MIT RESEARCH REACTOR

ANNUAL REPORT

TO

UNITED STATES NUCLEAR REGULATORY COMMISSION

FOR THE PERIOD JULY 1, 1979 - JUNE 30, 1980

BY

REACTOR STAFF

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Introduction

This report has been prepared by the staff of the Massachusetts Institute of Technology Research Reactor for submission to the Director of Region 1, United States Nuclear Regulatory Commission, Office of Inspection and Enforcement, in compliance with the requirements of the Technical Specifications to Facility Operating License No. R-37 (Docket No. 50-20), Paragraph 7.13.5, which requires an annual report following the 30th of June of each year.

The MIT Research Reactor (MITR), as originally constructed, consisted of a core of MTR-type fuel, fully enriched in uranium -235 and cooled and moderated by heavy water in a four-foot diameter core tank, surrounded by a graphite reflector. After initial criticality on July 21, 1958, the first year was devoted to startup experiments, calibration and a gradual rise to one megawatt, the initially licensed maximum power. Routine three-shift operation (Monday-Friday) commenced in July 1959. The authorized power level was increased to two megawatts in 1962 and five megawatts (the design power level) in 1965.

Studies of an improved design were first undertaken in 1967. The concept which was finally adopted consisted of a more compact core, cooled by light water, and surrounded laterally and at the bottom by a heavy water reflector. It is undermoderated for the purpose of maximizing the peak of thermal neutrons in the heavy water at the ends of the beam port re-entrant thimbles and for enhancement of the neutron flux, particularly the fast component, at in-core irradiation facilities. The core is hexagonal in shape, 15 inches across, and utilizes fuel elements which are rhomboidal in cross section and which contain U Al_x intermetallic fuel in the form of plates clad in aluminum and fully enriched in uranium-235. Much of the original facility, e.g. graphite reflector, biological shield, cooling system, containment, etc., has been retained.

After Construction Permit No. CPRR-118 was issued by the former U. S. Atomic Energy Commission in April 1973, major components for the modified reactor were procured and the MITR-I was shut down on May 24, 1974, having logged 250,445 megawatt hours during nearly 16 years of operation.

The old core tank, associated piping, top shielding, control rods and drives, and some experimental facilities were disassembled, removed and subsequently replaced with new equipment. After preoperational tests were conducted on all systems, the U. S. Nuclear Regulatory Commission issued Amendment No. 10 to Facility Operating License No. R-37 on July 23, 1975. After initial criticality for MITR-II on August 14th 1975 and several months of startup testing, power was raised to 2.5 MW in December. Routine 5 MW operation was achieved in December 1976.

This is the fifth annual report required by the Technical Specifications, and it covers the period July 1, 1979 through June 30, 1980. Previous reports, along with the "MITR-II Startup Report" (Report No. MITNE-198, February 14, 1977) have covered the startup testing period and the transition to relatively routine reactor operation. This report covers the third full year of routine reactor operation at the 5 MW licensed power level. It was a year in which the safety and reliability of reactor operation fully met the requirements of reactor users. A summary of operating experience and other activities and related statistical data are provided in the following Sections A - H of this report.

A. SUMMARY OF OPERATING EXPERIENCE

1. General

During the period covered by this report (July 1, 1979 - June 30, 1980), the MIT Research Reactor, MITR-II, was operated on a routine, four days per week schedule, normally at a nominal 5 MW. It was the third full year of normal operation.

The reactor averaged 83.1 hours per week at full power compared to 79.8 hours per week for the previous year. During a week when there is no holiday, major maintenance, long experiment changes, waste shipping, etc., the reactor is at power for 90 - 95 hours.

In the second half of FY79 (i.e. MIT's fiscal year, July through June), operating hours were curtailed somewhat as a measure to conserve fuel when the fuel fabricator's delivery schedule began slipping badly. At the beginning of FY80, the fuel re-order appeared much more certain, and so operating hours were again increased. Also, the change from a 24 to a 25 element core (mentioned below) added sufficient reactivity so that greater burnup (an element average of about 40%) than planned became possible and stretched out the existing fuel supply.

In August 1979 the reactor reverted to the earlier Monday-Friday operating schedule, with maintenance scheduled for Mondays and, as necessary, for Saturdays.

The reactor was operated throughout the year with either 24 or 25 elements in the core. The remaining two positions were occupied either by irradiation facilities or by solid aluminum dummy elements. Compensation for reactivity lost due to burnup was achieved for the first four months of the year by replacing many of the relatively fresh B-Ring elements with moderately spent fuel and, in the process, converting from a 24 to a 25 element core. Compensation for reactivity lost due to burnup was achieved during the last eight months of the year by making five refuelings in which the relatively fresh elements originally removed from the B-Ring were gradually reinserted. Elements being removed from the B-Ring during these refuelings were used to replace C-Ring elements that were approaching the end of their useful life. In addition, there were two refuelings involving fresh fuel. The first involved introducing three of the more highly-loaded elements (nominally 510g. U-235 as described in Section A.3 of this report) to the B-Ring while the second entailed insertion of the last of the original MITR-II elements (445g. U-235) into the A-Ring.

There were four other fuel shuffles. One in August 1979 reinserted fuel that had been removed during a search for an element with faulty cladding. The other three were temporary core configurations used only to obtain axial flux scan data. None was operated at more than 500 watts for more than an hour.

Protective system surveillance tests are conducted on Friday evenings after shutdown (about 1800), on Mondays, and on Saturdays as necessary.

As in FY78, the reactor was operated throughout the period without the fixed hafnium absorbers, which were designed to achieve a maximum peaking of the thermal neutron flux in the heavy water reflector beneath the core. These had been removed in November 1976 in order to gain the reactivity necessary to support more in-core facilities.

2. Experiments

The MITR-II was used throughout the year for experiments and irradiations in support of research and training programs at MIT and elsewhere.

Experiments and irradiations of the following types were conducted:

a) Neutron diffraction spectrometer alignment and studies (4 ports).

b) Molecular dynamics studies with an inelastic scattering spectrometer.

c) Dosimetry measurements of the neutron beam in the medical therapy facility in preparation for animal studies.

d) Dosimetry measurements for pneumatic rabbits and other irradiation facilities.

e) Irradiations of biological, geological, oceanographic, and medical specimens for neutron activation analysis purposes.

f) Activation of ablation monitor wires for re-entry vehicles.

g) Production of phosphorus-32, gold-198, and dysprosium-165.

h) Irradiation of tissue specimens on particle track detectors for plutonium radiobiology, of steel for boron location, and of geological samples for fissile element distribution.

i) Use of the facility in reactor operator training.

j) Irradiation damage studies of candidate fusion reactor materials.

k) Studies of fatigue failure as a function of surface bombardment and bulk irradiation damage.

l) Components of a safeguards system of interest to the Arms Control and Disarmament Agency for monitoring the security of reactors and special nuclear materials were installed in various parts of the reactor facility and tested.

m) Plans were initiated for recording the output of control and process channels from the MIT Reactor as part of a study leading to analysis of power reactor signals by computer.

3. Changes to Facility Design

As indicated in last year's report the uranium loading of MITR-II fuel is being increased from 29.7 grams of U-235 per plate and 445 grams per element to 34 and 510 grams respectively. The new loading results in 41.2 w/o U in the core, based on 7% voids, and corresponds to the maximum loading in Advanced Test Reactor (ATR) fuel. The fuel fabricator, Atomics International Division of Rockwell International, completed the production of 25 of the more highly loaded elements in December. Three of the first four shipped have been in operation in the core since January of this year. The remaining 21 are in storage at AI and will be shipped to MIT as needed over the next two years.

One of the containment building hot cells described in last year's report was completed during the year and placed in operation. Two remote manipulators have been added. The cell has been used principally for examining and handling the capsules used in the above - mentioned fatigue failure studies. The second cell should be completed during the coming year.

Other changes in the facility are reported in Section E.

4. Changes in Performance Characteristics

Performance characteristics for the MITR-II were reported in the "MITR-II Startup Report", and no significant changes have occurred since that time.

5. Changes in Operating Procedures Related to Safety

There were no amendments to Facility Operating License No. R-37 or to the Technical Specifications during the year. MIT's letter of March 13, 1980 to USNRC's Office of Nuclear Reactor Regulation requested a license amendment that would authorize the receipt, possession and use of byproduct materials activated in reactors other than the MITR.

With respect to operating procedures, a summary of those related to safety is given below:

a) A revision to the equipment tag-out procedure (Procedure Manual 1.14.3), initiated during the prior year, was instituted during FY1980 (Safety Review #0-78-24). A tag-out status board has been added to the procedure.

b) A formal procedure (PM 7.4.4.2) for the inservice inspection of the primary core tank and fuel, initiated during the prior year, was instituted during FY1980 (SR # 0-78-27).

c) Procedure PM 3.10.1, which had been written in the prior year for sectioning and disposal of the old MITR-I core tank, was used for the above purposes in FY1980 (SR #0-79-1). The core tank and other waste were shipped to Barnwell, So. Carolina in October 1979, using Chem-Nuclear Systems, Inc., cask #LL-50-100.

d) Procedure PM 7.4.5.1 was written to provide an in-house method for calibrating the gas meter used in the annual containment building leakage test.

e) Procedure PM 1.22 for reporting defects under 10CFR21 was revised (1) to incorporate a 10CFR21 change regarding "commercial grade items" and (2) to extend coverage of the procedure to special nuclear material held under MIT licenses other than Facility License No. R-37.

f) The "Emergency Plans for the MIT Reactor", SAR Appendix 13.A.1, and implementing procedures in Section 4 of the Procedure Manual were updated (SR #0-79-13, #0-79-15, #0-80-11 and #0-80-18). There were no substantive changes. As noted in Section E, Appendix 13.A.1 was submitted to NRC as SAR Revision No. 19 in March 1980.

g) Procedure PM 3.11.4 was prepared to provide a written procedure for removal, inspection and re-insertion of an experiment capsule installed in one of the in-core irradiation positions (SR #0-79-14).

h) Procedure PM 6.1.5.2 was prepared to provide a written procedure for testing of the Campus-Patrol radio-telephone patch by which reactor personnel can communicate directly with the Campus Patrol cruiser (SR #0-79-16).

i) Procedure PM 3.11.3 was prepared to provide a written procedure for verifying the operability of several alarms associated with an in-core experiment prior to operation of the experiment (SR #0-79-18).

j) Chapter 1 of the Procedure Manual, Administrative Procedures, was updated in many areas, i.e. organization, charts, security, supervisor duties, circulation of safety reviews, log maintenance, protective clothing requirements, potential dose rate changes, refueling procedure requirements, audits, review and approval of preoperational tests, and miscellaneous other changes (SR #0-79-23, -35, -36, #0-80-6 and 0-80-15).

k) A set of procedures for Procedure Manual Section PM 3.12 was prepared to establish limitations and guidelines for use of the two hot cells installed in the containment building (SR #0-79-24).

l) Procedure PM 2.6.7 was prepared in response to NRC Region #1 Immediate Action Letter 79-14 for the purpose of instituting a new procedure designed to achieve compliance with radiation protection procedures and to provide a method for documenting violations and corrective actions (SR #0-79-25).

m) A one-time procedure was written and used to demonstrate that the fuel transfer flask lifting mechanism has an adequate safety factor (SR #0-79-26).

n) Procedure PM 7.5.1 was prepared to provide a written procedure and a better record of ion chamber and fission chamber replacements (SR #0-79-28).

o) Procedure PM 7.5.2 was prepared to provide instructions for preventive maintenance on Leeds and Northrup indicating instruments and to provide a record of such maintenance (SR #0-79-29).

p) Procedure PM 6.5.16.2 was revised to insure that neutron shadowing effects are avoided during calibration of shim blades against the regulating rod and against each other (SR #0-79-30).

q) Procedure PM 3.10.2 was prepared to provide a written procedure for the sectioning and disposal of radioactive rubble from the MITR-I modification (SR #0-79-31). The rubble was shipped to Barnwell, So. Carolina in November 1979 using Chem-Nuclear Systems Inc. cask #LL-50-100.

r) Procedure PM 6.5.16.1 for calibration of the regulating rod was revised to document the worth of the rod in comparison with the Technical Specification requirements and to provide an improved data sheet (SR #0-79-32).

s) Procedures PM 6.5.6.2 and 6.5.6.3 for the calibration of system pressure gages were revised by adding to each procedure the specific list of gages to which each applies (SR #0-80-1).

t) Procedures PM 1.16.2 and 1.16.3 established extensive checklists for documenting the training programs for operators and for senior operator/shift supervisors (SR #0-80-3 and #0-80-20).

u) Procedure PM 1.16.1 was revised to require that licensed personnel who score less than 80% in any category of the annual examination will undergo retraining in that category (SR #0-80-5).

v) A general review was made of startup and shutdown checklists in Chapter 3 of the Procedure Manual. Except as noted in (w) (x) below the changes made were not substantive and not related to safety, although the general improvement in the checklists should increase safety (SR #0-80-14).

w) Procedure PM 3.2.4 was prepared to provide a written procedure for responding to alarms received at Campus Patrol Headquarters from the reactor when the containment building is secured (generally over weekends). It contains cautionary steps related to potential radiation and fire hazards, provides for systematic checks, and specifies the steps for properly securing the building after responding to an alarm (SR #0-80-14). In order to reduce the number of weekend nuisance alarms, the system was modified to initiate alarms only for a number of selected conditions for which a prompt response was judged to be desirable, such as high core tank temperature, low core tank level, high radiation, smoke, etc. (SR #E-79-7).

x) Procedure PM 3.3.1 and PM 3.3.1.1 supersede previous checklists used for refueling and other fuel handling. The procedures are not changed, but some checklists have been combined to avoid duplication, and a number of cautionary checks have been added (SR #0-80-14).

y) Miscellaneous minor changes to operating procedures and equipment were approved and implemented throughout the year.

6. Surveillance Tests and Inspections

There are many written procedures in use for surveillance tests and inspections required by the Technical Specifications. These procedures provide a detailed method for conducting each test or inspection and specify an acceptance criterion which must be met in order for the equipment or system to comply with the requirements of the Technical Specifications. The tests and inspections are scheduled throughout the year with a frequency at least equal to that required by the Technical Specifications. Twenty-three such tests and calibrations are conducted on an annual, semi-annual or quarterly basis.

Other surveillance tests are done each time before startup of the reactor if shut down for more than 16 hours, before startup if a channel has been repaired or de-energized, and at least monthly; a few are on different schedules. Procedures for such surveillance are incorporated into daily or weekly startup, shutdown or other checklists.

During the reporting period, the surveillance frequency has been at least equal to that required by the Technical Specifications.

The results of tests and inspections required by the Technical Specifications have been satisfactory with one exception (Reportable Occurrence # 50-20/80-1); NRC was notified in accordance with Technical Specification 7.13 in this case. Conditions having safety implications were found as the result of other tests and inspections and were likewise reported to NRC (Reportable Occurrences # 50-20/79-5 and #50-20/80-2).

B. Reactor Operation

Information on energy generated and on reactor operating hours is tabulated below:

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total
1. Energy Generated (MWD):					
a) MITR-II (MIT FY80) (normally at 4.9 MW)	213.5	208.5	232.8	210.5	865.3
b) MITR-II (MIT FY76-79)					2,552.6
c) MITR-I (MIT FY59-74)					10,435.2
d) Cumulative, MITR-I & MITR-II					13,853.1
2. Hours of Operation, MIT FY1980, MITR-II					
a) At Power (>0.5 MW) for research	1106.6	1033.2	1137.5	1044.7	4,322.0
b) Low Power (<0.5 MW) for training (1) and test	50.2	87.0	19.8	27.3	184.3
c) Total critical	1156.8	1120.2	1157.3	1072.0	4,506.3

Note: (1): These hours do not include training conducted while the reactor is at full power for research purposes (spectrometer, etc.) or for isotope production. Such hours are included in previous line.

C. Shutdown and Scrams

During the period of this report there were 30 inadvertent scrams, and 20 unscheduled power reductions or shutdowns.

The term "scram" refers to shutting down of the reactor through protective system action when the reactor is at power or at least critical, while the term "reduction" or "shutdown" refers to an unscheduled power reduction or shutdown to subcritical by the reactor operator in response to an abnormal condition indication. Rod drops without protective system action are included in shutdowns.

The following summary of scrams and shutdowns is provided in approximately the same format as last year in order to facilitate a comparison.

		Total
I.	Nuclear Safety System	
a)	Period channels during normal startup, resulting from electrical noise.	6
b)	Electric Company Power Dips.	1
c)	Level channel tripped on high level due to trip being set slightly under 5 MW (should be about 5.5 MW)	2
d)	Electronic component failure (coaxial cable)	3
e)	Operator error in deactivating or switching channels	2
f)	Technician error in doing maintenance	4
g)	Failure of a chamber (Channel #5)	5
	Subtotal	23
II.	Process Systems	
a)	Low flow secondary coolant due to trip of one secondary pump breaker on thermal overload	1
b)	Low pressure primary system indication due to improper valve line-up in secondary system. (Primary system was functioning properly; caused by momentary pressure pulse transmitted by Lamella heat exchanger).	1
c)	High temperature primary system due to trip being set too low	1
d)	High temperature primary system due to electronic noise on recorder	2
e)	Operator action after misreading an alarm signal	1

		Total
f)	Low flow primary coolant due to trip of one primary coolant pump circuit breaker on overload. (This may have been due to a transient ground on one phase of the externally-supplied electric power.)	1
	Subtotal	7

III. Other Scrams or Unscheduled Shutdowns

a)	Operator shutdown by "All Rods In" to investigate	
	i) D_2O system conductivity	1
	ii) Improper or lack of response of a period or level channel	5
	iii) D_2O flow recorder malfunction	1
	iv) Loss of helium supply to an irradiation thimble	1
	v) Loss of ventilation due to loss of externally-supplied steam	1
	vi) Railroad tank car accident in adjacent town (leakage of hazardous chemical)	1
	vii) Blade drops due to blade magnet failure	2
	viii) Binding of a shim blade due to a small piece of foreign material in the blade's slot or guide tube (Reportable Occurrence #50-20/80-2)	1
	ix) Flow/ΔT recorder	1
b)	Operator lowered power to 500 Kw to investigate spike on core purge monitor	1
c)	Operator lowered power to 2.5 MW to:	
	i) Investigate thermal overload on regulating rod breaker	1
	ii) Investigate partial run-in on blades 5 and 6 caused by technician error	1
	iii) Temporary loss of cooling tower fans due to faulty vibration switches.	3
	Subtotal	20
	Total	50

A study of the above list reveals that only four scrams or shutdowns are attributable to external causes (off-site power dip or ground, building steam loss, railroad accident). Twelve were the direct result of personnel actions (wrong instrument settings, inadvertent circuit interference during at-power maintenance, wrong valve line-up, insufficient cleanliness). Twenty-five were instrumentation or cabling failures. To a significant degree, scrams and shutdowns of the types in the last two categories are within the control of reactor personnel. Efforts are being made to reduce the frequency through continued instrument upgrading, preventive maintenance, and improved procedures and practices.

D. Major Maintenance

Major maintenance projects during FY80, including the effect, if any, on safe operation of the reactor, are described in this section.

1) A program to upgrade instrumentation was continued during FY80. Because of excessive maintenance and obsolescence on older units, some of which had been in use since the initial operation and for which it is increasingly difficult to obtain spare parts, several components were replaced with new units having equivalent or improved characteristics. These included a new radiation monitor multi-point recorder, a simulated level generator for testing and calibrating level channels, solid-state count rate amplifiers and scalers for the startup channels, and process system instrumentation. Several coaxial cables for neutron chambers were replaced. The preventive maintenance program has been revised and extended to provide increased reliability of the instrumentation systems.

2) Two shipments of radioactive components from the MITR-I reactor were made during the year. The first shipment disposed of the old MITR-I core tank in Chem-Nuclear Systems, Inc., No. LL-50-100 cask. Samples of the core tank were retained for possible studies of radiation damage effects in aluminum. The second shipment, using the same cask, contained assorted rubble from dismantling of MITR-I. A third and final shipment is required, but many delays in obtaining a burial allocation at Barnwell, S. C., and use of the shipping container resulted in postponement of the third shipment until FY81.

3) Further work was done on gaskets related to the reactor containment building. The rubber gasket on the exhaust auxiliary damper was replaced after signs of wear were noted. It was shown by inspection and test to provide the necessary seal. The gasket on the outer door of the truck lock, which had been replaced in April 1979, did not provide an adequate seal during the April 1980 building pressure test (Reportable Occurrence # 50-20/80-1). It was found to be more difficult to make a good seal at all points with the harder rubber installed in 1979 than with the softer rubber that had previously been used. A new gasket of the original type has now been procured. It will be installed and tested shortly. Meanwhile building integrity is maintained by the inner door.

4) The containment building heating and air conditioning system was overhauled and partially rebuilt. New pneumatically-operated temperature and humidity controls were installed to replace the original electrically-operated controls. This involved a 10CFR50.59 change, which is described under Section E.

5) Two of the six electro-magnets that couple control blades to the drive mechanisms failed during the year and had to be replaced.

6) After the heavy water system conductivity meter began to require extensive recalibration and maintenance, it was replaced with a new Bechman meter similar to the one on the primary system.

7) Many other routine maintenance and preventive maintenance jobs were done throughout the year.

E. Section 50.59 Changes, Test and Experiments

This section contains a description of each change to the facility or procedures and of the conduct of tests and experiments carried out under the conditions of Section 50.59 of 10 CFR 50, together with a summary of the safety evaluation in each case.

The review and approval of changes in the facility and in the procedures as described in the SAR are documented in the MITR records by means of "Safety Review Forms". These have been paraphrased for this report and are identified on the following pages for ready reference if further information should be required with regard to any item. Pertinent pages in the SAR have been or are being revised to reflect these changes, and they will be forwarded to the Chief, Standardization and Special Projects Branch, Division of Licensing, USNRC.

The conduct of tests and experiments on the reactor are documented in the experiments and irradiations files. During FY 1980 all experiments have been done in accordance with the descriptions provided in Section 10 of the SAR, "Experimental Facilities".

1. SR #E-79-5 (4/27/79)

Startup Channel Modifications

Startup Channels #1 and #2 were modernized by replacing vacuum tubes with solid state circuits as part of the program to upgrade instrumentation described in Section D-1. As part of the change, an ion chamber was added to Channel #1 to provide period indication and scram in the power range, making it the same as Channel #2. This will normally provide a third period channel in the power range and will provide backup in the event that either of the other two fail. The SAR description for Channel #1 (Subsection 7.1.1.2.1) will be changed accordingly in a subsequent SAR revision.

Reactor Staff approval 10/5/79

2. SR #0-79-13 (6/8/79)

Update of Emergency Plan and Procedures

Appendix 13.A.1 of the SAR contains the "Emergency Plans for the MIT Reactor". Implementing procedures are in Section 4 of the MITR Procedure Manual. The plans were updated in several respects; none are substantive.

Reactor Staff approval 8/1/79
MIT Reactor Safeguards Committee approval 11/21/79

Revisions to Appendix 13.A.1 were submitted to NRC as SAR Revision No. 19 in a letter dated 3/12/80.

3. SR #E-80-1 (6/5/80)

Primary Flow Backup Scram

A direct reading of primary flow is provided by the new flow-ΔT recorder, which obtains its reading from a new D/P cell that was installed across an orifice in the primary coolant supply line when the new recorder was acquired. The original D/P cell, used with the same orifice for the previous recorder, now provides a signal for an optical meter that has been calibrated to ± 5 GPM. When switched into the withdraw permit circuit, it causes a scram on either low flow or loss of power to the instrument.

The optical meter scram switch is wired in parallel with the recorder scram switch, and either can be selected by means of a two-position key switch. The optical meter has been used to provide backup flow indication in the control room but not to function as one of the safety channels required by Technical Specification 3.7-1, pending further review and experience with its performance. Before its use as a required safety channel, the startup checklists and test and calibration procedures will be revised to provide the surveillance and calibrations required by Technical Specifications 4.3-1b and 4.3-2c. SAR Fig. 7.3a2 will be changed as indicated above in a subsequent SAR revision.

Reactor Staff approval 6/6/80

4. SR #M-80-2 (4/10/80)

Containment Penetrations for Air Conditioning System

During overhaul of the containment building air conditioning system the controls were changed from electrical to pneumatic. This required three additional penetrations for 1/4" O.D. instrument air lines. Criterion 56 of Appendix A, 10CFR50, for penetrations that connect directly to the containment atmosphere allows special provisions for specific classes of lines, such as instrument lines. The lines are open to the containment atmosphere through two 0.020" diameter orifices, and thus they are similar to the instrument lines described on SAR pages 16.17a and b, except that each line is equipped with a manual isolation valve just outside the containment. The lines comply with the recommendations of Regulatory Guide 1.11.

Reactor Staff approval 4/10/80

F. Environmental Surveys

Environmental surveys, outside the facility, were performed using area monitors. The systems (located approximately in a 1/4 mile radius from the reactor site) consist of calibrated G.M. detectors with associated electronics and recorders.

The detectable radiation levels due to Argon-41 are listed below:

Site		July 1, 1979 - June 30, 1980
North		1.7 mR
South		1.2 mR
East		3.8 mR
West		2.3 mR
Green (East)		0.5 mR
	Average	1.9 mR

Fiscal Year	Average Level (mR)	Energy Generated (MWD)
1977	1.7	702
1978	1.9	941
1979	1.5	818
1980	1.9	865

G. Radiation Exposures and Surveys Within the Facility

A summary of radiation exposures received by facility personnel and experimenters is given below:

Whole Body Exposure Range (Rems)	Period 7/01/79 - 6/30/80 No. of Personnel
No Measurable	44
Measurable - Exposure Less than 0.1	42
0.1 - 0.25	4
0.25 - 0.5	11
0.5 - 0.75	6
0.75 - 1.0	4
1.0 - 2.0	3
TOTAL	114

Summary of the results of radiation and contamination surveys from July 1979 to June 1980:

During the 1979-1980 period, the Reactor Radiation Protection Office continued to provide radiation protection services necessary for full power (5 megawatts) operation of the reactor. Such services (performed on a daily, weekly, or monthly schedule) include the following:

1. Collection and analysis of air samples taken within the reactor containment shell, and in the exhaust ventilation system.
2. Collection and analysis of water samples taken from the reactor cooling towers, D_2O system, waste storage tanks, shield coolant, heat exchangers, fuel storage facility, and the primary system.
3. Performance of radiation and contamination surveys, radioactive waste collection, calibration of reactor radiation monitoring systems, and servicing of radiation survey meters.
4. The providing of radiation protection services for control rod removal, spent-fuel element transfers, ion column removal, etc.

The results of all surveys described above have been within guide lines established for the facility.

H. Radioactive Effluents

The nature and amounts of radioactive effluents from the MITR during FY80 are summarized in Table H-1a, b and c.

For the activity in liquids released to the sanitary sewerage system, the amounts are given on lines 1(a), 1(b), 2(a), and 2(b). Line 1(a) gives the totals of activities, except tritium, in liquids released to the sanitary sewerage system both from the waste tanks and from the cooling towers. For some waste tank discharges, the Line 1(a) activities sometimes exceed 3×10^{-6} µCi/ml, usually due to activated corrosion products. In these cases, the activities measured are given on Line 1(b). In calculating concentrations no credit is taken for dilution by non-radioactive waste water from the Nuclear Engineering Building on the reactor facility site or from the remainder of the MIT Cambridge campus, since these are not routinely measured. The volumes of water discharged from the waste tanks and the cooling tower blowdown are measured, however, and are given on lines 2(a) and 2(b). The total concentrations for nuclides other than tritium did not exceed 3×10^{-6} µCi/ml, when credit is taken for dilution of the waste tank water by the measured cooling tower water, both of which discharge into the sewer at the same point.

The principal gaseous nuclide is Ar-41 from the stack. The annual average concentration as a percent of MPC (53.0%) is down slightly from last year (61.3%). The curies per unit of energy generated was also down slightly 9.5 Ci/MWD in FY80, compared to 10.4 Ci/MWD in FY79.

Other gaseous effluents are reported in the balance of Table H-1a and in Table H-1b. The sum of the fractions of MPC add up to approximately 0.04%. Values are calculated from analyses made of the core purge gas (air flowing across the top of the core tank and through the primary coolant storage tank at 5-6 CFM). Concentrations here are 1400 times greater than after dilution in the building exhaust (8500 CFM), and it is possible to detect concentrations of nuclides, such as the Kr, Xe and I reported last year. None of these have been detected since the removal of an element with faulty cladding in June 1979.

The activity in solid waste shipments are reported in Table H-1c.

Table H-1a

SUMMARY OF MITR RADIOACTIVE EFFLUENTS

FISCAL YEAR 1980

		MPC(1) (µCi/ml)	Units	1979: July	Aug.	Sept.	Oct.	Nov.	Dec.	1980: Jan.	Feb.	Mar.	Apr.	May	June	Total
Activity in liquids released to sanitary sewerage systems:																
1(a)	Total gross β, excluding ^3H		(Ci)	NDA(2)	0.000(3)	NDA	NDA	NDA	0.000	NDA	NDA	NDA	NDA	0.000	0.000	0.000
(b)	Specific nuclides other than ^3H where line 1(a) >3 x 10^{-6} µCi/ml (Co-60 identified)		(Ci)	NDA	0.000	NDA	NDA	NDA	0.000	NDA	NDA	NDA	NDA	0.000	0.000	0.000
2(a)	^3H from waste tanks		(Ci)	No Disch.	0.017	No Disch.	No Disch.	No Disch.	0.068	No Disch.	No Disch.	No Disch.	No Disch	0.010	0.003	0.098
	Average concentration	1×10^{-1}	($\times10^{-4}$ µCi/ml)		52				220					34	5.2	63.3(4)
	Volume of effluent water(5)		($\times10^{4}$ liters)		0.33				0.31					0.30	0.62	1.56
(b)	^3H from cooling towers		(Ci)	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.002	0.002	0.002	0.002	0.002	∿ 0.013
	Average concentration	1×10^{-1}(8)	($\times10^{-4}$ µCi/ml)	0.008	0.011	0.014	0.007	0.005	0.017	0.026	0.019	0.024	0.019	0.023	0.024	0.018
	Volume of effluent water(5)		($\times10^{4}$ liters)	[illegible]5.7	28.4	21.6	43.1	58.4	64.5	74.2	77.8	82.7	80.6	70.1	83.1	710
Activity in gaseous wastes:																
1.	^{41}Ar from stack		(Ci)	544	856	705	835	664	656	341	712	726	691	422	567	8219
	Average concentration(6)	4×10^{-8}	($\times10^{-8}$ µCi/ml)	1.83	2.30	2.37	2.24	2.23	2.21	2.26	2.39	2.44	1.86	1.42	1.90	2.12(7) 53% MPC
2(a)	^3H from stack		(Ci)	0.67	0.99	0.75	0.81	0.69	0.83	0.91	0.62	0.76	0.88	0.76	0.86	9.53
	Average concentration(6)	2×10^{-7}	($\times10^{-11}$ µCi/ml)	2.25	2.72	2.50	2.17	2.32	2.78	2.51	2.08	2.55	2.37	2.55	2.88	2.47 0.01% MPC
(b)	^3H from cooling tower		(Ci)	0.002	0.003	0.003	0.001	0.001	0.003	0.005	0.003	0.004	0.003	0.004	0.005	0.037
	Average concentration	2×10^{-7}	($\times10^{-11}$ µCi/ml)	1.34	1.72	2.05	0.81	0.79	2.22	2.68	2.23	2.74	1.95	3.2[illegible]	3.41	2.10 0.01% MPC

Notes: (1) 10CFR20. (2) NDA - No Detectable Activity, less than 1.26×10^{-6} µCi/ml Beta for every sample. (3) 0.000 indicates less than 0.0005 Ci. (4) Weighted Average of individual discharges. (5) Does not include other diluent from MIT estimated at 2.7 million gals/day. (6) Average concentrations of gaseous stack wastes include authorized dilution factor of 3000. (7) Fiscal year totals are averaged over 12 months for gaseous releases. (8) Technical Specifications 3.8-1.b limits cooling tower concentration to 1×10^{-3} µCu/ml.

Table H-1b

SUMMARY OF MITR RADIOACTIVE EFFLUENTS FISCAL YEAR 1980

Activity in Gaseous Waste

Estimates of annual releases from stack for other nuclides based on representative samples:

	Nuclide	MPC (uCi/ml)	Average Conc. (uCi/ml)		% MPC	Curies
3 (a)	^{80}Br	3×10^{-8}	0.045×10^{-11}		0.0015	.174
(b)	^{80m}Br	0.01×10^{-8}	0.002×10^{-11}		0.02	.008
(c)	^{82}Br	4×10^{-8}	0.001×10^{-11}		0.00003	.004
				TOTAL	0.022	

Table H-1c

SUMMARY OF MITR RADIOACTIVE SOLID WASTE SHIPMENTS FISCAL YEAR 1980

	Units	October 1979	November 1979	February 1980	March 1980	May 1980	Total
1. Solid waste packaged	Cubic Feet	117	117	230	82.5	83.02	629.5
2. Total activity (irradiated components, ion exchange resins, etc.) ^{60}Co, ^{51}Cr, $^{55-59}Fe$, ^{65}Zn, etc.	(Ci)	100.6	84	0.122	0.019	0.057	184.8
3. (a) Dates of Shipment		10-9-79	11-28-79	2-1-80	3-11-80	5-29-80	5 shipments
(b) Disposition to licensee for burial		Chem-Nuclear Systems	Chem-Nuclear Systems	Interex	Interex	Interex	