OPERATING STATISTICS
FISCAL YEAR JULY 1, 1977 THROUGH JUNE 30, 1978

Prepared by
A. Francis DiMeglio, Director

FEBRUARY, 1979

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STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

RHODE ISLAND ATOMIC ENERGY COMMISSION
Nuclear Science Center
South Ferry Road
Narragansett, R. I. 02882

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POOR ORIGINAL

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CHRONOLOGY POOR ORIGINAL

General Assembly establishes R.I. Atomic Energy Commission (Title 42, Chapter 27, General Laws)	January 26, 1955
General Assembly approves construction of research reactor (Chapter 142, Laws of 1958)	May 20, 1958
Electorate approves proposal to construct research reactor	November, 1958
RIAEC applies to U.S. Atomic Energy Commission for construction permit	December 21, 1961
USAEC grants construction permit	July 27, 1962
Groundbreaking for reactor facility	August 28, 1962
USAEC grants operating license	July 21, 1964
Reactor goes critical	July 28, 1964
Reactor operates at 1000 KW for first time	May 18, 1965
RIAEC applies to USAEC for license amendment permitting 2000 KW operation	July 27, 1967
Reactor operates at 2000 KW for first time	September 17, 1968
Contract to Architect-Engineer for laboratory wing addition	May, 1970
Laboratory wing completed	July, 1971
Two 12' x 60' trailers added	June, 1975

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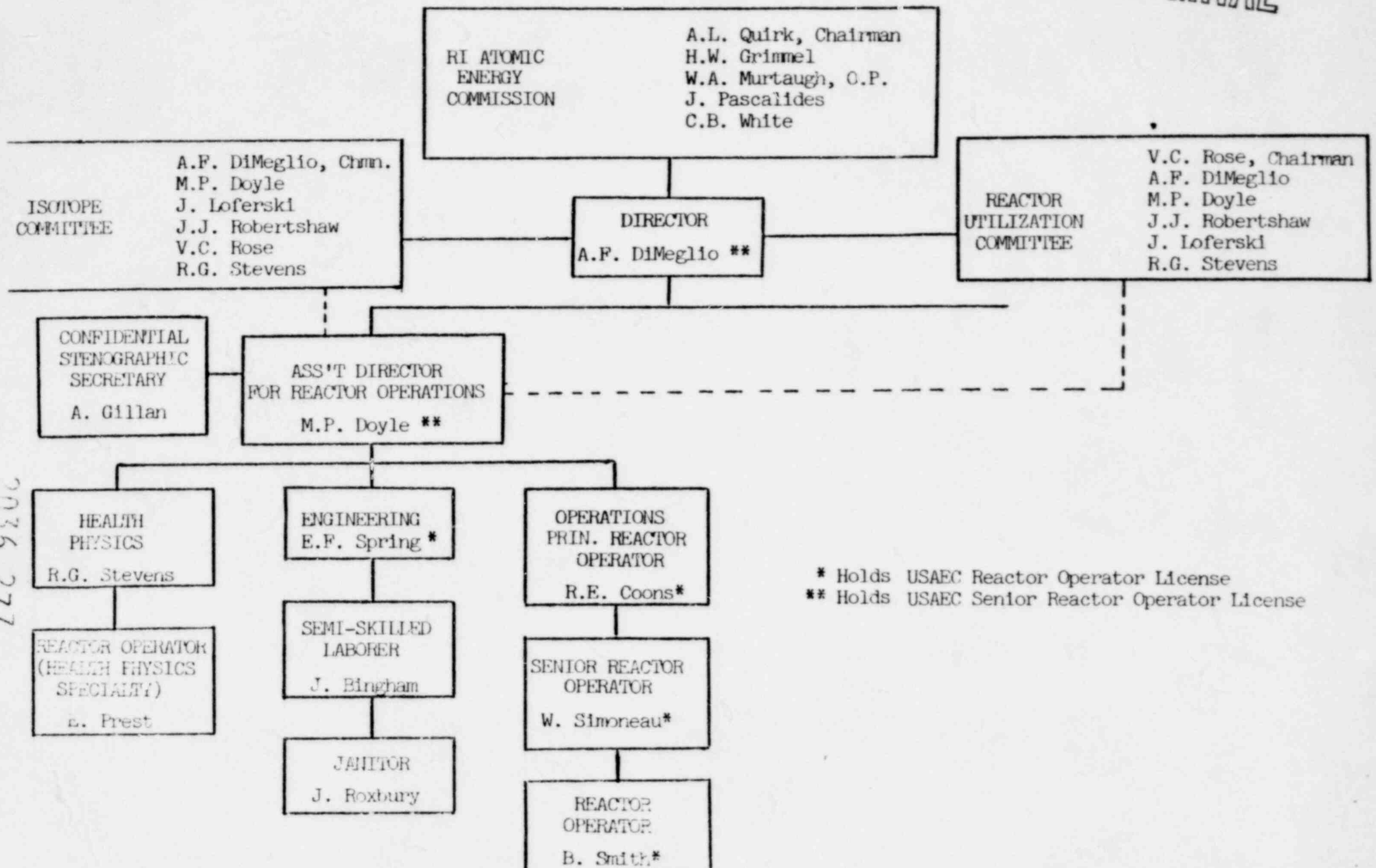

* Holds USAEC Reactor Operator License
** Holds USAEC Senior Reactor Operator License

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FUNCTIONS OF THE RIAEC AT THE

R.I. NUCLEAR SCIENCE CENTER

The function of the RINSC is to provide the following services to the universities, hospitals and, to a limited extent, industrial organizations in the State of Rhode Island.

1. Operate the reactor as required by the experimental program during or outside of regular working hours.
2. Provide neutrons for irradiation of samples.
3. Provide gamma rays for the irradiation of samples.
4. Provide neutrons at beam port facilities for spectrometry experiments.
5. Provide laboratory facilities for use with radioactive materials produced in the reactor.
6. Provide laboratory facilities for use with radioactive materials procured elsewhere.
7. New facilities.
8. Provide consulting for experimenters planning to utilize the reactor facilities.
9. Provide laboratory courses for students at colleges in Rhode Island requiring the reactor or specialized equipment associated with the reactor.
10. Provide facilities and guidance for graduate students performing thesis research.
11. Provide facilities for research by post-doctoral fellows and visiting scientists.
12. Provide tours and public information lectures for high school and college science classes and civic and professional groups.
13. Maintain reactor facility systems and procedures.
14. Perform studies concerning the improvement of existing facilities and establishment of new facilities required by experimenters.

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OPERATING STATISTICS FOR THE

RHODE ISLAND NUCLEAR SCIENCE CENTER

1. OPERATING TIME - The reactor has been operated during and outside of regular working hours to meet the needs of the experimental program. Most operation is at a nominal power level of 2000 kilowatts (KW). The average number of hours operated per week is shown in Figure 1. Further increases in weekly operating hours will require extended shift operation.

   Reactor operation outside of regular working hours is often required to meet the needs of experimenters. The number of hours the reactor operated other than Monday through Friday, 8:00 A.M. to 4:30 P.M. is shown in Figure 2. Only the hours the reactor actually ran are shown. Tours, maintenance, etc. outside of regular working hours are not shown.

   Figure 3 presents the total energy developed as a function of fiscal year. The product of power level in megawatts (MW) times operating hours is a measure of the availability of the reactor for research.

   The reactor is operated primarily to meet the needs of the experimental programs. Little reactor time is required for measurements on the reactor itself. The increase in average hours per week and megawatt hours in spite of the decrease in overtime implies improved reliability of reactor systems.

2. NEUTRON IRRADIATIONS - The number of neutron irradiations performed is shown in Figure 4. Beam port experiments are not included. The number of individual samples irradiated with neutrons is shown in Figure 5.

   Most of these irradiations are performed using two pneumatic transfer (rabbit) systems for sample insertion into and removal from the reactor. Since these two systems will soom limit expansion of experimental programs, a third automated irradiation system (discussed in Section 7) is being designed.

3. GAMMA RAY IRRADIATIONS - Gamma ray irradiations are performed using fuel elements from the reactor after reactor shutdown. Since the gamma ray intensity from fuel elements decreases with time after reactor shutdown, the elements must be returned to the reactor and operated at full power for continued irradiations. During the year, 8 irradiations with gamma rays were performed.

4. NEUTRONS AT BEAM PORTS - Neutrons which emerge from reactor beam ports during reactor operation are utilized in spectrometry experiments and in engineering experiments. The reactor system includes six radial beam ports and one through port with varying geometrical and neutron characteristics.

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Experiment 11 is at beam port L-2.

Experiment 82 is at beam port R-2 since FY1976.

Experiment 91 is being installed in the modified thermal column.

Experiment 94 is being performed at beam port R-1.

The total energy generated during beam port use is shown in Figure 6. The ordinate represents the product of MW-hrs generated during beam port use and the number of ports during the generation. The significant increase in beam port use is expected to continue since the URI Physics department has made a commitment to neutron spectroscopy research.

5. LABORATORY FACILITIES FOR USE WITH RADIOACTIVE MATERIALS PRODUCED IN THE REACTOR - Samples which are exposed to neutrons from the reactor become radioactive. To work with these radioactive materials, a USNRC by-product material license and special facilities are required. The RINSC by-product license is broad enough to include most materials produced. Laboratories have been constructed in the Science Center for chemically processing and counting of these radioactive materials. Much of the laboratory fixtures and furniture has been purchased by the users and deeded to the Science Center before installation.

   Major uses of laboratories & facilities include experiments 8, 24, 36, 43, 45, 49, 58, and 73.

   All of the space available for laboratories has been utilized. As discussed in Section 14, studies are underway to increase available space by using two more house trailers.

6. LABORATORY FACILITIES FOR USE WITH RADIOACTIVE MATERIALS PROCURED ELSEWHERE - Experimenters may require radioactive materials which are not produced in the reactor. Often the experiment cannot be performed at the experimenter's own laboratory because of lack of handling facilities and personnel trained in the use of the radioactive materials. These experimenters then request space, advice and specialized facilites from the RINSC.

   Major uses of laboratories & facilities include experiments 64, 68, 73, and 84.

7. NEW FACILITIES - URI installed a second clean lab at the Science Center for use by a URI scientist performing research at the Center.

   In order to accommodate experiment 91, the thermal column is being modified to incorporate a radial beam tube.

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The design of a computer controlled fast pneumatic irradiation facility is nearing completion. The system will be installed at a beam port during the next year.

The Center was required by the U. S. Nuclear Regulatory Commission to renew its license for the use of radioactive material. Since the original license application was made in 1963, considerable new information was provided to NRC.

8. CONSULTATIONS WITH EXPERIMENTERS - Before an experiment is performed at the RINSC, considerable time must be spent by the professional staff in providing specifications about the reactor, design assistance and review for radiological and nuclear safety. Direct assistance to experimenters has ranged from minor efforts such as temporary loan of equipment to activities of considerable magnitude. One example of the latter category is the work performed for hospitals where all but sample preparation is performed by RINSC personnel. Because of the expansion of experimental programs, considerable time is consumed by this function.

   The Science Center staff also plays a major role in the selection and purchase of equipment for experimenters. After delivery, the staff sets up, calibrates and operates the equipment for experimenters.

9. NUCLEAR EDUCATION & TRAINING COURSES - Schools in Rhode Island have utilized the reactor facility in their course work. This utilization has consisted of demonstrations of neutron activation analysis, lectures on nuclear power and lectures on the properties and uses of a research reactor and is shown in Figure 7.

10. GRADUATE THESIS RESEARCH - The advanced degrees awarded based on research performed at the RINSC are shown in Figure 8. Also shown are anticipated degrees for graduate students currently performing research.

11. POST-DOCTORAL FELLOWSHIP AND VISITING SCIENTISTS SUPPORT - Occassionally individuals associated themselves with universities for post-doctoral training in areas involving the reactor. The contribution of the RINSC has thus far consisted of office and laboratory space and use of irradiation facilities. Figure 9 presents a tabulation of post-doctoral fellows.

12. TOURS AND PUBLIC INFORMATION - Tours of the RINSC are permitted by eighth grade and above science classes and interested civic and professional groups. Three open houses in conjunction with URI open houses have been held. Tours have averaged about 2000 individuals per year. In addition, the Science Center has provided speakers to school, civic and professional organizations to discuss career opportunities and nuclear power.

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13. MAINTENANCE OF REACTOR FACILITY SYSTEMS AND PROCEDURES - Maintenance and improvements on the reactor system are necessary in order to operate reliably and to satisfy the requirements necessary to maintain our USAEC operating license R-95 and our by-product material license in good standing. In addition, operating and emergency procedures and radiological safety regulations must be reviewed and updated and records maintained to show compliance with these procedures. Review of these records is an important part of the frequent inspections by USNRC.

During FY78, the RUC met twice.

During the year, there were three inspections of operations by the U. S. Nuclear Regulatory Commission. These included general operations. The reactor operation was also audited by representatives of the University of Lowell Reactor. Although several recommendations were made, no areas of non-compliance were found.

14. STUDIES - In order to make the reactor facility suitable for use by increasing numbers of scientists, completion of existing facilities and construction of new facilities are required. The studies are performed by the Satff of RINSC and, since most systems are unique, include specialized design. In addition, staff members have participated in study groups concerning nuclear power in Rhode Island.

The projects pursued during the year and their status is as follows:

(1) Use of new design fuel elements in the reactor. This is required because there are no U.S. vendors of the alloy type fuel now used in the reactor. A reactor operations license amendment must be obtained from NRC before the new fuel is used.

(2) Conversion of the thermal column to a beam port. This project is continuing and will be completed during the coming year.

(3) Installation of two additional house trailers. This project is continuing and will be accomplished during the coming year.

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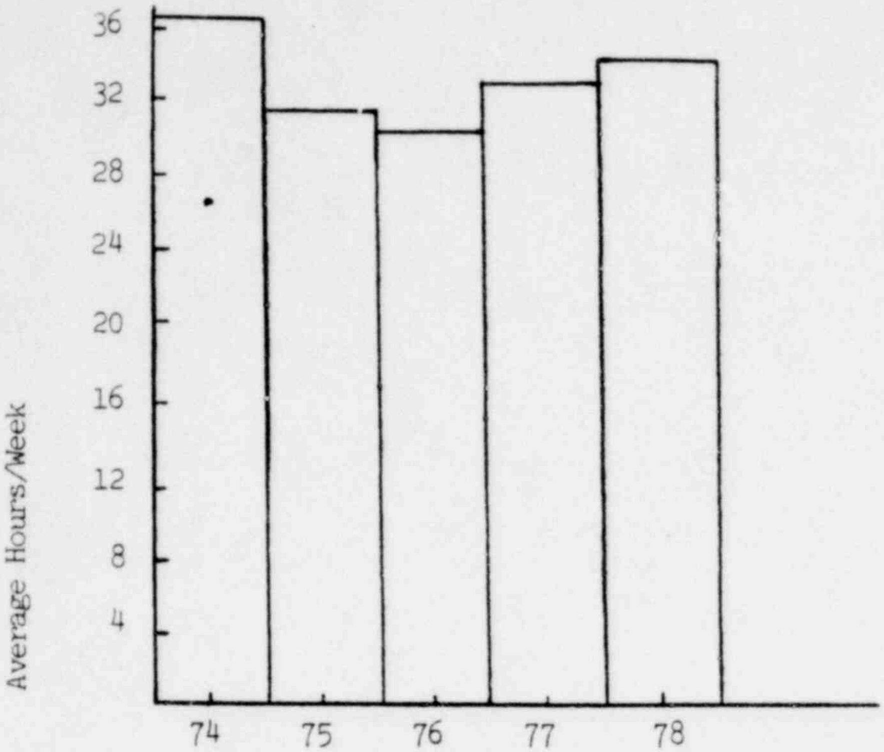
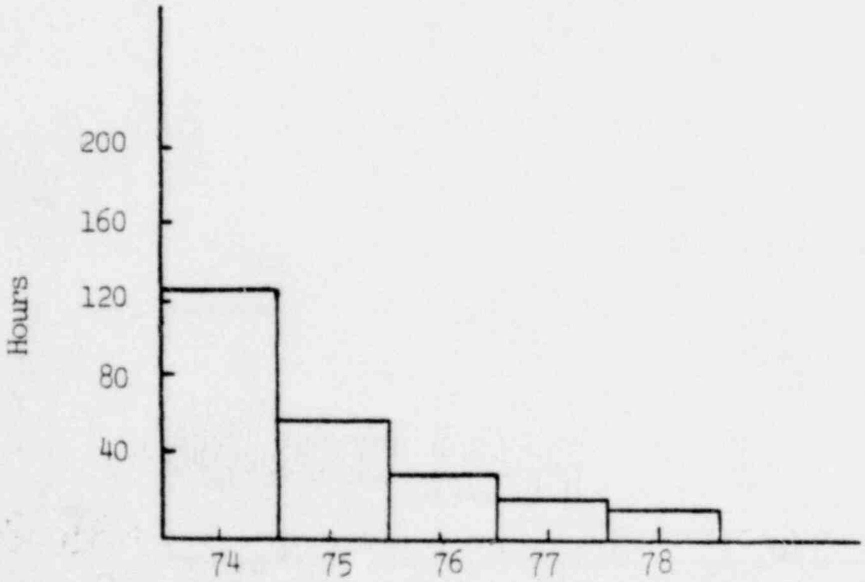


Fiscal Year

Figure 1. Average Hours Operated Per Week



Fiscal Year

Figure 2. Hours of Operation Outside of Regular Working Hours

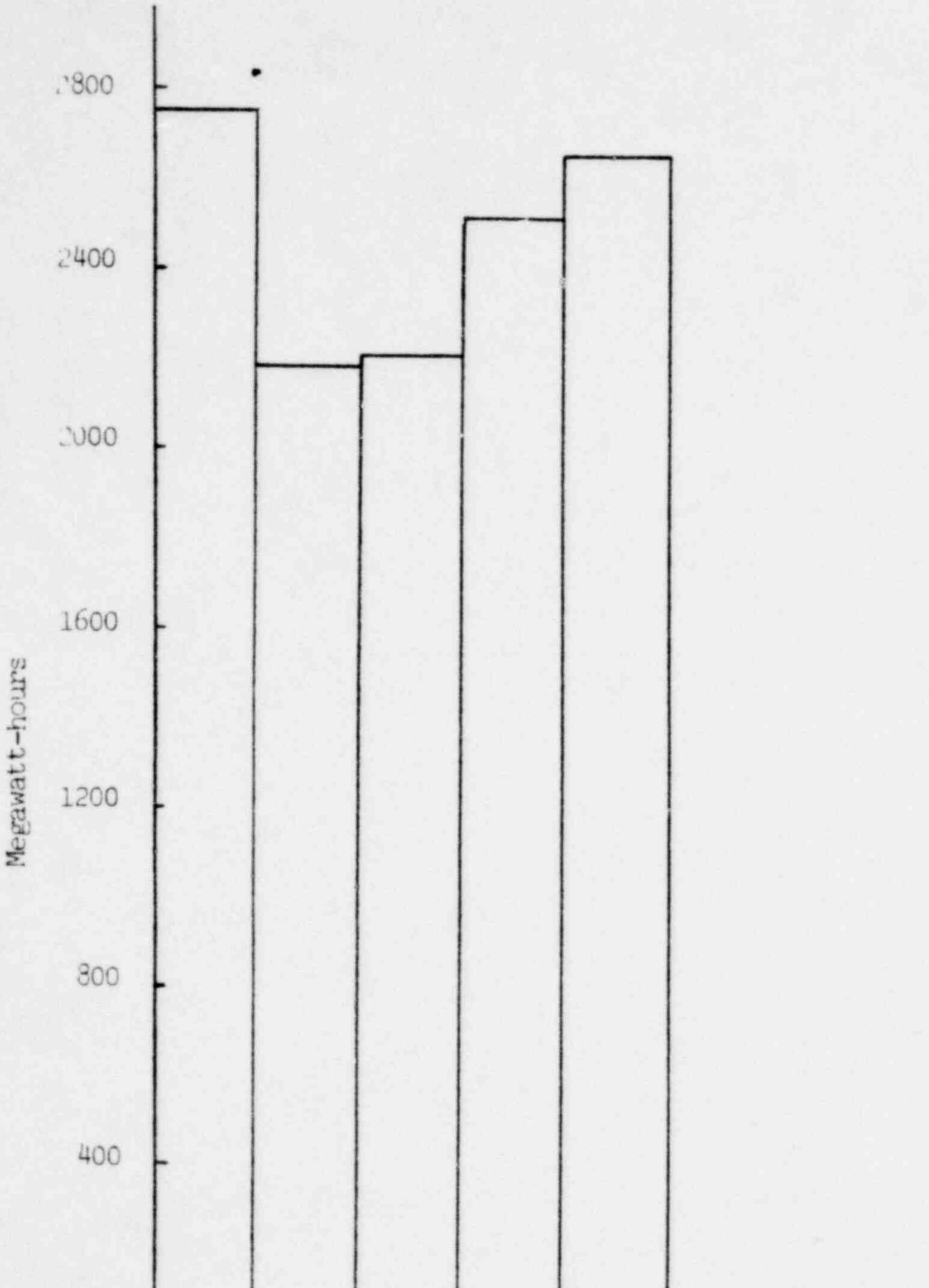


Figure 3. Total Power Generated

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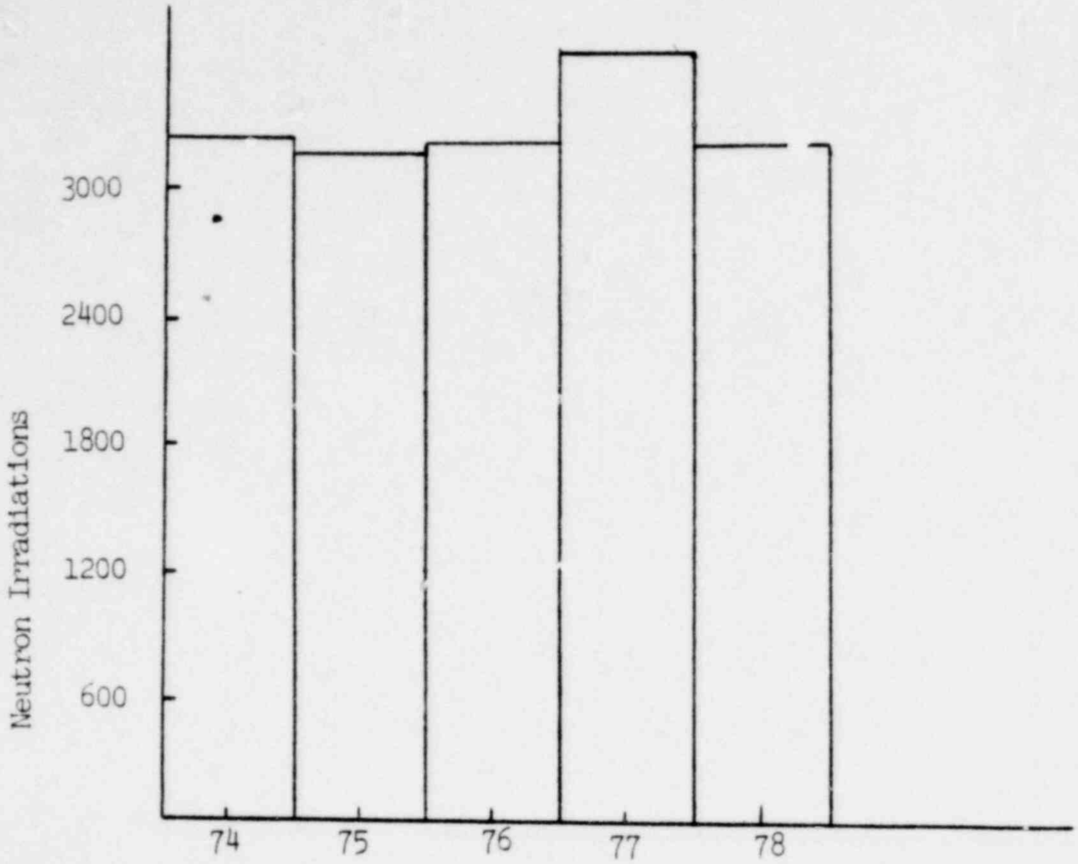
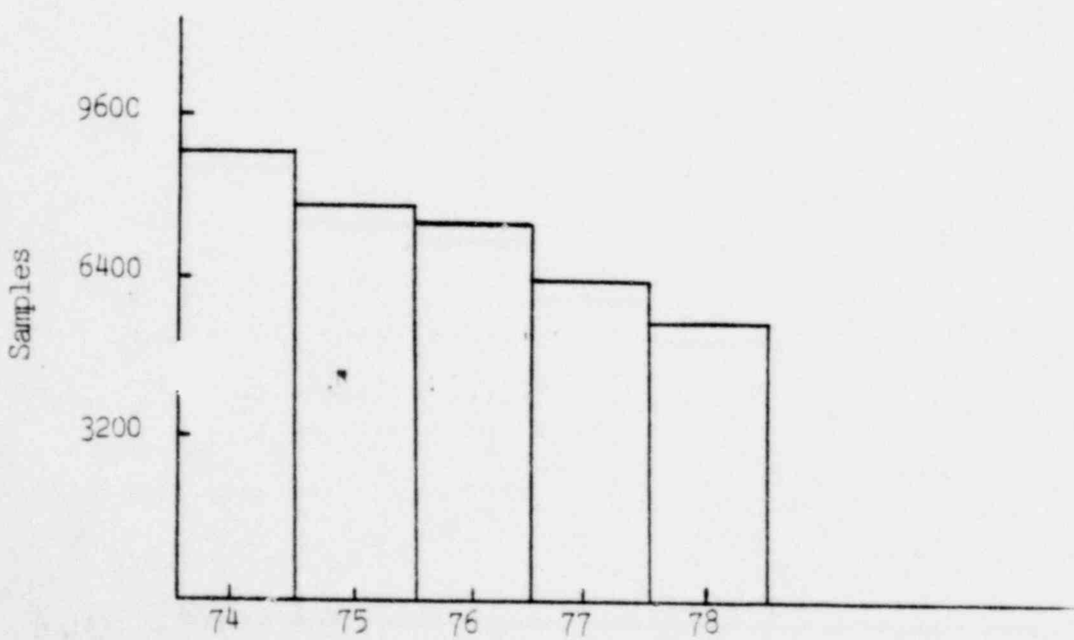


Fiscal Year

Figure 4. Neutron Irradiations



Fiscal Year

Figure 5. Samples Irradiated with Neutrons

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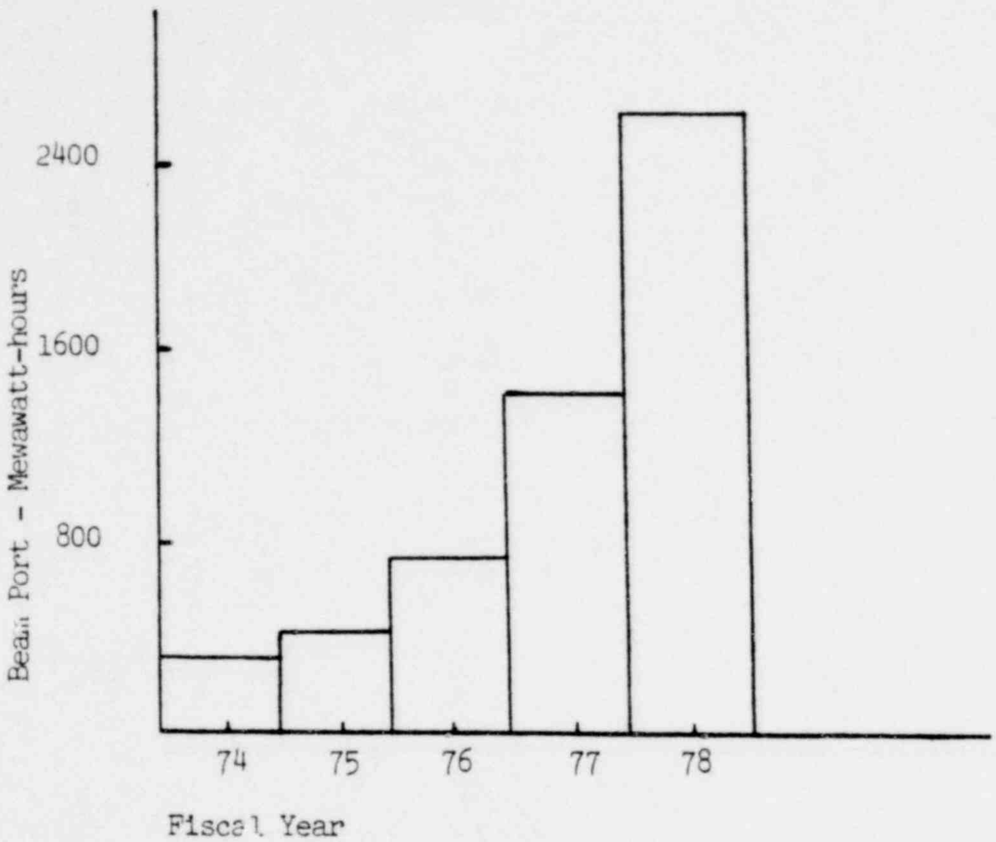

Figure 6. Beam Port Use

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FIGURE 7 - Use of Reactor Facility in Nuclear Education and Training Courses

INSTITUTION	DEPARTMENT	COURSE NO. & NAME	# STUDENTS
URI	Chemistry	191-General Chemistry	12
"	"	511-Advanced Anal. Chem.	10
"	"	518-Radiochemistry	10
"	"	615-Trace Analysis	10
"	"	616-Applied Instr. Methods	12
"	Nucl. Engr.	581-Intro. to Nucl. Engr.	16
"	" "	582-Health Physics	0
"	" "	583-Reactor Laboratory	0
"	Physics	120-Physics of the Energy Crisis	17
"	"	340-Modern Physics	25
"	"	341-Modern Physics	25
"	"	484-Physics Lab.	4
"	"	560-Neutron Physics	6
"	Oceanography	521-Chemical Oceanography	16
"	Food Sci. & Tech.	432-Biochem. of Food Process.	22
"	Animal Science	354-Genetics Lab.	12
Brown	Engineering	143-Experimental Methods in Materials Science	16
Brown/R. I. Hospital	Nuclear Medicine	1-Radiation & Life	8
"	" "	Medical Tech. Training	4
Prov. Col.	Biology	Ecology	10

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Figure 8 - ADVANCED DEGREES AWARDED

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Year - 1978

DEGREE	SCHOOL	DEPARTMENT	RECIPIENT	THESIS
Ph.D.	URI	Chemistry	Paul R. Walsh	Arsenic in the Atmosphere
Ph.D.	URI	Oceanography	Wm. F. Graham	Atmospheric Pathways of the Phosphorus Cycle
Ph.D.	URI	Oceanography	Martin R. Fish	Melting and Mineralogy of Ocean Basalts
Ph.D.	URI	Oceanography	Wm. M. White	Geochemistry of the Centrl North Atlantic
Ph.D.	URI	Biological Sciences	Thomas L. Doty	Laural Amphibian Population Dynamics
Ph.D.	URI	Chemistry	John P. Maney	Metal Analysis of Maternal-Fetal Blood System
M.S.	URI	Chemistry	Clifford P. Weisel	Cadmium & Lead Enrichments on Sea Salt Aerosol Above Narragansett Bay collected by the Bubble Interfacial Microlayer Sampler
M.S.	URI	Oceanography	Azhari F. Ahmed	Fluxes & Processes of Deposition of Atmospheric Sea Salt to the Earth's Surface
M.S.	URI	Zoology	Peter Samulsen	Investigation of the Home Range & Homing Behavior of the Red Bat Salamander-Plethodon cinereus

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FIGURE 8 - (Cont'd) ANTICIPATED ADVANCED DEGREES

YEAR	DEGREE	SCHOOL	DEPARTMENT	RECIPIENT
1979	Ph.D.	URI	Oceanography	T. Johnston
1980	Ph.D.	URI	Oceanography	B. Mosher
1978	Ph.D.	URI	Oceanography	R. Lorens
1978	Ph.D.	URI	Oceanography	P. N. Froelich
1978	M.S.	URI	Oceanography	E. Rowe
1979	M.S.	URI	Oceanography	D. Graham
1978	Ph.D.	URI	Physics	C. F. Majkrzak
1980	Ph.D.	URI	Oceanography	J. Devine
1979	Ph.D.	URI	Oceanography	G. Klinkhammer
1978	Ph.D.	Brown	Geological Sciences	T. S. Cross
1978	Ph.D.	MIT-WHOI	Oceanography	W. Gardner
1980	Ph.D.	URI	Physics	C. K. Saw
1980	Ph.D.	URI	Oceanography	E. Butler
1980	Ph.D.	URI	Oceanography	T. Fogg
1981	Ph.D.	MIT-WHOI	Oceanography	M. Kurz
1979	M.S.	URI	Electrical Engineering	R. Rao
1980	Ph.D.	URI	Electrical Engineering	A. Corey
1980	Ph.D.	URI	Chemistry	R. W. Heaton
1980	Ph.D.	URI	Chemistry	M. E. Hughes
1979	M.S.	URI	Chemistry	J. J. Przewocnik
1979	M.S.	URI	Chemistry	B. S. Martin
1979	M.S.	URI	Chemistry	J. C. Rossell
1980	Ph.D.	MIT-WHOI	Oceanography	R. Anderson

FIGURE 8 - (Cont'd) ANTICIPATED ADVANCED DEGREES

YEAR	DEGREE	SCHOOL	DEPARTMENT	RECIPIENT
1981	Ph.D.	URI	Physics	L. C. Lu
1980	Ph.D.	URI	Oceanography	C. Weisel
1978	Ph.D.	URI	Oceanography	R. Rivkin
1981	Ph.D.	URI	Physics	R. Stevens
1982	Ph.D.	URI	Chemistry	D. P. Stout

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FIGURE 9 - POST-DOCTORAL FELLOWSHIP SUPPORT

YEAR	INDIVIDUAL	UNIVERSITY	SPONSORING INSTITUTION	RESEARCH INTEREST
3-1977 to Present	C. K. Unni	URI Oceanography	NSF	Experiment #45
3-1977 to 12-'77	L. Schutz	URI Oceanography	ONR	Experiment #45
6-1977 to Present	R. McCaffrey	URI Oceanography	NSF	Experiment #45
7-1977 to Present	Y. P. Sharma	URI Physics	NSF	Experiment #82
5-1978 to Present	D. Heggie	URI Oceanography	NSF	Experiment #58

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EXPERIMENTS PERFORMED AT THE
RHODE ISLAND NUCLEAR SCIENCE CENTER

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COMPLETED EXPERIMENTS

No. 73, *Solubility of Iron in Sea Water as a Function of pH Using Barium-133*, D. Kester, URI, Oceanography

No. 79, *Production of Osmium Dysprosium and Europian Isotopes. Also, Irradiation of Blood Samples*, D. Hnatowich, MIT, Nuclear Engineering

No. 90, *Determination of elemental composition of T Cuprodurans by neutron activation analysis*, G. Jones, Univ. of New Hampshire, Microbiology

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EXPERIMENTS PERFORMED AT THE
RHODE ISLAND NUCLEAR SCIENCE CENTER

CONTINUING EXPERIMENTS

No. 8, *Experiments and Irradiations in Support of Reactor Operations Including Neutron and Gamma Ray Fluxes and Activation Analysis*, A. F. DiMeglio and M.P. Doyle, R. I. Nuclear Science Center

No. 11, *Study of Thermal Energy of Various Metals by Measuring the Number of Neutrons, As a Function of Energy, Scattered from the Sample*, S. S. Malik and J. S. Desjardins, URI, Physics

No. 12, *Observation of Sex Chromosone Mutations in Fruit Flies Subjected to Gamma Irradiation*, L. T. Smith, URI, Agric. Chemistry

No. 13, *Irradiation of Bacon as a Demonstration of Food Pasturization by Radiation*, K. L. Simpson and A. G. Rand, URI, Agric. Chemistry

No. 24, *Activation Analysis of Rock Samples to Quantitatively Determine the Rare Earth Content*, J. G. Schilling, URI, Oceanography

No. 36, *Activation Analysis of Marine Samples*, D. K. Phelps, P. J. Riesenfeld, National Marine Water Quality Laboratory, EPA

No. 43, *Production of Isotope Tracers Such as Ta-182 to Study Salamander Orientation, Activation Analysis of Marine Samples, Gamma Irradiation of Amphibians*, C. R. Shoop, URI, Zoology

No. 45, *Activation Analysis Studies of Geochemical Cycle of Halogens between Ocean and Atmosphere. Also, Activation Analysis Studies on Global Transport of Air Pollution Material*, R. Duce, Oceanography, URI

No. 46, *Neutron and Gamma Irradiation of Alkali-Halides in Glow Curve Spectrophotometry Studies*, A. Choudry, URI, Physics

No. 49, *Activation Analysis of Trace Element Components of Cardiovascular System*, J. L. Fasching, URI, Chemistry

No. 58, *Activation Analysis Studies of Fossil Coral, Basalts and River Sediments*, M. Bender, URI, Oceanography

No. 71, *Irradiation of Human Extracted Teeth*, R. S. Manley, Westwood Research Laboratory, Inc.

No. 76, *Calcium Metabolism in Patients Using Activation Analysis Techniques*, R. Neer, Mass. General Hospital

No. 78, *Neutron Activation Analysis of Seawater particulate Samples, Standards and NBS Coal Fly Ash Standards*, P. Brewer, WHOI

No. 82, *Neutron Spectroscopy Using Beam Port R-2*, S. Pickart, URI, Physics

No. 83, *Thorium partitioning in sedements*, R. Heath, URI, Oceanography

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No. 84, *Investigation of influx & efflux characteristics of materials in the dinaflagellate Phrocystis noctilura*, E. Swift, URI, Oceanography

No. 85, *Uptake studies of material in marine ecosystems*, P. Santshi, Lamont Doherty Geological Observatory of Columbia University

No. 86, *Uptake studies of Algae*, T. Smayda, URI, Oceanography

No. 87, *Activation Analysis Determinations of trace elements in human tissue*, T. Kneip, New York University Environmental Medical Center

No. 88, *Gamma Irradiation of Dodium borated glass*, P. J. Bray, Brown, Physics

No. 89, *Efficiency Study of APDC-Cobalt Coprecipitation using radio traces*, D. Kester, URI, Oceanography

No. 91, *Spin density destribution and stochiometry of colloidal magnetic particles by means of low angle scattering of polarized neutrons*, A. J. Nunes, URI, Physics

No. 92, *Activation Analysis of halogens in atmosphere*, J. Moyers, Univ. of Arizona

No. 93, *Activation analysis studies of oceanic particulates*, J. Edmond, MIT-Woods Hole, Earth and Planetary Sciences

No. 94, *Neutron damage investigation of optical fibers*, S. S. Mitra, URI, Electrical Engineering

No. 95, *Irradiation of human enamel dental material*, S. A. Mundorff, Eastman Dental Center, Rochester, N. Y.

No. 96, *NAA of stratospheric samples*, W. W. Berg, National Center for Atmospheric Research, Boulder, Colorado

No. 97, *Sterilization of soil samples with γ rays*, L. Englander, Agriculture, URI

No. 98, *Cross section measurements of C*, S. Dockmen, Physics, Univ. of Pennsylvania

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APPENDIX A

ENVIRONMENTAL CONSIDERATIONS

The discharges from the R. I. Nuclear Science Center consist of heat, radioactive solids, liquids and gases.

1. Heat - A research reactor is operated for the neutrons and gamma rays it produces. The heat must be disposed of as a waste product. At present, the power level of the reactor is 2000 kilowatts. Heat disposal is through closed cycle evaporative cooling of water by the atmosphere in a cooling tower using recirculating tap water. The only effect on the environment is a small increase in the humidity and temperature of the air in the vicinity of the cooling tower. For some atmospheric conditions a visible water vapor plume is formed.

2. Radioactive Solids - All radioactive solid waste generated by the reactor and the research programs is collected into waste disposal drums and transferred to a commercial waste disposal firm licensed by the U. S. Nuclear Regulatory Commission. This firm disposes of the material in a USNRC licensed land burial site. During FY 1978, 88.2 cubic feet of material containing about 68 millicuries of activity was transferred for disposal.

3. Radioactive Liquids - All radioactive liquids drain into holding tanks from which the liquids may be discharged to the Narragansett Bay Campus laboratory waste treatment plant after determination of radioactivity content and pH. The total radioactivity released during FY 1978 was 3.4 millicuries. Averaged over the discharge time, the concentration is 8.16×10^{-6} microcuries/milliliter; averaged over the year, the concentration is 4.1×10^{-8} microcuries/milliliter which was 0.006% of the maximum permissible concentration.

4. Radioactive Gases - During operation of the reactor, radioactive gases are produced and disposed of (after monitoring) through a 115 foot stack. The principle gas is radioactive Argon-41 which has a 1.8 hour half life. Fission gases such as iodine, zenon, krypton and tritium have never been detected in the stack effluent. The average Argon-41 concentrations off site in FY 1978 was 1.96×10^{-9} uCi/cc or 4.9% of the maximum permissible concentration.

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