NUCLEAR REACTOR LABORATORY
AN INTERDEPARTMENTAL CENTER OF
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JOHN A. BERNARD
Director of Reactor Operations
Principal Research Engineer

138 Albany Street, Cambridge, MA 02139-4296
Telefax No. (617) 253-7300
Tel. No. (617)

Activation Analysis
Coolant Chemistry
Nuclear Medicine
Reactor Engineering

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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Attn.: Document Control Desk

Subject: Annual Report, Docket No. 50-20, License R-37, Technical Specification 7.13.5

Gentlemen:

Forwarded herewith is the Annual Report for the MIT Research Reactor for the period July 1, 2007 to June 30, 2008, in compliance with paragraph 7.13.5 of the Technical Specifications for Facility Operating License R-37.

Sincerely,

Thomas H. Newton, Jr., Ph.D., PE
Associate Director, Engineering
MIT Research Reactor

Edward S. Lau, NE
Superintendent
MIT Research Reactor

John A. Bernard, Ph.D., PE, CHP
Director of Reactor Operations
MIT Research Reactor

JAB/gw

Enclosure: As stated

cc: USNRC – Senior Project Manager
Research and Test Reactors Branch A
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

USNRC – Senior Reactor Inspector
Research and Test Reactors Branch B
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

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MIT RESEARCH REACTOR
NUCLEAR REACTOR LABORATORY
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

ANNUAL REPORT

to

United States Nuclear Regulatory Commission

for

the Period July 1, 2007 – June 30, 2008

by

REACTOR STAFF

Table of Contents

MIT RESEARCH REACTOR

ANNUAL REPORT TO

U. S. NUCLEAR REGULATORY COMMISSION

FOR THE PERIOD JULY 1, 2007 - JUNE 30, 2008

INTRODUCTION

This report has been prepared by the staff of the Massachusetts Institute of Technology Research Reactor for submission to the United States Nuclear Regulatory Commission, 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, 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 to 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 under-moderated 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 UAL_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 and thermal shields, secondary cooling systems, 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 completed its mission 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 14, 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. Three shift operations, Monday through Friday, was continued through 1995 when a gradual transition to continuous operation (24 hours per day, 7 days per week with a shutdown for maintenance every 4-5 weeks) was initiated. The current operating mode is continuous operation at full power.

In July 1999, an application to relicense the reactor for twenty years and to upgrade its power level to 6 MW was submitted to the U.S. Nuclear Regulatory Commission. That request is now being processed. In December 2000, a fission converter medical facility was commissioned. This facility generates the best epithermal beam in the world for use in the treatment of certain types of cancer.

This is the thirty-third annual report required by the Technical Specifications, and it covers the period July 1, 2007 through June 30, 2008. 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 routine reactor operation. This report covers the thirty-first full year of routine reactor operation at the 5-MW licensed power level. It was another year in which the safety and reliability of reactor operation met and exceeded requirements and expectations.

A summary of operating experience and other activities and related statistical data are provided in Sections A through I of this report.

A. SUMMARY OF OPERATING EXPERIENCE

1. General

The MIT Research Reactor, MITR-II, is operated to facilitate experiments and research including in-core irradiations and experiments, medical studies such as boron neutron capture studies, and neutron activation analyses. It is also used for student laboratory exercises and student operator training, and education and outreach programs. Additionally, the reactor has been used for industrial production applications and other irradiation services. When operating, the reactor is normally maintained at a nominal 5 MW. For this reporting period, the nominal full power operating cycle continued to be four weeks at a time, followed by a shutdown lasting half a day to five days, for reactor and experiment maintenance and other necessary outage activities. The reactor would then be re-started to full power and maintained there for another four to five weeks.

The reactor averaged 139 hours per week at power compared to 142 hours per week for the previous year and 118 hours per week two years ago. The higher average for the past two years is the result of an effort at downtime reduction via improved outage planning and implementation, and preventive maintenance such as strategic replacement of key reactor components.

The reactor was operated throughout the year with 24 fuel elements in the core. The remaining three positions were occupied by solid aluminum dummies or in-core experiments. During FY2008, compensation for reactivity lost due to burnup was provided by six refuelings. These followed standard MITR practice which is to introduce fresh fuel to the inner portion of the core (the A- and B-Rings) where peaking is least and to place partially spent fuel into the outer portion of the core (the C-Ring). In addition, fuel elements were inverted and rotated so as to achieve more uniform burnup gradients in them. Six new fuel elements were introduced into the reactor core during FY2008.

The MITR-II fuel management program remains quite successful. All of the original MITR-II fuel elements (445 grams U-235) have been permanently discharged. The overall burnup for the discharged ones was 42%. (Note: One was removed prematurely because of excess out-gassing.) The maximum overall burnup achieved was 48%. A total of one hundred eighty-seven of the newer, MITR-II fuel elements (506 grams U-235) have been introduced to the core. Of these, one hundred nineteen have attained the maximum allowed fission density and were discharged. Six fuel elements have been identified as showing excess out-gassing and three were suspected of this. All nine have been removed from service and returned to an off-site DOE storage facility. The other fifty-nine are either currently in the reactor core, in the fission converter tank, or have been partially depleted and are in the wet storage ring awaiting reuse. During the period of FY2008, eight spent fuel elements were returned to an off-site DOE facility.

Protective system surveillance tests are conducted whenever the reactor is scheduled to be shut down.

As in previous years, 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 experiment facilities.

2. Experiments

The MITR-II was used for experiments and irradiations in support of research, training and education programs at MIT and elsewhere. Irradiations and experiments conducted in FY2008 include:

a) Use of the thermal neutron beam for the irradiation of Si photodetectors for Boston University researchers testing detectors for use in proton accelerators and colliders.

b) Activation of yttrium foils for an on-going clinical trial at the Massachusetts General Hospital and Sloan Memorial Kettering Cancer Center for spinal cord cancer removal therapy.

c) Activation of gold-198 seeds and ytterbium pellets for brachytherapy, xenated silicon chips for trace element analyses, and fusion material laminates for material science studies.

d) Activation of uranium foils for detector calibration at the Los Alamos National Laboratories and other national Department of Energy (DOE) facilities.

e) Activation of ocean sediments for the Woods Hole Oceanographic Institute and the University of British Columbia.

f) Experiments at the 4DH1 radial beam port facility by MIT undergraduates, including: 1) measurements of leakage neutron energy spectrum to determine reactor temperature; 2) measurement of neutron wavelength and time-of-flight; and 3) measurement of attenuation coefficients for eight shielding materials.

g) Use of the reactor for training MIT student reactor operators and for MIT nuclear engineering classes (courses 22.06, 22.09, 22.921, and the Reactor Technology Course for nuclear power executives).

h) NAA of Charles River sediments for investigation of pollution originating from the semiconductor industry for MIT Civil Engineering department.

i) Gamma irradiation of sensor materials for MIT Chemistry department.

j) NAA of crushed filtration beads samples for determination of iron contents for the Harvard School of Public Health.

k) Neutron transmutation doping of Si wafers for Lawrence Berkley National Labs. These wafers were then used for further neutrino detector research.

l) Activation of nanoparticles for radiotracer study of nanomaterial toxicity study for Harvard School of Public Health.

m) Testing of carbon composites as neutron shielding for portable electronic devices.

In addition to the above list of current activities, the MIT Nuclear Reactor Lab (NRL) has provided testing facilities for neutron irradiations in-core in support of the light-water nuclear power industry since 1989. The current focus of NRL's in-core materials and fuel group has been a long-term experiment to evaluate the feasibility of using SiC / SiC composite materials in pressurized water reactor (PWR) conditions. A first set of samples was irradiated from May 2006 to September 2006. This initial set of samples was shipped to Oak Ridge National Laboratory for further analysis although initial post-irradiation examination was done on-site. A second set of samples, including some samples carried over from the first irradiation, was irradiated from December 2006 to October 2007. Initial PIE has been completed and mechanical property testing at MIT is planned for FY2008. These materials have been proposed as a replacement for Zircaloy™ fuel cladding for PWRs in order to improve fuel performance in loss of coolant accidents and thus allow for increased reactor power and higher fuel burnup.

During this fiscal year, the Reactor staff continued to construct a smaller-scale diffractometer as reported in FY2006.

The MITR is completing a web-enabled neutron spectrometer at the 4DH1 beam facility. In collaboration with MIT's iLabs program, the MITR plans to debut the first online, interactive, real-time neutron-based experiment with a few partner universities. Using a combination of LabVIEW software and a prototype iLabs-developed architecture, this facility will provide educational opportunities to students nationwide and internationally that do not have the benefit of an on-site nuclear reactor or other neutron source.

A new initiative currently on-going is the collaboration with INL Advanced Test Reactor User Facility (ATR-UF) for materials testing. The MITR is the first university facility selected to partner with the ATR-UF. In addition to the first four experiments that were selected to be performed at ATR during FY2008, another one has been identified to be conducted at MITR in the near future. MITR staff are also working with INL staff to jointly develop advanced reactor instrumentation and FY2009 call-for-proposal.

3. Changes to Facility Design

Except for minor changes reported in Section E, no changes in the facility design were made during this fiscal year. As indicated in past reports the uranium loading of MITR-II fuel was increased from 29.7 grams of U-235 per plate and 445 grams per element (as made by Gulf United Nuclear Fuels, Inc.) to a nominal 34 and 510 grams respectively (made originally by the Atomics International (AI) Division of Rockwell International, now by BWXT). With the exception of seven elements (one Gulf, six AI) that were found to be out-gassing excessively, performance of these fuel elements has been good. The heavier loading results in 41.2 w/o U in the fuel meat, based on 7% voids, and corresponds to the maximum loading in Advanced Test Reactor (ATR) fuel. One hundred forty-seven elements fabricated by BWXT have been received, fifty-nine of which remain in use. One has been removed because of suspected excess out-gassing and eighty-seven have been discharged because they have attained the fission density limit.

The MITR is actively involved in feasibility studies for the use of low enrichment uranium (LEU) in the MITR, partially supported by the Reduced Enrichment for Research and Test Reactors (RERTR) Program at Argonne National Laboratory. These studies principally focus on the use of monolithic U-Mo fuels with uranium densities in excess of 15 g/cm^3, currently under development by the RERTR Program. Although preliminary studies show that the use of these fuels may be feasible, conversion of the MITR-II to lower enrichment must await the successful qualification of these fuels.

4. Changes in Performance Characteristics

Performance characteristics of the MITR-II were reported in the "MITR-II Startup Report." Minor changes have been described in previous reports. Performance characteristics of the Fission Converter Facility were reported in the "Fission Converter Facility Startup Report", and in the FY2006 report which described a 20% improvement in the intensity of the unfiltered epithermal neutron beam.

5. Changes in Operating Procedures

With respect to operating procedures subject only to MITR internal review and approval, a summary is given below of changes implemented during the past year. Those changes related to safety and subject to additional review and approval are discussed in Section E of this report.

a) PM 3.5, "Daily Surveillance Check", continued to be updated to reflect current instrument readings and locations of equipment, and to add a step for regular recording of the spent fuel storage pool water level for tracking and trending in response to a suggestion from American Nuclear Insurers. (SR#-0-07-1)

b) PM 1.4, "Safety Review Form", updated the form used as a cover page for Safety Reviews to match current 10 CFR 50.59 language, and in response to a suggestion from NRC, added a section for listing any additional conditions later imposed (particularly on experiments) by the MIT Reactor Safeguards Committee. (SR#-0-07-3)

c) "NTD Silicon Procedures for General Radiological Guidelines, Unload, Load, and Cleaning Cans/Dummies" brought the main handling procedures for the Silicon Program into the formal Safety Review process, and made numerous ALARA-oriented updates to them in response to UOR 2007-1, "Abnormal Radiation Exposure". (SR#-0-07-4 and SR#-0-08-2)

d) PM 3.1.1.4, "Two Loop Restart Incorporating Required Monthly Startup Surveillances", updated a frequently-used Special Procedure and assigned it a sequence number to incorporate it into the main Procedure Manual. Other changes included addition of places to initial for final review of each page upon completion, extra verification of trip settings for the Channel 4, 5, and 6 scram amplifiers, ALARA improvements, and removal of an optional three-heat-exchanger valve alignment. (SR#0-08-1)

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. Thirty 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 monthly startup, shutdown, or other checklists.

During this reporting period, the surveillance frequency has been at least equal to that required by the Technical Specification, and the results of tests and inspections were satisfactory throughout the year for Facility Operating License No. R-37.

7. Status of Spent Fuel Shipment

In FY2008, there was one shipment made, reducing the inventory of spent fuel at MIT to close to zero. The U.S. Department of Energy has indicated that further shipments may be feasible in FY2009 for future fuel discharges.

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 FY2008) (normally at 4.9 MW)	277.0	231.9	350.4	318.0	1177.3
b) MITR-II (MIT FY1976-2007)					28,057.7
c) MITR-I (MIT FY1959-1974)					10,435.2
d) Cumulative, MITR-I & MITR-II					39,670.2
2. MITR-II Operation (hours): (MIT FY2008)					
a) At Power (>0.5-MW) for Research	1963.1	1364.0	1962.2	1799.3	7088.6
b) Low Power (<0.5-MW) for Training[1] and Test	84.9	71.1	57.0	77.7	290.7
c) Total Critical	2048.0	1435.1	2019.2	1877.0	7379.3

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

C. SHUTDOWNS AND SCRAMS

During this reporting period, there were four inadvertent scrams and four unscheduled 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 "shutdown" refers to an unscheduled power reduction to subcritical by the reactor operator in response to an abnormal condition indication. Rod drops and electric power loss without protective system action are included in unscheduled shutdowns.

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

		Total
1.	Nuclear Safety System Scrams	
a)	Minor Scram as result of failure of the Channel #6 magnet current potentiometer.	1
b)	Minor Scram as result of a failing solder joint on a Channel #3 circuit board affecting its paired channel.	1
c)	Trip on Major Scram circuit as result of spurious electronic noise during inspection of junction box.	1
	Subtotal	3
2.	Process System Scrams	
a)	Low flow primary coolant trip as result of faulty block-switch on the variable frequency drive for primary pump MM-1A.	1
	Subtotal	1

3. Unscheduled Shutdowns

a)	Shutdown due to loss of offsite electricity.	2
b)	Shutdown due to loss of offsite steam supply to reactor building ventilation system.	1
c)	Shutdown due to ventilation exhaust damper trip caused by failure of motor-starter for its hydraulic pump.	1
	Subtotal	4
	Total	8

4. Experience during recent years has been as follows:

Fiscal Year	Nuclear Safety and Process System Scrams
2008	4
2007	5
2006	6
2005	6
2004	9

D. MAJOR MAINTENANCE

Major maintenance projects performed during FY2008 are described in this Section. These were planned and performed to improve safety, reliability and efficiency of operation of the MIT Research Reactor, and, hence, improving the predictability of the reactor operating schedule. Additionally, Reactor staff provided major support for all installations and removals of reactor experiments, including segregation of their highly-activated internal parts into various hot cells and designated storage locations. Reactor staff also provided monitoring of some continuously-operating experiments.

(a) Advanced Clad Irradiation (ACI) Experiment – This is the longest-running in-core experiment for the reactor. During the beginning of this fiscal year, the experiment developed a minor maintenance issue and was removed for repair in mid-July. It was reinstalled in late July, and operated to completion in mid-October when it was removed after a total of about nine months of irradiation in core.

(b) 4DH4 Diffractometer – Reactor staff designed, fabricated, and installed the key rotating drum shutter mechanism, and continued to support the development and testing of the diffractometer. Several new procedures were developed for testing at various power levels, including verification of beam centerline, and measurement of beam spread vs. distance. These measurements provided crucial data for fabrication of a new beam stop structure.

(c) 4DH1 Student Spectrometer – To continue supporting remote automation of this experiment, reactor staff installed safety railings, locking gates, and tall Plexiglas shields all around the spectrometer in order to prevent inadvertent entry into the beam path.

For continuous support of neutron transmutation doping of silicon (NTD Si), reactor staff created and upgraded many operational procedures and recordkeeping practices. There is an annual external audit to review the program for continuation of ISO 9001 Certification. Preventive maintenance on conveyor machinery was performed during each scheduled outage. During this fiscal year, both servers for computer control and monitoring software were upgraded for improved redundancy. Additionally, the two silicon storage corrals on the reactor floor were rearranged for improved material flow and inventory control. Their walls were reoriented to provide better radiation shielding for personnel. The silicon workbench on the reactor floor was fitted with a Plexiglas shield to minimize spread of contamination during handling of activated containers and silicon ingots. A new area radiation monitor was mounted at the workbench to provide real-time dose information to workers.

Major maintenance items performed in FY2008 are summarized as follows:

1) The Fission Converter secondary system cooling pumps were rebuilt and their shafts replaced to prevent shaft seal leaks. These pumps had been in service since 1999 and provided satisfactory performance.

2) The reactor cooling towers went through a two-week long five-year maintenance service. Four of the sixteen fan motors were rebuilt with improvements such as better windings and bearing components, and another four were done at a later time. Additionally, new epoxy was applied to the internal honeycombs within the towers to repair leakage. Some internal components were also replaced to improve air flow paths inside the towers.

3) Three major secondary coolant system valves (HV-3B, HV-4, and HV-4B) were replaced. These valves have to be manipulated every startup and shutdown. The new valves are much easier to operate, reducing equipment room stay-time and dose exposure to personnel operating them. These new valves are also designed to seal better for shutdown isolation.

4) Solenoid valve AV-35 was replaced with a hydraulic-operated automatic valve designed for fluid systems. (The electric solenoid valve used previously was better used with gas systems.) This valve automatically secures city water supply to the containment if a high level is detected in the equipment room wet-sump.

5) Over a dozen surveillance cameras were installed to monitor exterior views. Reactor staff installed all the associated mount points, conduits, and wiring. This represents an important security upgrade.

6) The NW12 steam boiler was replaced with a new high-efficiency unit. This boiler now provides the main steam heat to the reactor intake air in the winter. Automatic transfer valves were installed to allow backup steam from MIT's central steam supply in case this boiler fails. New pressure gages and pressure switches were also installed for better monitoring and control. The new boiler performed satisfactorily throughout the winter, with minor adjustments occasionally required.

7) The reactor's emergency batteries were checked under load using infrared imaging. No hot spots or ground fault deficiencies were identified.

8) Analog displays for five pneumatic instruments in the control room (core tank level ML-3B, secondary coolant flow HF-6, primary coolant storage tank level, shield coolant storage tank level, and reflector D_2O dump tank level) were replaced with new digital indicators. This replacement became a necessity as analog components became less available. The pneumatic function of these devices remained unchanged, providing continuous indication when there is a loss of electric power. All poly tubing for the pneumatic signals was also replaced.

9) The reactor containment elevator lifting jack and its jacket were replaced with a double-walled unit to meet new Massachusetts elevator safety codes. The

replacement was completed in several stages, each requiring reactor shutdowns for access to the elevator controller and hydraulic box. Additionally, the controller was upgraded and the hydraulic oil was replaced.

10) The hydraulic motor starter/contactor for the reactor exhaust ventilation damper was replaced with a current industrial-grade unit for improved reliability. It was also repositioned, for greater accessibility for routine inspection and maintenance.

11) Shim blades #2 and #3 were replaced as preventive maintenance.

12) Three riser pipe sections of the shield coolant manifold in the equipment room were replaced in an effort to prevent chronic development of leaks.

13) Six new radiation area monitors were installed to supplement the existing area monitor system. Additionally, the existing units were retrofitted for wireless transmission to a new telemetric computer logs data logging and routes visual display information to the control room.

14) A significant maintenance focus over the course of FY2008 was on shipping low-level waste to reduce the inventory on site. The two shipments included forty-one 55-gallon drums of liquid, and thirty-six 55-gallon drums of solid waste. Additionally, other bulk-volume low-level solid waste was sorted and packaged into five B-25 containers (12,000# capacity, certified for use in Type A packaging) and five B-12 containers (approximately half the size). These ten containers are now sealed airtight as per manufacturer's specification. They have been weighed and gamma-characterized, and will be shipped in the near future.

15) A bypass system was designed and installed to provide CO_2 cover gas to the reactor's graphite region without use of its original gasholder. Evaluation of this system has been underway for several months and remains ongoing. The ultimate goal is to retire the gasholder and dismantle it in order to provide space for installation of new heat exchangers.

16) A rainwater leak at the back stairwell's outer wall was repaired. This required sealing the wall seams below grade with cement sealant. This corrected a chronic seepage problem which had finally worsened to the point where the source could be identified.

17) The low temperature sensor for the containment building's ventilation intake was replaced with a new digital unit.

18) One of the two large air conditioning units for the containment building ventilation system was replaced on the rooftop of the utility room. It had been damaged beyond repair by an early-Spring snowstorm when an avalanche of ice that had collected on the containment building landed on top of it. There have been no previous examples of anything similar happening on that roof. The new A/C unit was installed farther from the containment wall to prevent a recurrence.

19) The variable frequency drive (VFD) controllers for the primary pumps were thoroughly inspected and tested. The controller for pump MM-1A was found to have an intermittently-faulty block switch, which was then replaced with an upgraded unit.

20) The ion column for the reactor primary coolant system was repacked and replaced five times during the fiscal year. The D_2O reflector system's ion column was repacked, deuterized, and replaced. The spent fuel storage pool's ion column was repacked and replaced. The shield system's ion column was also repacked and replaced after more than three years in service.

21) A full-size wooden mockup was constructed of the proposed design for the secondary chemistry hot cell in the reactor's basement. The new manipulator was mounted on the mockup to make sure that its designated position will allow it to reach all the key points inside the new cell. This provided significant data for the new design, which is intended to improve radiation protection, ventilation, lighting, and manipulator capability for post-irradiation sample handling for neutron activation analysis.

22) Reactor staff coordinated with a certified contractor to inspect the polar crane in the containment building. For this year, we had the contractor include a dye penetration test on the hook and shackles.

23) The main intake and exhaust ventilation dampers were cleaned, lubricated and vacuum-tested satisfactory. This is a scheduled preventive maintenance item to ensure reliable operation for containment isolation when needed.

24) All reactor pump motors, shafts, and bearings were inspected and lubricated twice during the year. This represents an upgrade in preventive maintenance practice for over a dozen pumps and blowers.

Many other routine maintenance and preventive maintenance items were also scheduled and completed throughout the fiscal year.

E. SECTION 50.59 CHANGES, TESTS, AND EXPERIMENTS

This section contains a description of each change to the reactor 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 either have or will be forwarded to the Document Control Desk, USNRC.

The conduct of tests and experiments on the reactor are normally documented in the experiments and irradiation files. For experiments carried out under the provisions of 10 CFR 50.59, the review and approval is documented by means of the Safety Review Form. All other experiments have been done in accordance with the descriptions provided in Section 10 of the SAR, "Experimental Facilities."

Advance Cladding Irradiation Facility
SR #0-06-4 (04/03/06), #0-06-6 (05/18/06)

An in-core experiment loop was installed on May 22, 2006, to investigate the effects at various stages of irradiation on specimens of silicon carbide intended for use in advanced fuel cladding designs. Its envelope of operating conditions is very similar to that of previous in-core experiments such as the Zircaloy Corrosion Loop and the Electro-Chemical Potential Loop. No new safety issues were raised. Operation continued in the summer of 2007. No experiments were performed in FY2008, but a new campaign is expected for FY2009.

F. ENVIRONMENTAL SURVEYS

Environmental monitoring is performed using continuous radiation monitors and dosimetry devices. The radiation monitoring system consists of G-M detectors and associated electronics at each remote site with data transmitted continuously to the Reactor Radiation Protection Office and recorded on strip chart recorders. The remote sites are located within a quarter mile radius of the facility. The fiscal year total detectable radiation exposures per sector, due primarily to Ar-41, are presented below. Units located at east and south sector were inoperable periodically during the reporting period due to site renovations. These values are adjusted for the period(s) the sites were not operational.

Site	Exposure (07/01/07 – 06/30/08)
North	0.33 mrem
East	0.27 mrem
South	0.72 mrem
West	0.13 mrem
Green (east)	0.28 mrem

Fiscal Year Averages

2008	0.3 mrem
2007	0.2 mrem
2006	0.2 mrem
2005	0.2 mrem
2004	0.2 mrem
2003	0.2 mrem
2002	0.3 mrem

G. RADIATION EXPOSURES AND SURVEYS WITHIN THE FACILITY

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

July 1, 2007 - June 30, 2008

Whole Body Exposure Range (rems)	Number of Personnel
No measurable	52
Measurable – < 0.1	69
0.1 – 0.25	16
0.25 – 0.5	3
0.5 – 0.75	0
0.75 – 1.00	0
1.00 – 1.25	0
1.25 – 1.50	0
1.50 – 1.75	0
1.75 – 2.00	0
2.00 – 2.25	1

Total Person Rem = 7.04   Total Number of Personnel = 141

From July 1, 2007 through June 30, 2008, the Reactor Radiation Protection Office provided radiation protection services for the facility which included power and non-power operational surveillance (performed on daily, weekly, monthly, quarterly, and other frequencies as required), maintenance activities, and experimental project support. Specific examples of these activities included, but are not limited to, the following:

1. Collection and analysis of air samples taken within the containment building and in the exhaust/ventilation systems.

2. Collection and analysis of water samples taken from the secondary, D_2O, primary, shield coolant, liquid waste, and experimental systems, and fuel storage pool.

3. Performance of radiation and contamination surveys, radioactive waste collection and shipping, calibration of area radiation monitors, calibration of effluent and process radiation monitors, calibration of radiation protection/survey instrumentation, and establishing/posting radiological control areas.

4. Provision of radiation protection services during fuel movements, in-core experiments, sample irradiations, beam port use, ion column removal, and fission converter beam installation and testing, etc.

The results of all surveys and surveillances conducted have been within the guidelines established for the facility.

H. RADIOACTIVE EFFLUENTS

This section summarizes the nature and amount of liquid, gaseous, and solid radioactive wastes released or discharged from the facility.

1. Liquid Waste

Liquid radioactive wastes generated at the facility are discharged only to the sanitary sewer serving the facility. The possible sources of such wastes during the year include cooling tower blowdown, the liquid waste storage tanks, and various sinks. All of the liquid volumes are measured, by far the largest being the 14,900,710 liters discharged during FY2008 from the cooling towers. (Other large quantities of non-radioactive waste water are discharged to the sanitary sewer system by other parts of MIT, but no credit for such dilution is taken because the volume is not routinely measured.)

Total activity less tritium in the liquid effluents (cooling tower blowdown, waste storage tank discharges, and engineering lab sink discharges) amounted to 17.9 E-6 Ci for FY2008. The total tritium was 34.5 mCi. The total effluent water volume was 14,907,020 liters, giving an average tritium concentration of 3.32 E-6 μCi/ml.

The above liquid waste discharges are provided on a monthly basis in the following Table H-3.

All releases were in accordance with Technical Specification 3.8-1, including Part 20, Title 20, Code of Federal Regulations. All activities were substantially below the limits specified in 10 CFR 20.2003. Nevertheless, the monthly tritium releases are reported in Table H-3.

2. Gaseous Waste

Gaseous radioactivity is discharged to the atmosphere from the containment building exhaust stack. All gaseous releases likewise were in accordance with the Technical Specifications and 10 CFR 20.1302, and all nuclides were substantially below the limits after the authorized dilution factor of 3000 with the exception of Ar-41, which is reported in the following Table H-1. The 1204.34 Ci of Ar-41 was released at an average concentration of 3.14 E-9 μCi/ml. This represents 31.4% of EC (Effluent Concentration ($1\text{x}10^{-8}$ μCi/ml)).

3. Solid Waste

One shipment of solid waste was made during the fiscal year. The information pertaining to this shipment is provided in Table H-2.

TABLE H-1

ARGON-41 STACK RELEASES

FISCAL YEAR 2008

	Ar-41 Discharged (Curies)	Average Concentration[1] (μCi/ml)
July 2007	45.67	1.59 E-9
August	113.35	3.16 E-9
September	55.52	1.94 E-9
October	164.51	5.68 E-9
November	65.02	1.80 E-9
December	63.57	2.20 E-9
January 2008	85.15	2.36 E-9
February	132.21	3.66 E-9
March	27.51	9.52 E-10
April	70.87	2.47 E-9
May	210.01	5.86 E-9
June	170.95	5.96 E-9
Totals (12 Months)	**1204.34**	**3.14 E-9**
EC (Table II, Column I)		1×10^{-8}
% EC		**31.4%**

(Note 1: Average concentrations do not vary linearly with curies discharged because of differing monthly dilution volumes.)

TABLE H-2

SUMMARY OF MITR-II RADIOACTIVE SOLID WASTE SHIPMENTS

FISCAL YEAR 2008

Description	
Volume	270 ft^3 (1)
Weight	8071 lbs. (1)
Activity	22 mCi
Date of shipment	May 20th, 2008
Disposition to licensee for burial	Toxco Material Management Corp., Oak Ridge, TN
Waste broker	Philotechnics Ltd., Oak Ridge, TN

(Note 1: The MITR-II solid waste was shipped in 36 drums (55 gallons each) along with solid waste from MIT campus. The shipment totaled 1040 ft^3 and 20,571 lbs.)

TABLE H-3

LIQUID EFFLUENT DISCHARGES
FISCAL YEAR 2008

	Total Activity Less Tritium (x10^{-6} Ci)	Total Tritium Activity (mCi)	Volume of Effluent Water(1) (x10^{4} liters)	Average Tritium Concentration (x10^{-6} μCi/ml)
July 2007	NDA	1.11	74.8	1.48
Aug.	NDA	4.40	174.8	2.52
Sept.	NDA	3.10	147.5	2.10
Oct.	NDA	0.632	106.8	0.592
Nov.	NDA	0.382	66.6	0.573
Dec.	NDA	1.53	131.0	1.17
Jan. 2008	NDA	1.24	144.3	0.86
Feb.	NDA	0.185	148.8	0.124
Mar.	NDA	0.178	116.1	0.152
Apr.	1.15	5.69	121.7	4.68
May	15.0	10.4	122.7	8.46
June	1.73	5.65	135.5	4.17
12 months	17.9	34.5	1490.7	2.31

(1) Volume of effluent from cooling towers, waste tanks, and NW12-139 Engineering Lab sink. Does not include other diluent from MIT estimated at 2.7 million gallons/day.

(2) No Detectable Activity (NDA); less than 1.26x10^{-6} μCi/ml beta for each sample.

I. SUMMARY OF USE OF MEDICAL FACILITY FOR HUMAN THERAPY

The use of the medical therapy facility for human therapy is summarized here pursuant to Technical Specification No. 7.13.5(i).

1. Investigative Studies

Investigative studies remain as summarized in the annual report for FY2005.

2. Human Therapy

None.

3. Status of Clinical Trials

The Phase I glioblastoma and melanoma trials with BIDMC have been closed because they used the original epithermal beam in the basement medical therapy room. A new beam that is superior in both flux and quality continues to be available from the Fission Converter Facility. No use of that beam is anticipated in the near term because of a nationwide funding hiatus for work of this type.