MIT RESEARCH REACTOR

ANNUAL REPORT

TO

UNITED STATES NUCLEAR REGULATORY COMMISSION

FOR THE PERIOD JULY 1, 1978 - JUNE 30, 1979

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.

This is the fourth annual report required by the Technical Specifications, and it covers the period July 1, 1978 through June 30, 1979. 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 second 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, 1978 - June 30, 1979), 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 second full year of normal operation, the startup program for the MITR-II having been completed during FY77 (November 1976).

During FY79, a Tuesday - Saturday schedule was in effect, and prevailed with a few exceptions throughout that year. This permitted maintenance and experiment changes, protective system surveillance tests, and partial completion of the checklists on the Monday day and evening shifts, followed by an early start on Tuesday. Some maintenance and surveillance testing was also accomplished after shutdown on Saturday, which generally occurred in the forenoon.

In December 1978 the reactor operating hours were reduced from 85-90 hours per week to about 70 hours per week as a measure to save fuel, since the fuel fabricator's delivery schedule was slipping badly, and the exhaustion of the MITR fuel inventory by Fall 1979 appeared to be a real possibility. For the year, the reactor averaged 79.8 hours per week at full power. At the time of writing this report, the fuel fabricator is well along in production, the delivery schedule is much more certain, and the reactor returned to a 90-hour week in July.

The reactor was operated throughout the year with 24 elements in the core. The remaining three positions were occupied either by irradiation facilities or by solid aluminum dummy elements. Reactivity was gained (to compensate for burnup) by making five refuelings in which two or three fresh elements were substituted for partially burned elements in the B-ring. The latter were held in the core tank storage ring for subsequent use as replacements for C-ring elements. In a sixth case, and also in one of the above five cases, the element in Position A-2 was replaced by another having less burnup. In a seventh case, the A-2 element and the 15 C-ring elements were all inverted (flipped end for end), which gained reactivity and also took advantage of this unique feature of the elements in order to achieve more uniform burnup.

Three other shuffles of fuel into and out of the core took place in June and July 1979 for the purpose of removing and identifying an element with faulty cladding which had been leaking small amounts of fission product gases into the primary coolant. Two other core alterations were related to changes in the type or location of irradiation facilities.

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 (3 ports).

b) Shielding studies and component alignment for an inelastic scattering spectrometer for molecular dynamics studies.

c) Reactor physics experiments in facilities equipped with neutron fission converters for fast breeder reactor blanket studies.

d) Dosimetry measurements of the neutron beam in the medical therapy facility.

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

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

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

h) Production of molybdenum-99 and gold-198.

i) Irradiation of tissue specimens on particle track detectors for plutonium radiobiology, and other studies.

j) Use of the facility in reactor operator training.

k) Irradiation damage studies of candidate fusion reactor materials.

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

3. Changes to Facility Design

A third primary coolant heat exchanger, which operates in parallel with the two previous exchangers, was installed during the year. NRC approval for the installation was received in the form of Amendment No. 14 to the Facility Operating (Licence No. R-37, dated August 25, 1978. After preoperational tests in October, the unit was placed in service and performs as predicted. It provides insurance against a long-term power reduction if any of the three exchangers fails, since two are normally sufficient for 5 MW operation, and it is possible to operate with any two or with all three.

As indicated in last year's report, a study of the feasibility of increasing the uranium loading in the MITR-II fuel proved satisfactory, and specifications for fabrication now call for 34 grams U-235 per plate, 510 grams per element, as compared to 29.7 grams and 445 grams respectively in the first and only other fuel procurement. The new loading results in 41.2 w/o U in the core, based on a 7% void fraction, and corresponds to the maximum loading in Advanced Test Reactor (ATR) fuel. The higher loading will increase the reactivity available from the fuel and increase its lifetime (subject to the maximum burnup permitted by the Technical Specifications).

Other changes in the facility design 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 two amendments to Facility Operating License No. R-37 during the year (in addition to Amendment No. 14 authorizing the installation of a third primary coolant heat exchanger). Amendment No. 15 incorporates the "Security Plan for the MIT Reactor" into the License. Amendment No. 15 adds a definition of the term "frequency" as applied to surveillance tests and other periodic activities.

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

a) A revised Procedure 1.16, "Requalification Program for Licensed Personnel", was adopted after approval by USNRC on May 26, 1978 (SR # 0-78-16).

b) A step was added to surveillance Procedure 6.1.1, Emergency Cooling System, to attach lead seals to the ECCS valves after returning them to the normal position on completion of the semi-annual test. Steps were added to the startup checklists, Procedures 3.1.1.2 and 3.1.2.2, to check the valve alignments and seals (SR # 0-78-17). This was in response to a recommendation in Occurrence Report 50-20/78-4.

c) A new Procedure 4.4.4.9 was written to specify the steps required for operation of the containment building pressure relief system (SR # 0-78-20). Prior written procedures had dealt only with the system use for other purposes, i.e. weekly exercise of the charcoal filters and annual building pressure test.

d) Startup Procedures 3.1.1.2 and 3.1.2.2 were revised to provide for recording of the shutdown margin on those checklists in order to give weekly documentation of its value (SR # 0-78-21). They were further revised to incorporate steps related to startup using the third primary heat exchanger (SR # 0-78-26). The abnormal Occurrence Procedures (AOP's) and the Test and Calibration Procedures were also revised as required to include the third exchanger (SR # 0-78-28).

e) Administrative Procedure 1.10.8, "Experiments and Irradiations", was revised to incorporate the requirements for use of the Building NW13 pneumatic send station, including approvals, daily pre-use tests, and new record forms. (SR #0-78-25).

f) A new AOP, #5.7.9, was prepared and approved to prov ide guidance to the operator in the event of an alarm on a "fatigue cracking" experiment installed in an in-core irradiation thimble (SR # 0-78-29 and SR # 0-79-2).

g) A new procedure, "Operating Procedure for Shipping MITR-I Core Tank", 3.10.1, was prepared and approved to cover the sectioning and shipping of the tank (SR # 0-79-1). The sectioning has been nearly completed, but shipping has been delayed due to diversion of the planned shipping cask to Three Mile Island.

h) Startup Procedures 3.1.1.2, 3.1.2.2 and 3.1.3 were revised to clarify the method of setting the level trips on the safety channels and to incorporate specifically a step for rechecking the trips at full power (SR # 0-79-4). These changes were in response to a recommendation in Occurrence Report #50-20/79-1.

i) A new "Procedure for Flux Mapping", 6.5.17, was developed and approved (SR # 0-79-5) for measuring the flux shape with U-Al foils.

j) A new Procedure 6.5.18, Control Blade Thickness Measurement, was developed and approved in order to provide a written procedure for this measurement (SR # 0-79-6).

k) 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 two exceptions (Reportable Occurrences # 50-20/79-2 and # 50-20/79-3), where NRC was notified in accordance with Technical Specification 7.13 in each case. Conditions having safety implications were found as the result of other tests and inspections and were likewise reported to NRC (Reportable Occurrences # 50-20/78-4, # 50-20/79-1, and # 50-20/79-4).

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 FY79) (normally at 4.9 MW)	219.0	211.8	188.9	198.2	817.9
b) MITR-II (MIT FY76-78)					1,734.7
c) MITR-I (MIT FY59-74)					10,435.2
d) Cumulative, MITR-I & MITR-II					12,987.8
2. Hours of Operation, MIT FY1979, MITR-II					
a) At Power (>0.5 MW) for research	1165.4	1061.2	936.0	988.2	4,150.8
b) Low Power (<0.5 MW) for training (1) and test	39.8	61.9	35.6	72.4	209.7
c) Total critical	1205.2	1123.1	971.6	1060.6	4,360.5

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. Shutdowns and Scrams

During the period of this report there were 33 inadvertent scrams, and ten unscheduled power reductions or shutdowns. If the multiple failures due to power supplies and old channel 2 failures (Ie(ii) and (Ii) are eliminated, the total is not far above last year's 22.

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.

I. Nuclear Safety System

a)	Period channels during normal startup, resulting from electrical noise	3
b)	Level channel high trip due to noise	1
c)	Electric Company power dips	2
d)	Level channel tripped on high level due to trip being set slightly under 5 MW (should be about 5.5 MW)	4

e) Electronic component failure in:		
I) Levl channel		1
II) Channel power supplies; rebuilt		7
f) Withdraw permit circuit open for no apparent reason		2
g) Operator error in deactivating channel		1
h) Technician error in doing maintenance		1
i) Channel 2, caused by old chamber failing; chamber replaced		7
j) Low Voltage Chamber Power supply scram caused by water from experiment cooling line leaking into instrument port		1
	Subtotal	30

II. Process System

a) Primary outlet temperature scram when cooling tower fan tripped off due to vibration		1
b) Low level core tank scrams caused by failure of insulation in level probe; insulated		2
	Subtotal	3

III. Other Scrams or Unscheduled Shutdowns

a) Operator shutdown by "All Rods In":	
(i) To investigate a decrease in Channel #2 chamber output caused by leak in experiment cooling line	1
(ii) High reading on core purge monitor; replaced element with faulty cladding	1
(iii) After trip of containment building exhaust fan due to overload when fan speed was increased slightly; overload trip level increased within rated limit.	1
(iiii) To investigate loss of helium supply for irridiation thimble; supply line repaired	1
b) Operator lowered power to 500 KW:	
(i) To check functioning of recombiner	1
(ii) To check local indication of flow in auxiliary heat exchangers	1

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c) Operator lowered power to 2.5 MW:

(i)	To investigate and correct sticking of regulating rod direction relay	1
(ii)	To investigate rising temperature in Fatigue Cracking Experiment	2
(iii)	When cooling tower fan tripped off (no apparent reason)	1
	Subtotal	10
	Total	43

D. Major Maintenance

Major maintenance projects during FY79, 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 FY79. 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 the primary flow - ΔT recorder (which also provides a signal to a new thermal power digital readout), a new regulating rod controller for automatic maintenance of power at a pre-set level, new picoammeters for channels #7 and #8, digital readouts to replace the vertical indicators for selected cooling system pressures, and miscellaneous minor changes. Additional changes were also initiated and will be accomplished in FY80, such as a new radiation monitor multi-point recorder, simulated period generator for testing and calibrating period channels, and solid-state count rate amplifiers and scalers for the startup channels.

2) Last year's report referred to a program for inspection and repair of the control blade drive mechanisms, required because of a weld failure in one and the subsequent rewelding of that one and five others. Reference was made to two remaining units, then serving as spares; these were repaired early in FY79, thus completing the program. A more detailed description of the problem and a safety evaluation were given in the FY77 report.

3) Work continued on plans and preparations for the disposal of additional radioactive components removed from the MITR-I reactor during its modification to MITR-II. The principal remaining component is the old core tank which has been in storage in the spent fuel pool. After review of available and suitable shipping containers, arrangements were made with Chem-Nuclear Systems, Inc., for rental of its CNSI LL-50-100

cask. In order to utilize this cask (or any other feasible container), it was necessary to cut the old core tank into sections small enough to fit the LL-50-100. An underwater plasma cutting torch was procured, and the tank was cut circumferentially roughly in half. As a result of the Three Mile Island accident, however, Chem-Nuclear diverted the cask for use at that reactor, and it is expected that the cask will not be available to MIT until the coming Fall. The core tank and miscellaneous other components from the MITR-I will be transferred (at least two shipments) to Chem-Nuclear for disposal at a licensed site by burial. Disposal of the tank within a few months is a necessity in order to clear the way for the transfer of spent fuel from the reactor to the spent fuel pool early in calendar 1980.

4) The auxiliary intake damper was slightly modified because of a failure to close on signal during testing (Occurrence Report 50-20/78-3). The problem was caused by sticking of the pivot, which is designed to permit closing of the damper by gravity. The pivot was changed in March 1979 to incorporate bronze bushings and teflon thrust washers and has operated satisfactorily during weekly tests since then.

5) Two gaskets related to building containment were renewed during the year. The gasket on the main exhaust damper began to show signs of wear which might lead to leakage when inspected in April. It was replaced, shown by inspection and test to provide the necessary seal; it was rechecked a week later as part of the containment leak test. The gasket on the outer truck lock door, which had been significantly flattened by more than 20 years of pressure, was replaced in March 1979. The new gasket, when tested as part of the containment leak test the following month, was found to be the source of a significant leak. The gasket pressure was increased, and then successfully leak tested separately the following month. Meanwhile the inner door provided the required containment integrity.

6) 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 Director of Nuclear Reactor Regulation, USNRC.

The conduct of tests and experiments on the reactor are documented in the experiments and irradiations files. During FY 1978 all experiments have been done in accordance with the descriptions provided in Section 10 of the SAR, "Experimental Facilities".

1. SR # M-78-3 (4/7/78)

Installation and Use of Hot Cells in the Containment Building

As described in last year's report, a hot cell (actually a pair of adjacent hot cells) has been designed for installation on the main floor of the containment building. It is to be used for such activities as the inspection and testing of experimental materials and for the transfer of irradiated materials from irradiation capsules to shipping containers.

Last Spring a number of existing shield blocks were modified and a few new ones were fabricated so as to fit properly together and to accommodate viewing windows, manipulators, ventilation, etc. Assembly of the blocks was not begun until July of this year, but it is now almost complete, and one of the cells is expected to be given its preoperational testing very shortly prior to being placed in operation.

Reactor Staff approval:

Initial: 4/13/78
Final: 8/23/78

MIT Reactor Safeguards Committee approval 9/6/78, subject to Subcommittee review and approval of specific items

2) SR # 0-77-13 (7/1/77)

Pneumatic Tube Send Station for Building NW13

This system and the procedures for assuring its safe use were described in last year's report. During FY79 the facility was completed, tested and placed in routine use.

Approvals: listed in FY78 report.

3. SR # 0-79-7 (3/19/79)

Change in D_2O Upper Reflector Temperature Alarm, DT-5

A thermocouple, DT-5, was installed in the D_2O upper reflector for the purpose of monitoring its temperature in comparison with other D_2O and primary system temperatures during the initial startup and rise to power of MITR-II. It was found that DT-5 temperatures are within a few degrees of the reflector outlet and core inlet temperatures; this is to be expected due to mixing in the former case and due to the large heat transfer surface formed by the core tank between the H_2O and D_2O in the second case. Consequently, on the basis of experience, DT-5 can now be considered redundant and no longer required.

DT-5 output was originally recorded on Temperature Recorder No. 3. When maintenance became excessive, DT-5 was transferred to an indicating meter having an adjustable up-scale alarm. Thus, the alarm feature was retained, but the recording function was not. For the reasons mentioned above, this change is not considered to have any safety significance. Since both the recording and alarm features, however, are mentioned in the SAR, the change is being reported under 10 CFR 50.59.

Reactor Staff approved 4/18/79

4. SR # E-79-1 (1/18/79)

Replacement of Power Galvanometer with Picoammeter

One of the improvements in reactor instrumentation made during the year was the replacement of the power galvanometer in the emergency power channel (#8) with a solid-state, digital-readout picoammeter. The picoammeter has its own battery supply, which powers the instrument in the event of loss of normal instrument power and also of standby power.

When the picoammeter was installed, it was decided for two reasons to abandon that part of the startup interlock system which required that the power galvanometer be switched to maximum sensitivity. The picoammeter switching circuits do not contain provisions for an interlock and, second, the sensitivity of the lowest scale is such that it is not normally desirable to use it. Also, the scale desired for startup depends upon the length of the shutdown. Startup checklists have been revised to include a step to set Channel 8 in the lowest usable range.

This is a 10 CFR 50.59 chan . because SAR Section 7.3 lists the power galvanometer as part of the startup interlock system and Fig. 7.3a3 shows the interlock. These references will be deleted in a future SAR change. This represents an improvement, not a reduction, in safety.

Reactor Staff approval 1/23/79

ENVIRONMENTAL SURVEYS

F. Environmental surveys, outside the facility, were performed using area monitors. The systems (located approximately in a ½ 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, 1978 - June 30, 1979
North	1.2 mR/year
South	1.0 mR/year
East	2.9 mR/year
West	1.8 mR/year
Green (East)	0.8 mR/year
AVERAGE	1.5 mR/year

The ratio of FY 1979 average (1.5 mR/year) over the FY 1978 average (1.9 mR/year) reflects a 21% decrease in the measured radiation levels. This was to be expected, at least in part, since the energy generated decreased by 13.1% (from 941.4 MWD to 817.9 MWD). The remaining 9% decrease (to give a total of 21%) is probably not significant, since the decrease in the Ar-41 stack release was proportional to the decrease in energy generated within 1%.

RADIATION EXPOSURES AND SURVEYS WITHIN THE FACILITY

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

Whole Body Exposure Range (Rems)	Period 7/01/78 - 6/30/79 No. of Personnel
No Measurable	96
Measurable - Exposure Less than 0.1	17
0.1 - 0.25	9
0.25 - 0.5	10
0.5 - 0.75	6
0.75 - 1.0	2
1.0 - 2.0	2
TOTAL	142

Summary of the results of radiation and contamination surveys from July 1978 to June 1979:

During the 1978-1979 period, the Reactor Radiation Protection Office continued to provide the routine radiation protection services necessary for full power (5 megawatts) operation of the reactor. The routine 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.

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 FY79 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, 2, 3(a) and 3(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 3(a) and 3(b). The 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 nuclides identified were mostly activated corrosion products and are listed on line 2.

The principal gaseous nuclide is Ar-41 from the stack. The annual average concentration as a percent of MPC (61.3%) is down slightly from last year (70.3%) because the reactor generated 817.9 MWD compared to 941.4 MWD the previous year for reasons given in Section A-1. The curies per unit of energy generated were almost identical, 10.4 Ci/MWD in FY79 and 10.3 Ci/MWD in FY78.

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 1%. 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 the Kr, Xe, and I nuclides reported in the table. Periodic measurements appear to indicate an equilibrium condition, although the concentrations were higher in May and June 1979 before a fuel element with faulty cladding was identified and removed from the core. Such measurements are continuing in order to detect any similar trends which may develop.

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

Table H -1a

SUMMARY OF MITR RADIOACTIVE EFFLUENTS

FISCAL YEAR 1979

	MPC [1] (µCi/ml	Units	1978: July	Aug.	Sept.	Oct.	Nov.	Dec.	1979: Jan.	Feb.	Mar.	Apr.	May	June	1978-79 Total
Activity in liquids released to sanitary sewerage system:															
1. Total gross β, excluding ^3H		(Ci)	0.001	0.000[2]	NDA[3]	0.000	NDA	NDA	0.000	NDA	NDA	NDA	0.001	NDA	0.002
2. Specific nuclides other than ^3H (Cr-51, Na-24, Zn-65, Fe-59 and Mn-54 and Co-60 identified)		(Ci)	0.001	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	NDA	0.001	NDA	0.002
3(a). ^3H from waste tanks		(Ci)	0.002	No	No	0.011	No	No	0.003	No	No	No	0.03	No	0.046
Average concentration	1×10^{-1}	($\times 10^{-4}$ µCi/ml)	7.8	disch.	disch.	15.3	disch.	disch.	7.5	disch.	disch.	disch.	29.7	disch.	16.7[4]
Volume of effluent water [5]		($\times 10^{4}$ liters)	0.82			0.71			0.33				1.01		2.81
(b) ^3H from cooling towers		(Ci)	0.005	0.005	0.004	0.004	0.005	0.005	0.003	0.003	0.002	0.001	0.001	0.001	0.039
Average concentration	1×10^{-1} [8]	($\times 10^{-4}$ µCi/ml)	0.078	0.071	0.062	0.078	0.087	0.091	0.071	0.090	0.034	0.029	0.026	0.014	0.064
Volume of effluent water [5]		($\times 10^{4}$ liters)	57.5	65.0	63.1	52.9	57.3	56.3	45.1	36.6	52.4	34.7	46.7	44.0	611.5
Activity in gaseous waste:															
1. ^{41}Ar from stack		(Ci)	608	782	650	674	828	616	787	733	619	728	871	605	8501
Average concentration [6]	4×10^{-8}	($\times 10^{-8}$ µCi/ml)	3.32	2.39	2.48	2.57	2.53	2.35	2.40	2.46	2.08	2.44	2.34	2.03	2.45[7] 61.3% MPC
2(a). ^3H from stack		(Ci)	0.60	0.87	0.46	0.45	0.84	0.51	0.65	0.55	0.67	0.67	0.92	0.82	8.01
Average Concentration	2×10^{-7}	($\times 10^{-11}$ µCi/ml)	2.29	2.66	1.77	1.72	2.55	1.95	1.97	1.85	2.26	2.23	2.46	2.75	2.21 0.011 MPC
(b). ^3H from cooling tower		(Ci)	0.020	0.018	0.016	0.016	0.016	0.019	0.011	0.018	0.007	0.004	0.006	0.003	0.154
Average Concentration	2×10^{-7}	($\times 10^{-11}$ µCi/ml)	14.9	10.6	10.9	11.1	9.9	14.7	7.4	15.1	6.1	3.8	3.5	2.5	9.21 0.05% MPC

Notes: (1) 10CFR20 (2) 0.000 indicates less than 0.0005 Ci. (3) NDA - No Detectable Activity (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 wastes include authorized dilution factor of 3000. (7) Fiscal year totals are averaged over 12 months for gaseous releases.
(8) Technical Specification 3.8-1.b limits cooling tower concentration to 1×10^{-3} µCi/ml.

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Table H-1b

SUMMARY OF MITR RADIOACTIVE EFFLUENTS FISCAL YEAR 1979

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}	0.047×10^{-11}	0.0016	0.17
(b)	^{80m}Br	0.01×10^{-8}	0.002×10^{-11}	0.02	0.006
(c)	^{82}Br	4×10^{-8}	0.001×10^{-11}	0.00003	0.004
4 (a)	^{85m}Kr	10×10^{-8}	2.75×10^{-11}	0.028	10.1
(b)	^{87}Kr	2×10^{-8}	5.63×10^{-11}	0.282	20.7
(c)	^{88}Kr	2×10^{-8}	6.29×10^{-11}	0.315	23.1
5 (a)	^{133}Xe	30×10^{-8}	5.05×10^{-11}	0.017	18.5
(b)	^{133m}Xe	30×10^{-8}	2.04×10^{-11}	0.007	7.5
(c)	^{135}Xe	10×10^{-8}	3.78×10^{-11}	0.038	13.9
(d)	^{135m}Xe	3×10^{-8}	1.44×10^{-11}	0.048	5.3
(e)	^{138}Xe	3×10^{-8}	9.99×10^{-11}	0.333	36.7
(f)	^{131}I	0.01×10^{-8}	0.008×10^{-11}	0.08	0.00004
			TOTAL	1.17	

Table H-1c

SUMMARY OF MITR RADIOACTIVE SOLID WASTE SHIPMENTS FISCAL YEAR 1979

	Units	1978 August	1979 March	Total
1. Solid waste packaged	(Cu.Ft.)	113	199*	312
2. Total activity (irradiated components, ion exchange resins, etc.) ^{60}Co, ^{51}Cr, $^{55-59}Fe$, ^{65}Zn, etc.	(Ci)	0.057	0.108	0.165
3. (a) Dates of shipment		8/25	3/20	2 shipments
(b) Disposition		To licensee for burial	Same as in August	