental Surveys

Surveys of the environs external to the reactor building have shown no increases in radiation levels or concentrations of radioactivity as a result of reactor operations.

Air particulate samples collected at continuously monitored sites have shown no reactor produced activities. Grab sampling of air downwind from the reactor has also shown no activity other than naturally occurring species.

Water samples collected from the Merrimack River upstream and downstream of the reactor location similarly have yielded no radioactivity associated with reactor operations.

While we have not found that film badges or limited numbers of TLD's have been useful in a routine program in environmental monitoring, we have recently instituted a TLD monitoring program in which we have assigned multiple dosimeters to five locations in the environment. The dosimeters are presently being retrieved on a relatively frequent basis (monthly to be extended to quarterly), but in the future will be left in the environment for from six months to one year. While these will not provide short term information, they are expected to provide reasonably accurate estimations of annual doses in the environment which can be compared against doses to control location dosimeters.

I. Radiation Exposures and Facility Surveys

1. Personnel Exposures

Personnel dose control efforts continue to attempt to maintain doses consistent with ALARA philosophy. The number of individuals involved in research, training, and education using the reactor has increased and the numbers receiving some response to radiation have also increased. Twenty-six individuals received measurable whole body penetrating doses; six were operations personnel, twelve were support personnel, and eight were experimenters. The highest quarterly dose received by an individual was about 50% of the 10CFR 20.101 allowed value. A dose summary is presented below.

Individual	Dose in Calendar Quarter (rem)			
	3rd quarter '78	4th quarter '78	1st quarter '79	2nd quarter '79
1. (Operative)	0.060	0.290	-	-
2. "	0.030	0.100	0.150	-
3. "	0.050	0.060	-	0.050
4. "	0.030	-	0.060	-
5. "	-	0.440	0.600	-
6. "	-	0.090	-	-
7. (Support)	-	-	0.040	-
8. "	-	0.040	0.050	-
9. "	-	0.050	-	0.030
10 "	0.050	-	-	-
11. "	0.100	0.290	0.040	-
12. "	0.040	-	-	-
13. "	0.030	-	-	-
14. "	0.060	-	0.050	-
15. "	-	0.050	-	-
16. "	-	0.030	-	-
17. "	-	0.040	-	-
18. "	-	0.030	-	-
19. (Experimenter)	0.040	-	-	-
20. "	0.160	0.100	-	-
21. "	0.020	-	-	-
22. "	-	0.040	-	-
23. "	-	0.020	0.120	0.150
24. "	-	-	0.070	-
25. "	-	-	0.050	-
26. "	-	-	0.030	-

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2. Radiation Surveys

Radiation levels measured in the reactor building have been typically less than 0.1 mrem hr^{-1} in general areas. A number of experiments have been conducted in which transient levels at specific locations have been in excess of 100 mrem hr^{-1}. 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.

3. Contamination Surveys

General area contamination has not been a problem in the reactor building. Contamination has expectedly occurred at specific locations where samples are handled and particular experiments have been in progress. Surface contamination levels have generally been less than 10^{-4} μCi/100 cm^2. Handling tools and other specific items have exhibited contamination up to about 10^{-2} μCi/100 cm^2. ^{24}Na is the most commonly encountered contaminant. Air sampling in the reactor building has identified no significant quantities of reactor produced airborne radioactivity.

J. Nature and Amount of Radioactive Wastes

1. Liquid Wastes

Following is a summary of radioactivity releases to the sanitary sewer during the reporting interval:

Date	Gross Beta Radioactivity Released (Ci)	Undiluted Gross Beta Activity Concentration (μCi/ml)	Diluted* Gross Beta Activity Concentration (μCi/ml) Daily	Monthly
9/6/78	9.38×10^{-6}	6.192×10^{-7}	3.290×10^{-8}	1.154×10^{-9}
10/17/78	6.35×10^{-6}	2.235×10^{-7}	2.126×10^{-8}	1.325×10^{-8}
10/26/78	1.049×10^{-4}	3.696×10^{-6}	3.729×10^{-7}	
12/11/78	1.022×10^{-4}	3.600×10^{-6}	3.425×10^{-7}	1.217×10^{-8}
1/10/79	3.097×10^{-4}	1.091×10^{-5}	1.038×10^{-6}	3.784×10^{-8}
1/18/79	8.129×10^{-6}	3.068×10^{-7}	2.919×10^{-8}	
2/1/79	7.952×10^{-6}	2.801×10^{-7}	2.665×10^{-8}	9.936×10^{-9}
2/21/79	6.745×10^{-5}	2.376×10^{-6}	2.260×10^{-7}	
4/6/79	7.015×10^{-5}	2.471×10^{-6}	2.351×10^{-7}	1.853×10^{-8}
4/19/79	8.050×10^{-5}	3.038×10^{-6}	2.890×10^{-7}	
5/16/79	3.865×10^{-4}	1.361×10^{-5}	1.295×10^{-6}	4.602×10^{-8}
6/7/79	4.875×10^{-4}	1.717×10^{-5}	1.633×10^{-6}	6.959×10^{-8}
6/25/79	7.819×10^{-5}	2.754×10^{-6}	2.620×10^{-7}	

*Diluted by daily flow of 2.7×10^{8} ml.

2. Gaseous Wastes

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

Total Activity Released (Curies)	Time Averaged Release Rate ($\mu Ci\ sec^{-1}$)	Time Averaged Release Concentration ($\mu Ci\ cm^{-3}$)	Saturation Quantity of ^{41}Ar in Total Environment Based on Time Averaged Release Rate (Curies)
55.875	1.772	2.504×10^{-7}	1.685×10^{-2}

3. Solid Wastes

Solid wastes, primarily paper, disposable clothing, and miscellaneous items have been packaged in appropriate containers but no off-site shipments have been made during the reporting period.