

5335 PRICE AVENUE, BUILDING 258
McCLELLAN, CA 95652
PHONE: (916) 614-6200
FAX: (916) 614-6250
WEB: <http://mnrc.ucdavis.edu>
SACRAMENTO, CA 95652
PHONE: (916) 614-6200
FAX: (916) 614-6250

29 June, 2015

United States Nuclear Regulatory Commission
Attn: Document Control Desk
US Nuclear Regulatory Commission
Washington, D.C. 20555-001

**Re: 2014 Annual Report for University of California Davis/ McClellan
Nuclear Research Center, Docket No. 50-607, License No. R-130**

To Document Control Desk:

Attached is the 2014 annual report for the McClellan Nuclear Research Center,
submitted in accordance with the reporting requirements of the Technical
Specifications document MNRC-0004-DOC-13 paragraph 6.7.1.

Thanks and Regards,

Walter Guy Steingass
Associate Director for Operations
McClellan Nuclear Research Center

A020
NRR



2014

ANNUAL REPORT

Docket Number 50-607

License Number R-130



1. Introduction

The University of California, Davis, McClellan Nuclear Research Center (MNRC) consists of a research reactor, associated radiography and positioning equipment, and a wide variety of equipment to support broad-based research activities. This MNRC Annual Report is published each year in support of the license provided by the United States Nuclear Regulatory Commission (NRC). The aforementioned license is for the operation of a steady-state TRIGA™ reactor with pulsing and square wave capability.

It is the primary intent of this document to provide information relevant to the safe operation of the UCD/MNRC. A brief description of the MNRC facility and administration is followed by operational events and health physics information concerning this facility during CY 2014.

2. UCD/MNRC Facility Description

The UCD/MNRC is located on the McClellan Industrial Park site; the reactor is housed in Building 258. The McClellan Industrial Park site is approximately 2600 acres, located eight miles northeast of Sacramento, California.

The UCD/MNRC facility is a three level 14,720 sq. ft. rectangular-shaped enclosure that surrounds a 2 MW research reactor. The UCD/MNRC provides four neutron beams to four bays for radiography and other research and commercial activities. All four bays are capable of using radiography film techniques, but Bays 1 and 3 normally use electronic imaging devices. Space, shielding and environmental controls are provided by the enclosure for neutron radiography operations performed on a variety of samples. Adequate room has been provided to handle the components in a safe manner.

In addition to the radiography bays, the UCD/MNRC reactor also has several in-core facilities ranging from a pneumatic tube system to a central irradiation facility.

For more detailed information on the UCD/MNRC project, the reader is referred to the UCD/MNRC Safety Analysis Report.

3.0 UCD/MNRC Administration

UCD/MNRC Organization. The UCD/MNRC is licensed by the Nuclear Regulatory commission (NRC) to operate under the provisions of operating license R-130.

The University of California Regents have designated the Chancellor at UC Davis to be the license holder. The UCD Chancellor has in-turn delegated the Vice Chancellor for Research to be the licensee of record.

The UCD/MNRC is under the direction of the UCD/MNRC Director.



4.0 Facility Modifications (Section 50.59 of 10CFR Part 50), and experiments.

None

5.0 Approved Changes to Experiments

1. Approved K-4-20 change, Added allowance for O₂N₂ gas mixture vs. He gas for Neutron Irradiator experiments
2. Approved K-4-46 change, Changed experiment name to General Radiography of Class I Energetics

6.0 Licensing and Regulatory Activities

6.1 NRC Items

- a. The Nuclear Regulatory Commission conducted a semi-annual audit the week of 10 February 2014. No significant findings reported.
- b. The Nuclear Regulatory Commission conducted an audit the week of 8 September 2014. No significant findings reported.
- c. Nuclear Regulatory Commission Examiner performed licensing examinations for 2 SRO candidates and 1 RO candidate on 29-30 July 2014
- d. Notified by letter effective May 27, 2014 that Al Adams is no longer our Program Manager, New PM is Ms. Linh N. Tran.

6.2 Nuclear Safety Committee (UCD/NSC)

- a. The Nuclear Safety Committee Chairman performed an audit on 13 January 2014.
- b. The Nuclear Safety Committee held its semi-annual meetings on 6 February and 3 September.
- c. The Nuclear Safety Committee performed an audit of the Radiation Safety Program during the month of November.
- d. The Nuclear Safety Committee performed an Operations audit on 2 September 2014.
- e. The Nuclear Safety Committee performed a Security audit on 3 September 2014.

7.0 OPERATIONS

OPERATING HISTORY:

TOTAL OPERATING HOURS THIS YEAR:	1100.22
TOTAL OPERATING HOURS:	48416.33
TOTAL MEGAWATT HOURS THIS YEAR:	1032.85
TOTAL MEGAWATT HOURS:	63255.44
TOTAL NUMBER OF PULSES PERFORMED THIS YEAR:	0
TOTAL NUMBER OF PULSES PERFORMED:	484



7.1 UNSCHEDULED REACTOR SHUTDOWNS and NOTED PROBLEM AREAS:

In 2014, there were two (2) unscheduled shutdowns at the MNRC reactor facility. The following is a list of the unscheduled shutdowns:

2014 UNSCHEDULED REACTOR SHUTDOWNS

Type of Failures	Total Number
CSC	0
Other	2
TOTAL NUMBER OF UNSCHEDULED SHUTDOWNS IN 2014	2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CSC	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	2	0	0	0
Notes									1			

Notes:

1: Loss of off-site power twice on the same day due to weather (high winds knocked out power lines)

January

1. There were no unscheduled shutdowns in the month of January.
2. There was one callback to the facility in January.
 - a. Uninterruptable Power Supply (UPS) fault caused by power interruption to the facility, cleared on acknowledgement.

February

1. There were no unscheduled shutdowns in the month of February.
2. There was one callback to the facility in February.
 - a. Stack Continuous Air Monitor (CAM) fault, alert, alarm. Particulate channel read 0 cpm. Started Reactor CAM. Replaced Stack CAM particulate channel Gross Detector card. All retests Sat.

March

1. There were no unscheduled shutdowns in the month of March.
2. There were no callbacks to the facility in March.

April

1. There were no unscheduled shutdowns in the month of April.
2. There were no callbacks to the facility in the month of April.

May

1. There were no unscheduled shutdowns in the month of May.
2. There was one callback to the facility in the month of May.
 - a. Rod Withdrawal Prohibit (RWP) alert, cleared on acknowledgement.



June

1. There were no unscheduled shutdowns in the month of June.
2. There were six callbacks to the facility in the month of June.
 - a. All were Rod Withdrawal Prohibit alerts, all cleared on acknowledgement.

July

1. There were no unscheduled shutdowns in July.
2. There was one callback to the facility in the month of July.
 - a. UPS fault, cleared on acknowledgement.

August

1. There were no unscheduled shutdowns in the month of August.
2. There were two callbacks to the facility in the month of August.
 - a. UPS fault. Cleared on acknowledgement.
 - b. Stack CAM alarm, cleared on acknowledgement. All readings and histories are normal, no indication of cause of spike.

September

1. There were two unscheduled shutdowns in the month of September:
 - a. Loss of building AC power (offsite power), on two occasions on the same day. Manually scrammed the reactor both times.
2. There were no callbacks to the facility in the month of September.

October

1. There were no unscheduled shutdowns in the month of October.
2. There were two callbacks to the facility in the month of October.
 - a. Both were Rod Withdrawal Prohibit alerts, cleared on acknowledgement.

November

1. There were no one unscheduled shutdowns in the month of November.
2. There was one callback to the facility in the month of November.
 - a. UPS fault. Cleared on acknowledgement

December

1. There were no unscheduled shutdowns in December.
2. There was one callback to the facility in the month of December.
 - a. Rod Withdrawal Prohibit alert, cleared on acknowledgement.



7.2 ANOMALIES:

During 2014, there was 1 reported anomaly at the MNRC facility and no Radiological Incident Investigations. The specifics are listed below

December

There was one anomaly reported in the month of December. The report is as follows:

Anomaly Report 12/1/2014 0700

Reactor Power Level – Shutdown for Annual Maintenance

Failure of the Emergency Generator to start.

The UCD/MNRC has a series of weekly maintenance items that are performed the first work day of each week. One of these items is the periodic exercise of the Emergency propane Generator to verify operability in order to satisfy conditions to operate above 1.5 Megawatts if required. On Monday December 1, 2014 the generator failed to start as programmed.

Several attempts were made to manually start and run the generator and to troubleshoot the problem but were unsuccessful, sometimes with a very loud response. There were no problems found with fuel, fuel lines, fuel filters, the battery, etc.

This Monday (12/1) was also the first day of the Annual Planned Maintenance shutdown period and as such no reactor power operations were anticipated for about 2 weeks. The generator is not required for operations below 1.5 Megawatts and when the reactor is shutdown. It is only required for Emergency Core Cooling operations in the event that the reactor core is uncovered or about to be uncovered after an extended period of high power operations and building power is lost in accordance with OMM 5160, and Technical Specifications Section 3.3 Reactor Coolant Systems section d.

Actions to correct the Anomaly:

The vendor that the UCD/MNRC uses to perform corrective or non-routine maintenance on the generator was contacted for the troubleshooting and repair work. The vendors' technical staff was unable to successfully troubleshoot the problem and ultimately decided that the unit needed to be replaced due the problem and the non-availability of some replacement parts.

At this time the UCD/MNRC Electronics Engineer began looking into the problem and discovered that there was a corrosion/loose connection issue with the points in the distributor and that the spark plug wires were old.



The spark plug wires were replaced and the connection at the distributor for the points was cleaned and tightened.

The generator was run satisfactorily several times in manual and started successfully when programmed.

Reliability was re-established on 12/19/2014.

Actions to prevent reoccurrence:

As part of the annual inspections of the generator set, special attention will be placed on looking at the distributor wiring and the spark plug wiring, both were original to the set and in excess of 20 years old.

7.3 MAINTENANCE OTHER THAN PREVENTIVE:

January

System #	Description	Work Performed
5130	Secondary Cooling Tower	Repair leak in tower. Reattached balance clean chamber boot and mounting bracket
5130	Secondary Pump	Replaced failed pump discharge pressure gage

February

System #	Description	Work Performed
5510	Pneumatic Transfer System	Replaced PTS blower HEPA filter
1001	Stack Continuous Air Monitor (CAM)	Replaced Particulate channel Gross Detector Card
5640	AC-7 (Bay 2 ventilation)	Replaced unit Safety Switch, replaced controller card, added refrigerant
5490	Helium Supply System	Replaced expended He supply bottle

March

System #	Description	Work Performed
1020	Equipment room Radiation Area Monitor (RAM)	Replaced GM tube in Equipment Room and Spare RAMs
1800	Reactor Ventilation	DOP test Reactor Room Exhaust filters
1803	Rad-Vac	DOP test Radiological Vacuum Cleaner



April

System #	Description	Work Performed
5330	NM-1000	Replace + 15 volt and -15 volt power supplies to correct noise issues.
5330	NM-1000	Replace two power supplies in lower cabinet to correct noise issues.
5330	DAC	Replace relay K-3 on ActionPak shelf of Digital Acquisition Cabinet (DAC) to correct erratic indications during manual test.

May

System #	Description	Work Performed
1001	Stack CAM	Replaced Particulate Channel Gross Detector Channel Card
5490	Helium Supply System	Replaced expended He supply bottle
5490	Helium Supply System	Relocate noise suppression snubbers on pressure switches

June

System #	Description	Work Performed
1001	Stack CAM	Replaced CRT display due to intermittent loss

July

System #	Description	Work Performed
5490	Helium Supply	Replaced expended He supply bottle
1001	Stack CAM	Install switch on Stack CAM Check Source pump
5740	Building Fire Sprinkler System	Replaced 5 HP air compressor for sprinkler dry pipe

August

System #	Description	Work Performed
5470	Fire Suppression	Replace leaking joint in Bay 4 staging area fire header, leak check sat.
5360	Uninterruptable Power Supply (UPS)	Troubleshoot/repair UPS Fault/Alarm. Left system shutdown for several hours. Performed checks on all electronic circuit boards and fuses. Reenergized unit, operations sat. No repairs performed.
5490	Helium Supply	Replace expended He supply bottle
5640	AC-7(Bay 2 Ventilation)	Replace AC-7 with current replacement model



September

System #	Description	Work Performed
5130	Secondary Cooling System	Replace conductivity card for Cooling Tower water treatment system
5120	Demineralizer System	Removed/cleaned/inspected and reassembled the Demin system resin bottle outlet strainer due to degraded flow. Found an even layer of resin fines coating the inner surface of the strainer element. Element cleaned with acetone and distilled water. Leak check sat.

October

System #	Description	Work Performed
5490	Helium Supply	Replace expended He supply bottle

November

System #	Description	Work Performed
1001	Stack CAM	Replace failed blower motor
1001	Stack CAM	Replace blower motor oil drain fitting
1001	Stack CAM	Replace all four castor/wheels on unit

December

1. MNRC completed the annual reactor maintenance shutdown during the month of December. Technical Specification required periodic maintenance as well as general maintenance was performed.
2. Parametric values noted during testing are as follows:

	Control Rod Worth:	
Transient Rod: \$1.95	Shim 1: \$2.64	Shim 2: \$2.54
Shim 3: \$2.75	Shim 4: \$2.99	Regulating Rod: \$2.82

Control Rod Scram Drop Times:		
Transient Rod: 0.35 sec	Shim 1: 0.38 sec	Shim 2: 0.37 sec
Shim 3: 0.40 sec	Shim 4: 0.39 sec	Regulating Rod: 0.39 sec

Shutdown Margin: \$5.84

A preliminary nuclear instrument calorimetric calibration was performed. Both the NPP channel and the NM-1000 channels of the Nuclear Instruments were satisfactory, and no adjustments were required.

High Power Scram checks and the final calorimetric were deferred until the emergency generator repairs were completed to permit operation at greater than 1.5 Megawatts.



Emergency generator repairs were completed and the unit was retested satisfactorily (and reliability confirmed) and returned to service on January 5, 2015.

On January 5, 2015 the last of the 2014 Annual Shutdown maintenance items were completed.

The normal nuclear instrument calorimetric calibration was performed. Both the NPP channel and the NM-1000 channels of the Nuclear Instruments were satisfactory, and no adjustments were required.

At Power Scram values: NPP-1000: 106% indicated, NM-1000: 105% indicated.

System #	Description	Work Performed
1001	Bay Continuous Air Monitor (CAM)	Replaced Particulate Channel check source solenoid
1001	Bay CAM	Replaced wheels on unit
1001	Stack CAM	Replaced Argon Channel check source solenoid
5640	HV-3 (Bay 4 Staging Area)	Replace belt on HV-3
5490	Helium Supply	Replace expended He supply bottle

7.4 Training

January

1. One Operator Trainee received Environmental Survey training.

February

1. There was no scheduled training for the month of February

March

1. All licensed Senior Reactor Operators were administered and passed the biennial requalification exam.
2. One student was trained on Radiological Lesson Plan B (Working with Radioactive Materials)
3. Licensed Senior Reactor Operators and trainees received training on Design and Operating Characteristics.
4. All Licensed Senior Reactor Operators and trainees received training on document revisions to Radiation Safety Procedures.

April

1. All facility personnel attended ALARA/Safety/Security training.
2. RSO attended DOT Hazardous Shipping training.
3. Hosted and conducted training for University of California Berkeley Nuclear Engineering classes. (Classroom and Practical Lab training)



May

1. MNRC conducted an all hands Annual Security Drill, involving Sacramento County Sheriff Department personnel and UC Davis Police.

June

1. There was no scheduled training for the month of June.

July

1. All licensed and candidate operators successfully completed the Annual Operators Examination.
2. MNRC conducted summer school classed for the University COSMOS program.
3. One Reactor Operator candidate and two Senior Reactor Operator (Instant) candidates were administered Nuclear Regulatory Commission (NRC) licensing written and oral examinations.
(Note: Both the SRO instants passed the both examinations. The RO candidate passed the oral section of the exam but failed one section of the written exam).

August

1. There was no schedule training in the month of August.

September

1. All licensed operators and trainees attended Fuel and Fuel Handling training.
2. Wesley Frey and Tim Essert became certified Licensed Senior Reactor Operators by the NRC.

October

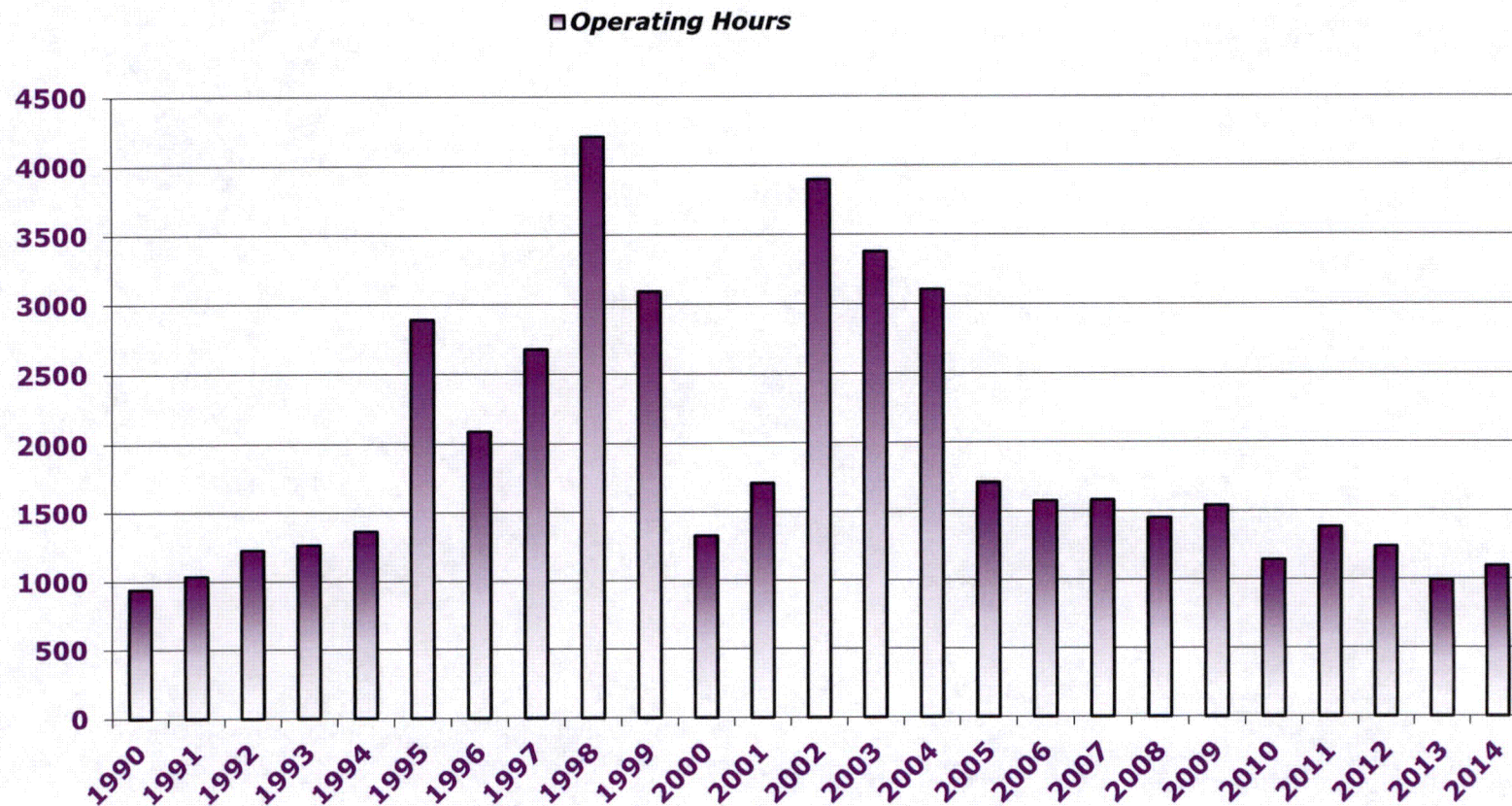
1. All Licensed Operators and trainees attended Normal, Abnormal and Emergency Procedures training.

November

1. There was no scheduled training for the month of November

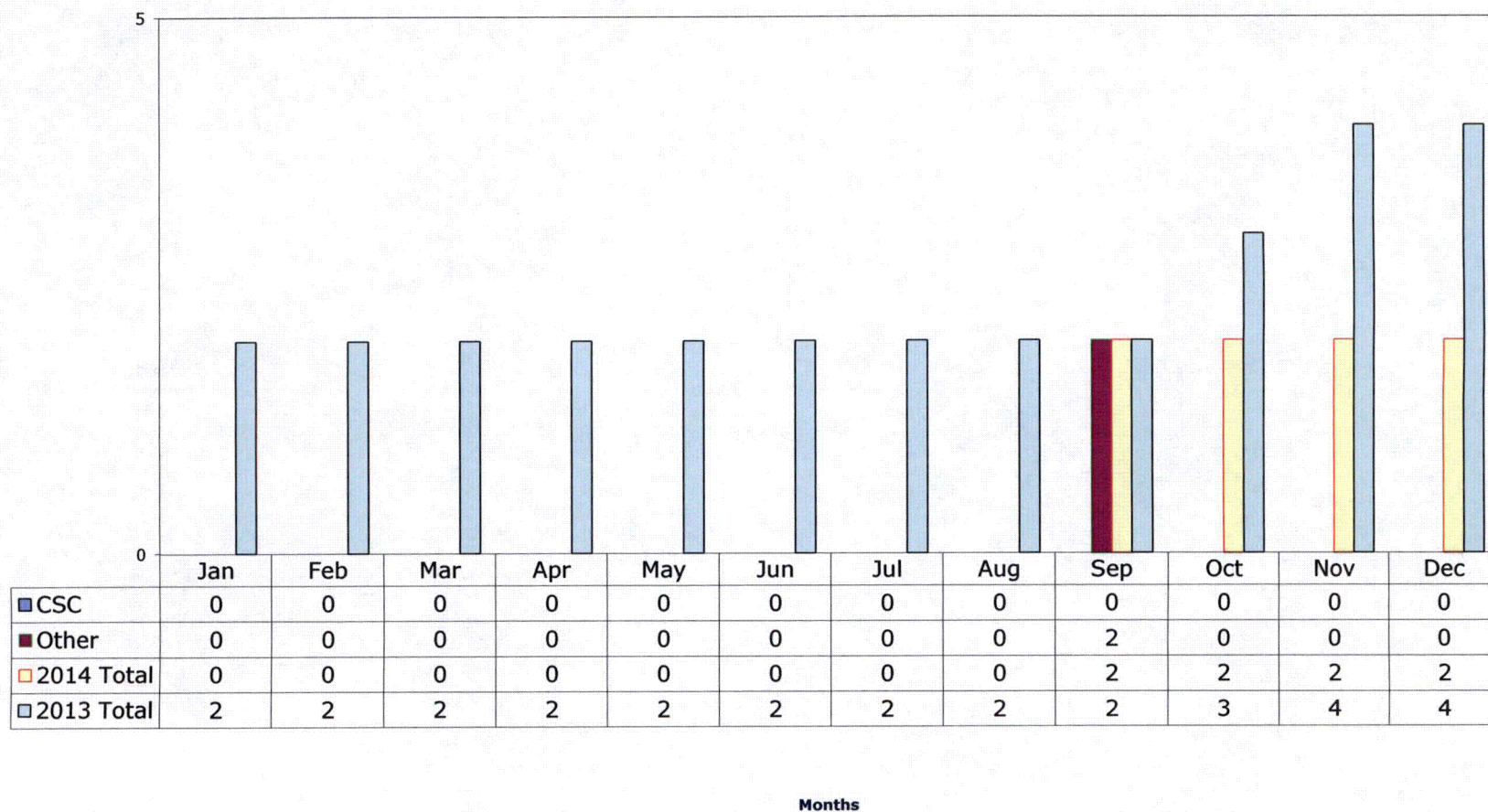
December

1. There was no scheduled training for the month of December.





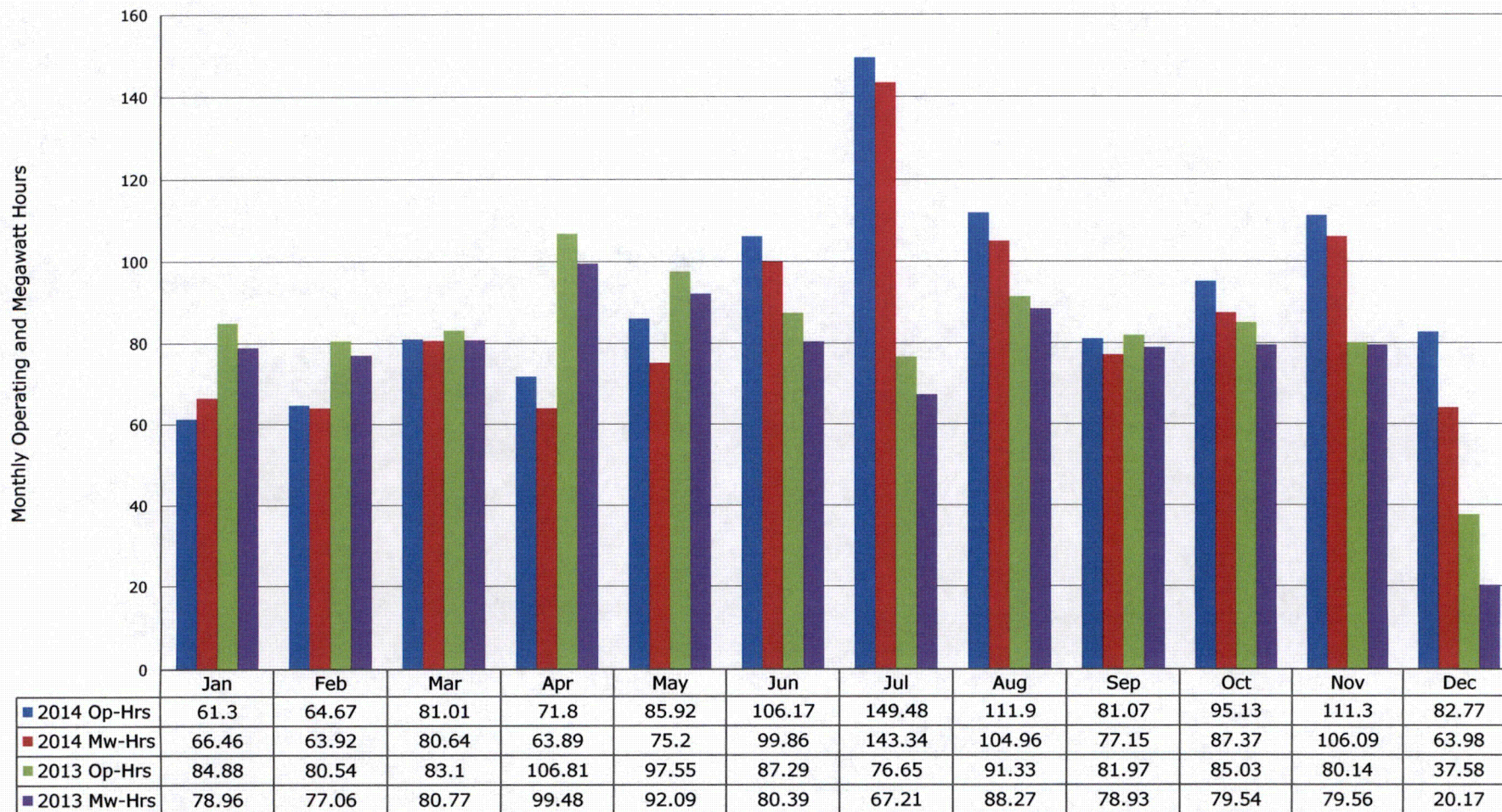
Unscheduled Reactor Shutdowns 2014





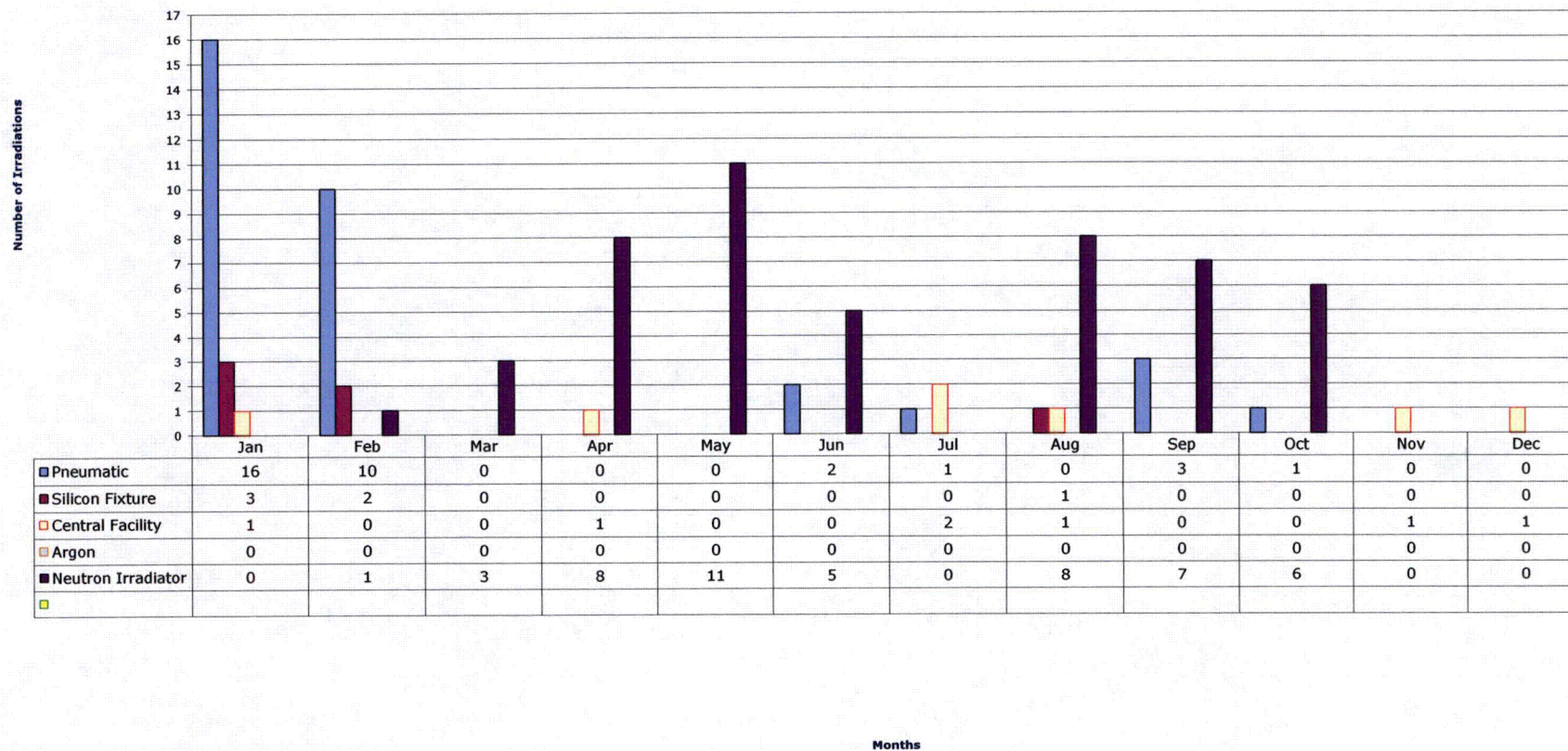
Reactor Hours (2014)

Reactor Hours 2014



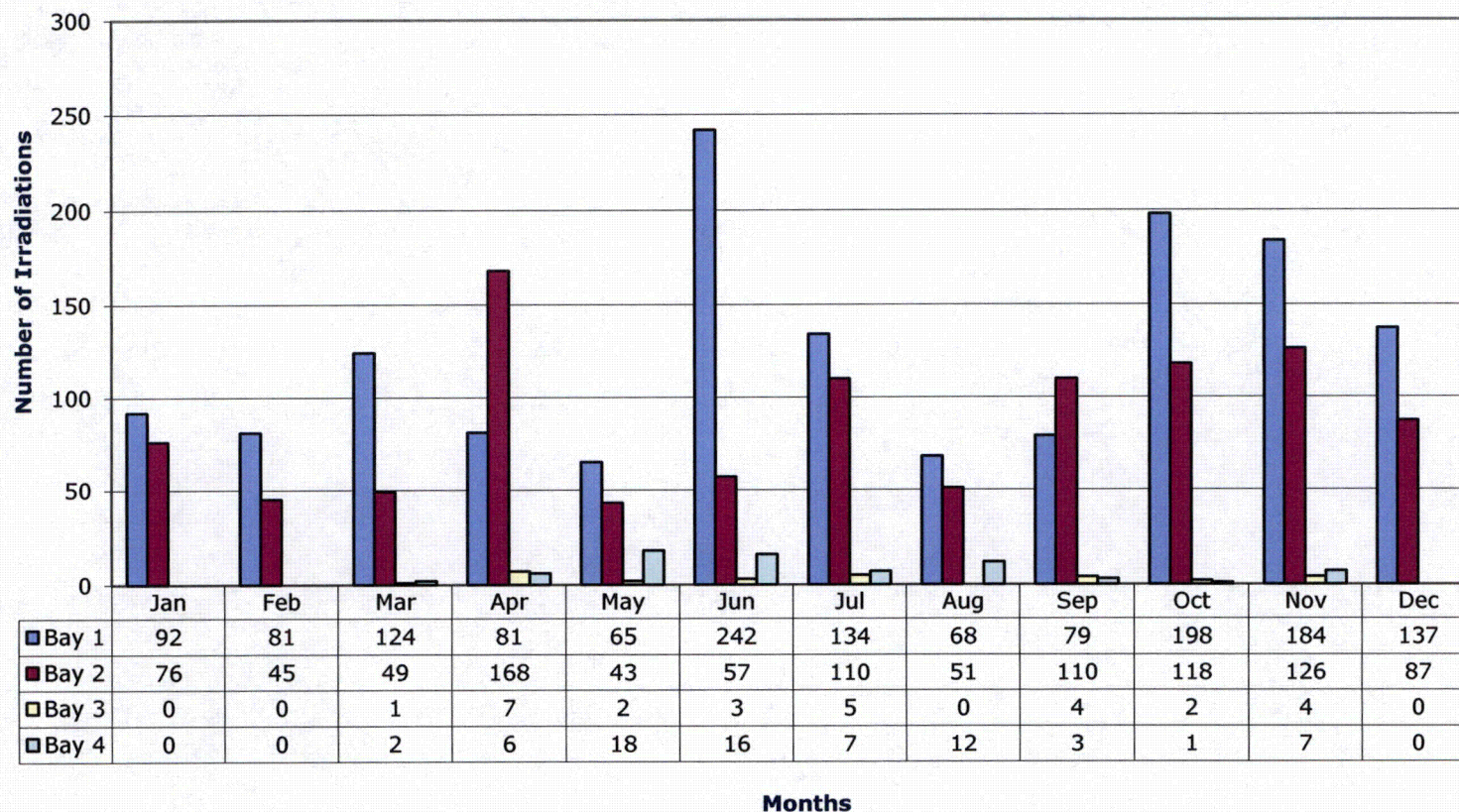


Reactor Tank Irradiation Facilities 2014



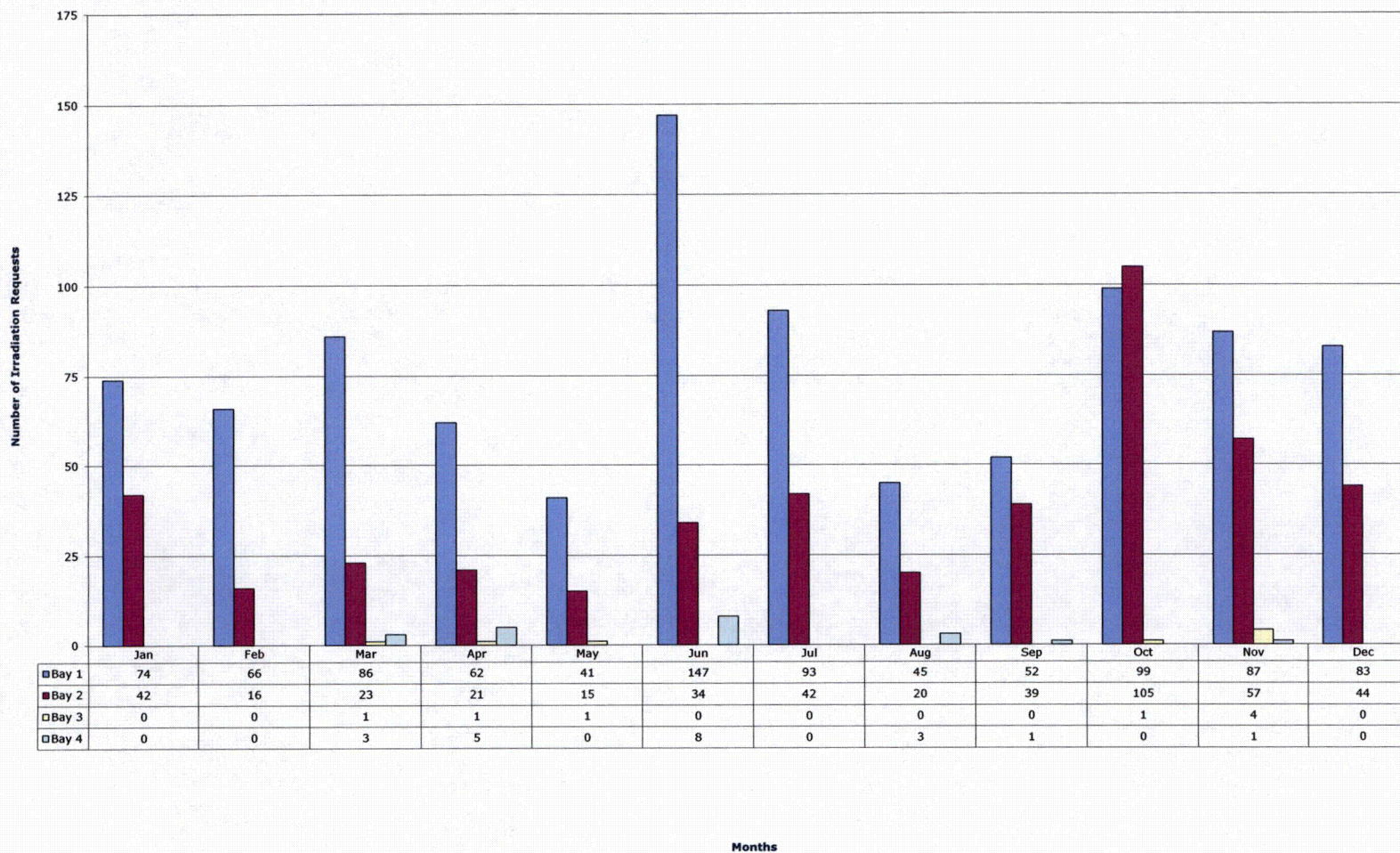


Bay Utilization (Shutter Operations) 2014





Bay Irradiation Requests Completed 2014





8.0 Radioactive Effluents

A summary of the nature and amount of radioactive effluents released or discharged to the environment beyond the effective control of the MNRC, as measured at or prior to the point of such release or discharge, include the following:

8.1 Liquid Effluents

No liquid effluents were released during 2014.

8.2 Airborne Effluents

Airborne radioactivity discharged during 2014 is tabulated in Table 1 below.

TABLE 1
2014 SUMMARY OF AIRBORNE EFFLUENTS

MONTH	TOTAL EST. QUAN. Ar-41 RELEASED	EST. MAX AVG. CONC. OF Ar-41 IN UNRESTRICTED AREA ⁽¹⁾⁽³⁾	FRACTION OF APPLICABLE 10CFR20 Ar-41 CONC. LIMIT FOR UNRESTRICTED AREA ⁽¹⁾	EST. DOSE ⁽²⁾ FROM Ar-41 FOR UNRESTRICTED AREA ⁽¹⁾	FRACTION OF APPLICABLE 10CFR20 DOSE CONSTRAINT FOR UNRESTRICTED AREA ⁽¹⁾⁽⁴⁾	TOT. EST. QUANTITY OF ACT. IN PART. FORM WITH HALF-LIFE >8 DAYS	AVERAGE CONC. OF PART. ACT. RELEASED WITH HALF-LIFE > 8 DAYS
	(Ci)	(uCi/ml)	(%)	(mrem)	(%)	(Ci)	(uCi/ml)
JAN	1.70	9.59E-11	1.0%	5.84E-01	5.84%	NONE	NONE
FEB	0.83	4.70E-11	0.5%	2.86E-01	2.86%	NONE	NONE
MAR	0.76	4.25E-11	0.4%	2.59E-01	2.59%	NONE	NONE
APR	0.64	3.59E-11	0.4%	2.19E-01	2.19%	NONE	NONE
MAY	0.66	3.72E-11	0.4%	2.27E-01	2.27%	NONE	NONE
JUN	1.16	6.52E-11	0.7%	3.97E-01	3.97%	NONE	NONE
JUL	1.60	9.02E-11	0.9%	5.49E-01	5.49%	NONE	NONE
AUG	1.00	5.65E-11	0.6%	3.44E-01	3.44%	NONE	NONE
SEP	1.20	6.78E-11	0.7%	4.13E-01	4.13%	NONE	NONE
OCT	1.20	6.75E-11	0.7%	4.11E-01	4.11%	NONE	NONE
NOV	1.99	1.12E-10	1.1%	6.82E-01	6.82%	NONE	NONE
DEC	1.47	8.30E-11	0.8%	5.05E-01	5.05%	NONE	NONE
TOT	14.2	8.01E-10		4.87		NONE	NONE
AVG	1.18	6.67E-11	0.7%	4.06E-01	4.06%		

(1) This location is 240 meters downwind which is the point of maximum expected concentration based on the worst case atmospheric conditions (see MNRC SAR Chapter 11).

(2) Based on continuous occupancy and the calculation techniques used in Appendix A of the MNRC SAR (Ar-41 at 2.3E-10 uCi/ml continuous for one year equals 1.4 mrem).

(3) 10CFR20 Limit for concentration is 1E-8 (Appendix B, Table 2);

(4) Constraint for dose is 10 mrem/year [10CFR20.1101(d)]



8.3 Solid Waste

One (1) B-25 box of solid waste was shipped to Thomas Gray & Associates.
Total: 98ft³, 54mCi

9.0 Radiation Exposure

Radiation exposure received by facility operations personnel, facility users, and visitors during 2014 is summarized in Table 2 below.

TABLE 2
2014 SUMMARY OF PERSONNEL RADIATION EXPOSURES

	NUMBER OF INDIVIDUALS	AVERAGE TEDE PER INDIVIDUAL (mrem)	GREATEST INDIVIDUAL TEDE (mrem)	AVERAGE EXTREMITY (mrem)	GREATEST EXTREMITY (mrem)
FACILITY PERSONNEL⁽¹⁾	9	23	79	55	209
FACILITY USERS	26	.35	3	*	*
VISITORS	919	<0.1	2	*	*

(1) Only four facility personnel actually received exposure.

* Extremity monitoring was not required.



10.0 Radiation Levels and Levels of Contamination

Radiation levels and levels of contamination observed during routine surveys performed at the MNRC during 2014 are summarized in Table 3 below.

TABLE 3
2014 SUMMARY OF RADIATION LEVELS AND CONTAMINATION LEVELS
DURING ROUTINE SURVEYS

	AVERAGE (mrem/hr)	HIGHEST (mrem/hr)	AVERAGE (dpm/100cm ²)	HIGHEST (dpm/100cm ²)
OFFICE SPACES	<0.1	<0.1	<5000 ⁽¹⁾	<5000 ⁽¹⁾
REACTOR CONTROL RM	<0.1	<0.1	<5000 ⁽¹⁾	<5000 ⁽¹⁾
RADIOGRAPHY CONTROL RM	<0.1	<0.1	<5000 ⁽¹⁾	<5000 ⁽¹⁾
COUNTING LAB	<0.1	<0.1	<5000 ⁽¹⁾	<5000 ⁽¹⁾
STAGING AREA	<0.1	<0.1	<5000 ⁽¹⁾	<5000 ⁽¹⁾
COMPOUND	<0.1	<0.1	<5000 ⁽¹⁾	<5000 ⁽¹⁾
EQUIPMENT RM	0.2	120	<800 ⁽²⁾	<800 ⁽²⁾
DEMINERALIZER AREA	18	350	<800 ⁽²⁾	<800 ⁽²⁾
REACTOR RM	2.0	270	<800 ⁽²⁾	<800 ⁽²⁾
SILICON STORAGE SHED	<0.1	<0.1	<5000 ⁽¹⁾	<5000 ⁽¹⁾
RADIOGRAPHY BAYS	3.7 ⁽³⁾	600	<800 ⁽²⁾	<800 ⁽²⁾

(1) <5000 dpm/100 cm² = Less than the lower limit of detection for a scanning survey.

(2) <800 dpm/100 cm² = Less than the lower limit of detection for a swipe survey.

(3) Due to Bay 1 Storage Areas; all other areas and bays are significantly lower (typically <0.1 mrem/hr).



11.0 Environmental Surveys

Environmental surveys performed outside of the MNRC during 2014 are summarized in Tables 4 & 5 below. The environmental survey program is described in the MNRC Facility Safety Analysis Report.

TABLE 4
2014 SUMMARY OF ENVIRONMENTAL TLD RESULTS
(WITH NATURAL BACKGROUND⁽¹⁾ SUBTRACTED)

	AVERAGE (mrem)	HIGHEST (mrem)
ON BASE (OFF SITE 1-20 & 64)	5	14
ON SITE (SITES 50 – 61 & 65-71)	13	20

(1) Natural background assumed to be the off base (Sites 27-42) average of 25 mrem.



TABLE 5
2014 SUMMARY OF RADIOACTIVITY IN WELL WATER

	ALPHA (pCi/l)	BETA (pCi/l)	TRITIUM (pCi/l)	Cs-137 (pCi/l)
AVERAGE	<MDA	2.36	<MDA	<MDA
HIGHEST	<MDA	3.21	<MDA	<MDA

MDA is the minimum detectable activity at the 95% confidence level.

The MDA range for the analyzed radionuclides (pCi/L).

	MIN	MAX
Alpha	1.68	2.13
Beta	2.02	2.36
Tritium	290	326
Cs-137	4.92	6.59