



2020

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 2020.

## **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. 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.**

1. K-4-53 (Sb source production in the Central Irradiation Facility (CIF)).
2. K-4-54 (P-32 source production in the CIF).

#### **5.0 Approved Changes to Experiments**

None

#### **6.0 Licensing and Regulatory Activities**

##### **6.1 NRC Items**

- a. The Nuclear Regulatory Commission conducted a semi-annual inspection the week of 6 January 2020. No significant findings reported.
- b. The Nuclear Regulatory Commission conducted an inspection the week of 15 June 2020. No significant findings reported.
- c. One Senior Reactor Operator retired and his license was terminated.
- d. Licensing Renewal documentation was transmitted to the Nuclear Regulatory Commission on 10 July 2020 for 2 Senior Reactor Operators. They are currently in "Timely Renewal".

##### **6.2 Nuclear Safety Committee (UCD/NSC)**

- a. The Nuclear Safety Committee held its semi-annual meetings on 6 March and 23 September 2020.
- b. The Nuclear Safety Committee performed an Operations audit for 2020 on 14 January 2021.
- c. The Nuclear Safety Committee performed an audit of the Radiation Safety Program on 9 November 2020.
- d. The Nuclear Safety Committee performed a Security audit on 23 October 2020.

#### **7.0 OPERATIONS**

##### **OPERATING HISTORY:**

TOTAL OPERATING HOURS THIS YEAR:	1638.47
TOTAL OPERATING HOURS:	56186.73
TOTAL MEGAWATT HOURS THIS YEAR:	1549.28
TOTAL MEGAWATT HOURS:	70483.99
TOTAL NUMBER OF PULSES PERFORMED THIS YEAR:	0
TOTAL NUMBER OF PULSES PERFORMED:	484

### 7.1 UNSCHEDULED REACTOR SHUTDOWNS and NOTED PROBLEM AREAS:

In 2020, there was one (1) unscheduled reactor shutdown at the MNRC reactor facility. The following is a list of the unscheduled shutdowns:

#### 2020 UNSCHEDULED REACTOR SHUTDOWNS

Type of Failures	Total Number
CSC	0
Other	1
TOTAL NUMBER OF UNSCHEDULED SHUTDOWNS IN 2020	1

	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	1	0	0	0	0	0
Notes							1					

Notes:

1: Scram Database Timeout – Cleared on Rebooting the Control System Console (CSC) computer

#### January

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

#### February

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

#### March

1. There were no unscheduled shutdowns in the month of March.
2. There was one callback to the facility in March.
  - a. The Stack Continuous Air Monitor (CAM) experienced a momentary fault (Derivative Alarm) that cleared on acknowledgement.

#### 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 were no callbacks to the facility in the month of May.

#### June

1. There were no unscheduled shutdowns in the month of June.
2. There was one callback to the facility in the month of June.
  - a. The Stack CAM was found to be in a fault, alert and alarm condition with all displayed indications normal. It appears that the Stack CAM rebooted itself.

**July**

1. There was one unscheduled shutdown in July.
  - a. Reactor Scram, caused by Database Timeout. Cleared on reboot.
2. There was one callback to the facility in the month of July.
  - a. Callback due to loss of site power.

**August**

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

**September**

1. There were no unscheduled shutdowns in the month of September.
2. There were two callbacks to the facility in the month of September.
  - a. Callback due to a flock of birds flying through sensors.
  - b. Callback due to momentary spike in Stack CAM indications

**October**

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

**November**

1. There were no unscheduled shutdowns in the month of November.
2. There were two callbacks to the facility in the month of November.
  - a. Fire Alarm caused by a failed smoke detector.
  - b. Callback due to a Scram Database Timeout message. Cleared on reboot.

**December**

1. There were no unscheduled shutdowns in December.
2. There was one callback to the facility in the month of December.
  - a. Scram Database Timeout. Cleared on reboot.

**7.2 ANOMALIES:**

During 2020, there were no anomalies at the MNRC facility and no Radiological Incident Investigations.

**7.3 MAINTENANCE OTHER THAN PREVENTIVE :**

**January**

<b>System #</b>	<b>Description</b>	<b>Work Performed</b>
5490	Helium Supply	Replace expended Helium Supply bottle

**March**

<b>System #</b>	<b>Description</b>	<b>Work Performed</b>
1800	Reactor Ventilation	DOP test Reactor Room Exhaust HEPA filters
1803	Rad-Vac	DOP test Radiological Vacuum Cleaner
5490	Helium Supply	Replace expended Helium Supply bottle
1001	Stack CAM SCA card	Replaced Stack CAM SCA card. Recalibrated the Argon Channel

**April**

<b>System #</b>	<b>Description</b>	<b>Work Performed</b>
5490	Helium Supply	Replace expended Helium Supply bottle
5640	AC-9	Replaced AC-9 with new unit

**May**

<b>System #</b>	<b>Description</b>	<b>Work Performed</b>
5490	Helium Supply	Replaced expended helium supply bottle
5330	NM-1000 Calibration Mode 4 noise problem	Troubleshoot and repaired NM-1000 Calibration Mode 4 noise issue.
1001	Reactor CAM fuse holder	Replaced failed Rx CAM fuse holder
5740	Fire System air compressor	Replaced failed Fire system air compressor and the leaking inlet manifold to the fire suppression system

**June**

<b>System #</b>	<b>Description</b>	<b>Work Performed</b>
5120	Demineralizer system resin bottles	Replaced 2 depleted Demineralizer System resin bottles
5490	Helium Supply	Replaced expended helium supply bottle

### July

System #	Description	Work Performed
5510	Pneumatic Transfer System	Replaced failed EF-3 Blower motor
5310	CSC Status Monitor	Replaced Failed CSC Status monitor
5490	Helium Supply	Replaced expended helium supply bottle

### August

1. MNRC completed the annual reactor maintenance shutdown during the month of August. 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: \$1.84	Shim 1: \$2.50	Shim 2: \$2.36
Shim 3: \$2.46	Shim 4: \$2.93	Regulating Rod: \$2.69

	Control Rod Scram Drop Times:	
Transient Rod: 0.35 sec	Shim 1: 0.40 sec	Shim 2: 0.37 sec
Shim 3: 0.42 sec	Shim 4: 0.39 sec	Regulating Rod: 0.41 sec

Shutdown Margin: \$6.38

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: 107% indicated, NM-1000: 100% indicated.

### September

System #	Description	Work Performed
5490	Helium Supply	Replaced expended helium supply bottle
5330	NM-1000 Cambelling Module	Replaced 2 IC sockets in the Cambelling Module. Retests Sat.
5330	NM-1000	Replaced leaking capacitor. Retest Sat.

#### October

System #	Description	Work Performed
5330	CSC Computer	CSC computer did not recover after UPS load test. Replaced CSC computer hard drive.
5490	Helium Supply	Replaced expended helium supply bottle

#### November

System #	Description	Work Performed
5620	Reactor Room Ventilation	Replaced failed EF-1 fan motor.

#### December

System #	Description	Work Performed
5740	Smoke Detector	Replaced failed below deck smoke detector
5490	Helium Supply	Replaced expended helium supply bottle

### 7.4 Training

#### January

1. Two Senior Reactor Operators completed training on Administrative Controls and Procedures.
2. Three Facility personnel received training on Emergency Drills and Basic Emergency Response.
3. Five Senior Reactor Operators participated in a Security Drill.

#### February

1. One Senior Reactor Operator completed training on Administrative Controls and Procedures

#### March

1. One Senior Reactor Operator completed training on Administrative Controls and Procedures.
2. Five Senior Reactor Operators completed training on Facility Design and Operating Characteristics.

#### April

1. Facility personnel completed Annual ALARA and annual Safety/Security training.
2. One Senior Reactor Operator completed training on Administrative Controls and Procedures.
3. Four Senior Reactor Operators completed and passed the Biennial Requalification Exam.





**May**

1. Facility personnel attended training for Document Changes.

**June**

1. Two Senior Reactor Operators completed their Biennial Medical exams.
2. One trainee received training on Building Cranes and rigging.

**July**

1. Facility personnel received training on changes to the Neutron Radiography training program.

**August**

1. All Senior Reactor Operators and one trainee completed Fuel and Fuel Handling training.
2. One trainee received training on Building Cranes and rigging.

**September**

1. No training was held in September.

**October**

1. All Senior Reactor Operators completed the Annual Operators Examination.

**November**

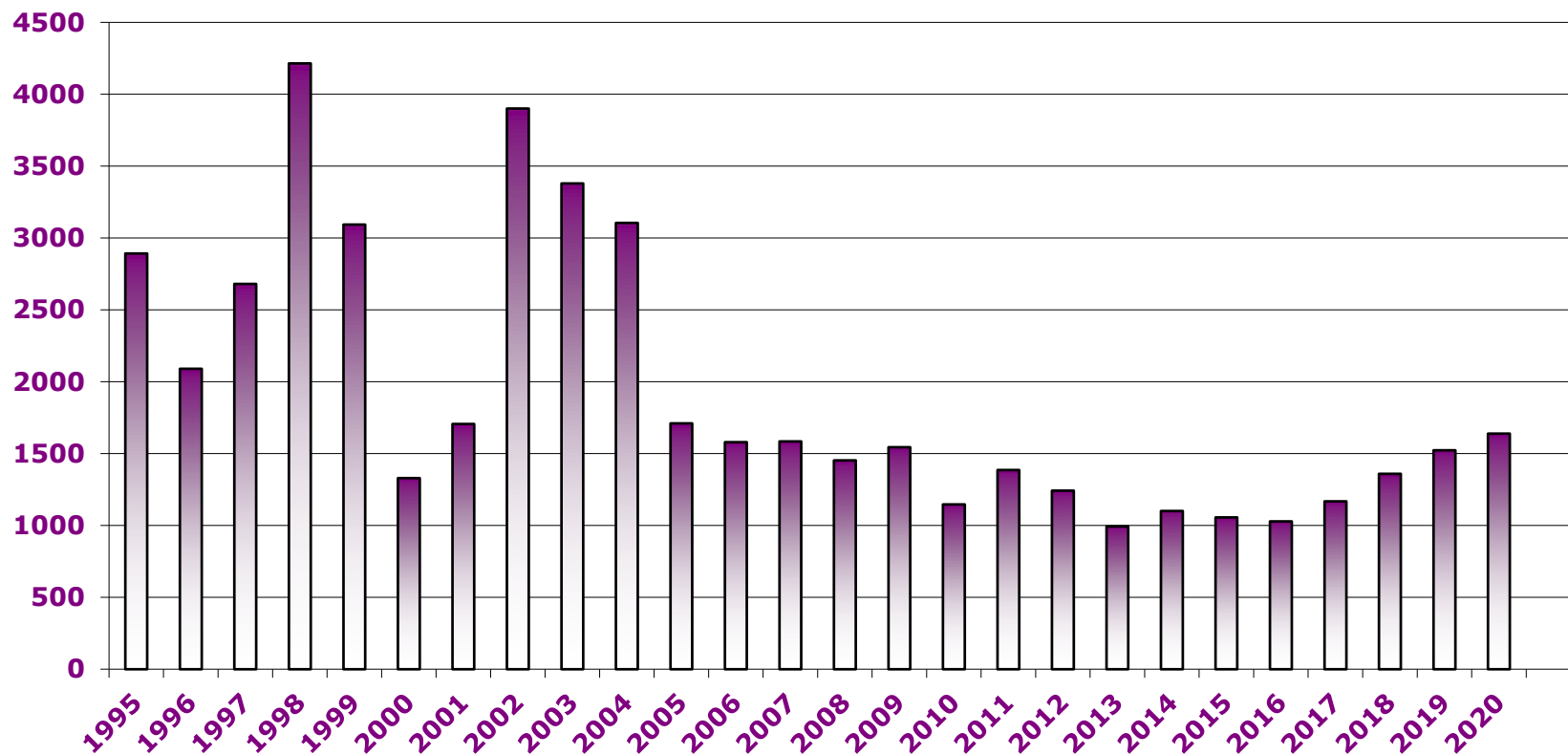
1. No training was held in November.

**December**

1. No training was held in December.

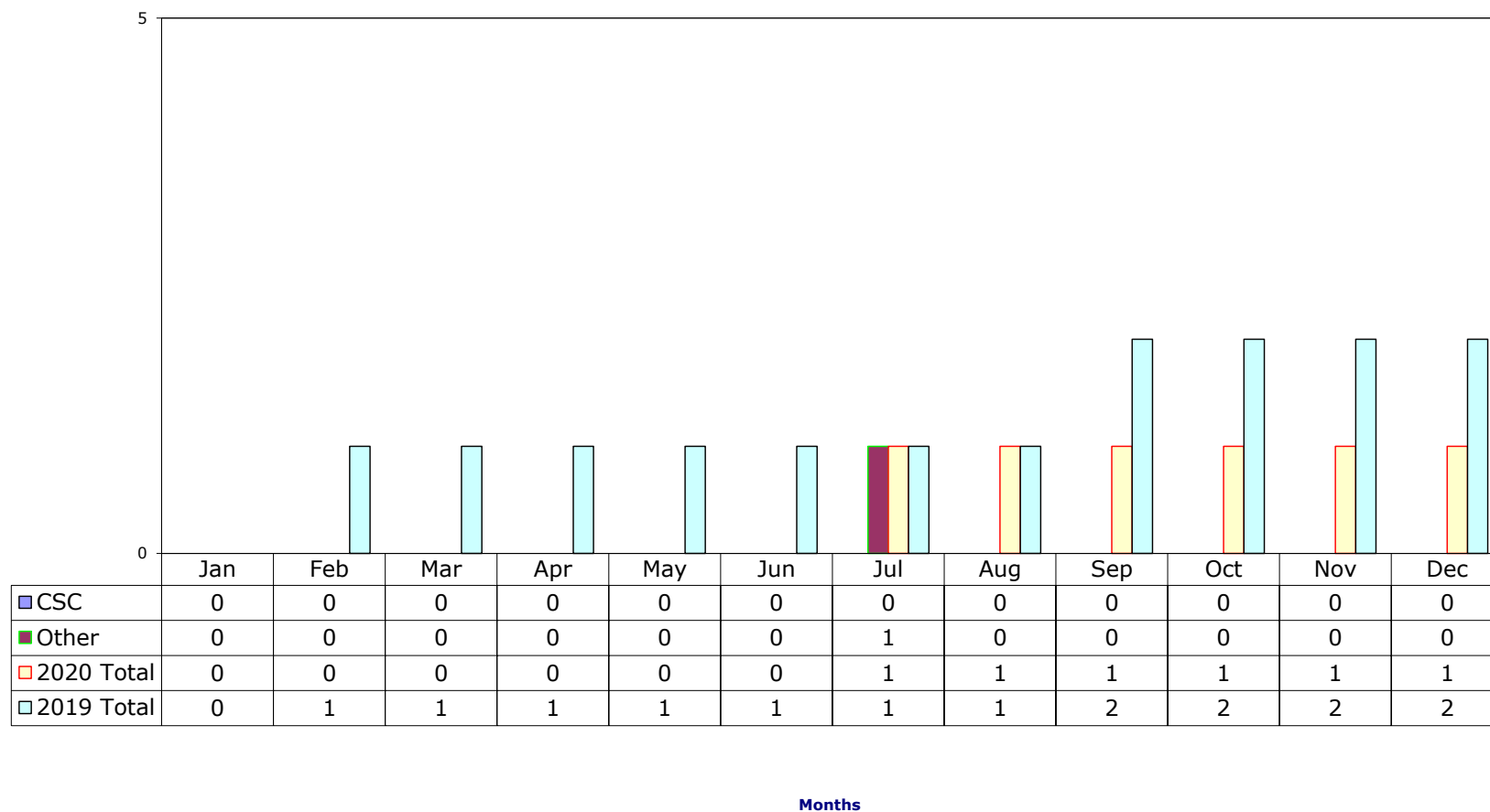


■ *Operating Hours*





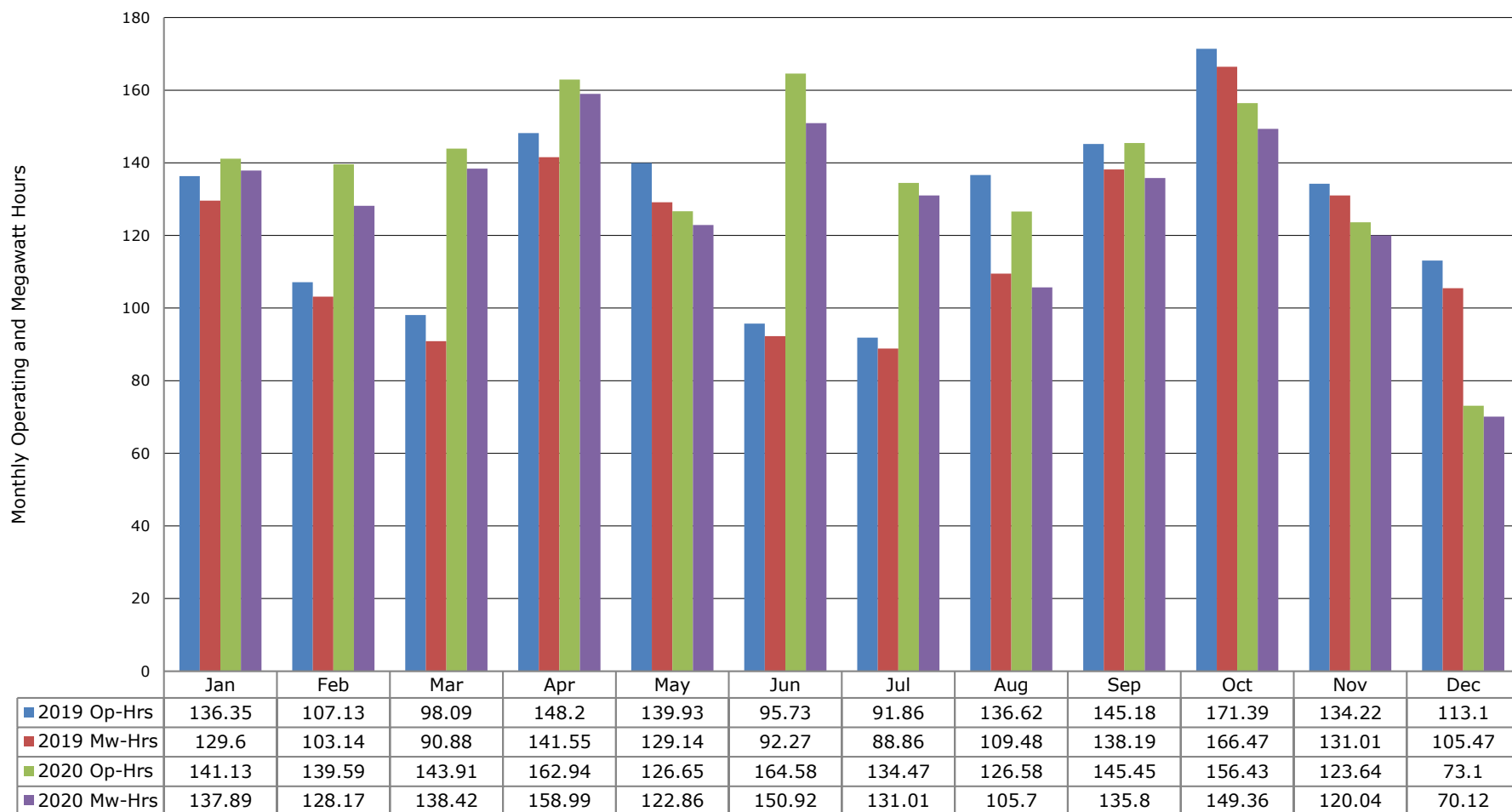
## Unscheduled Reactor Shutdowns 2020





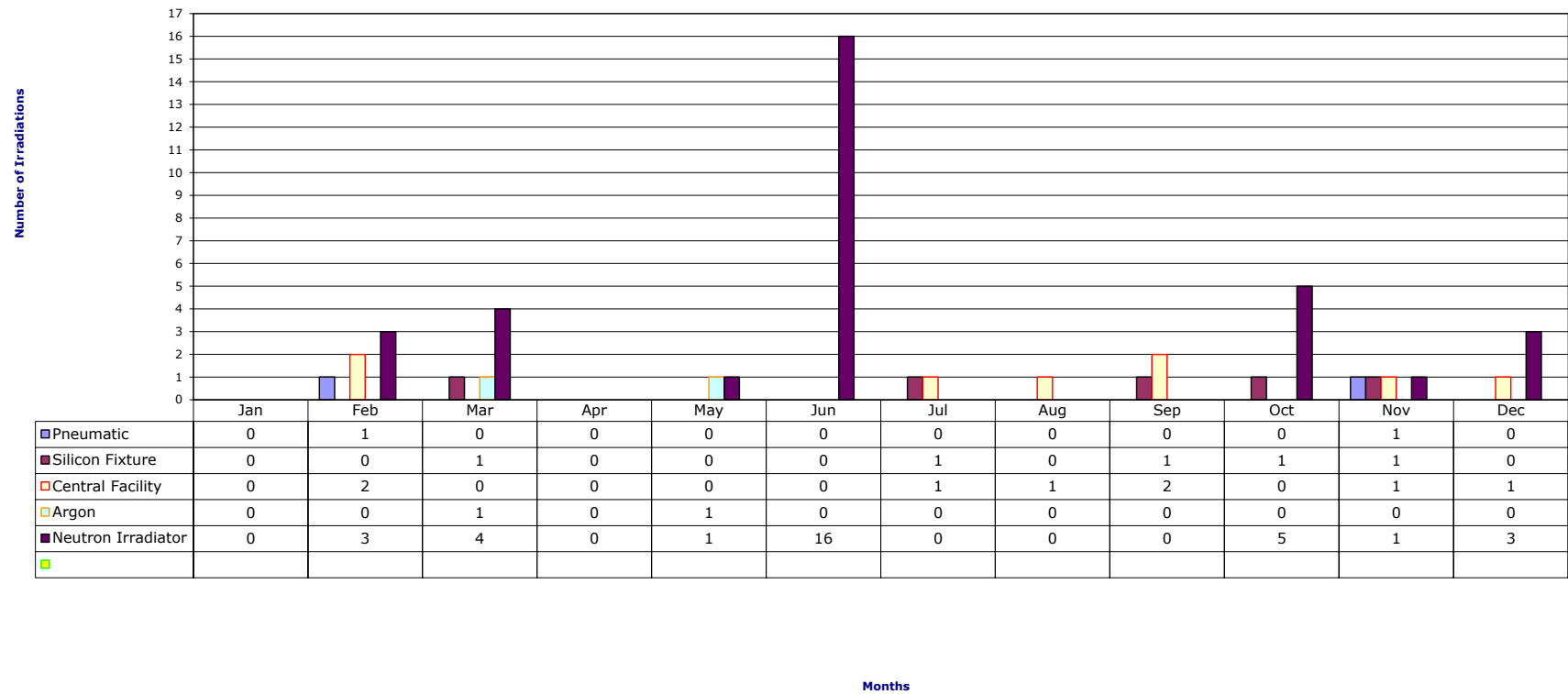
## Reactor Hours (2020)

### Reactor Hours 2020

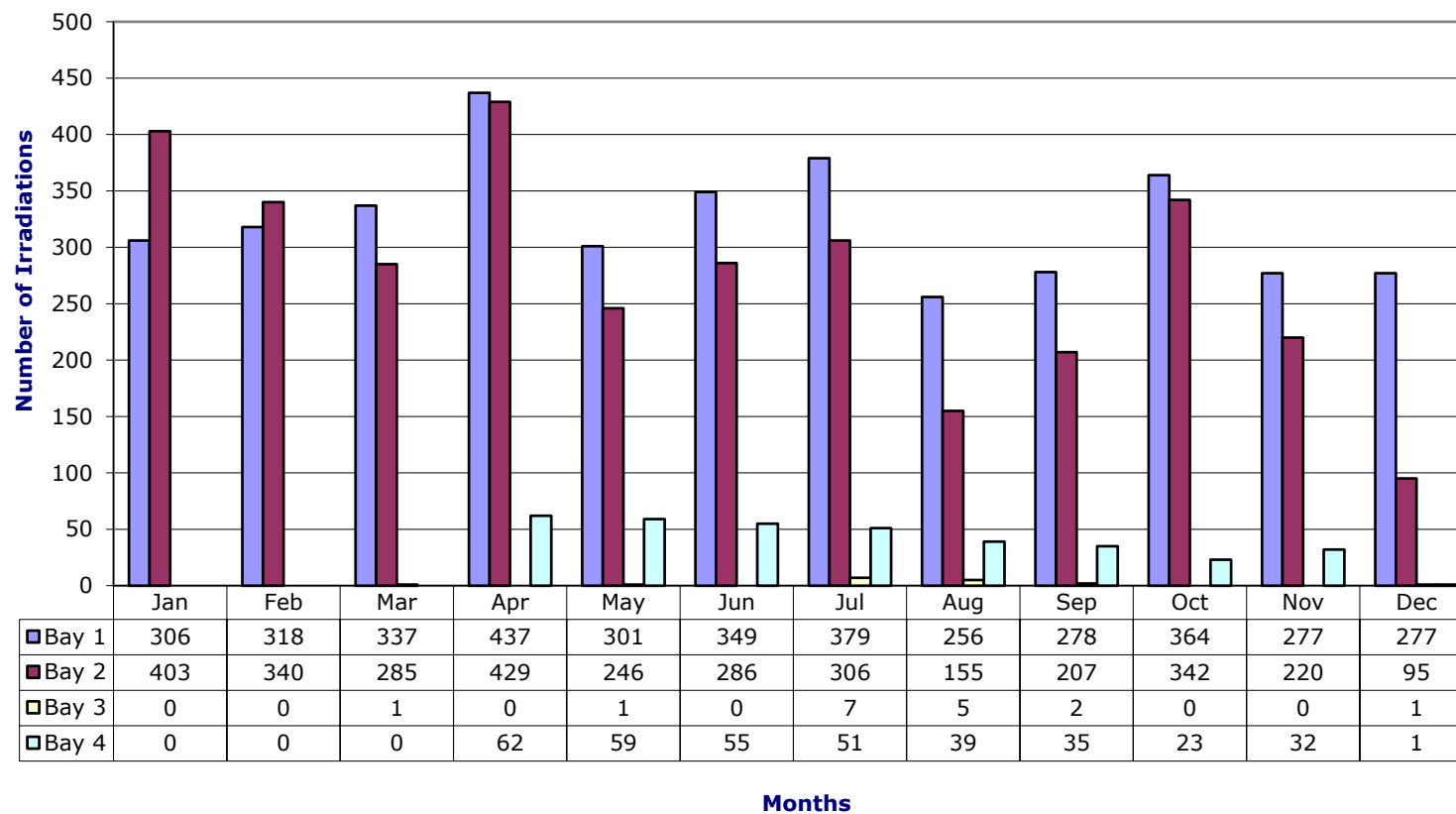




**Reactor Tank Irradiation Facilities 2020**

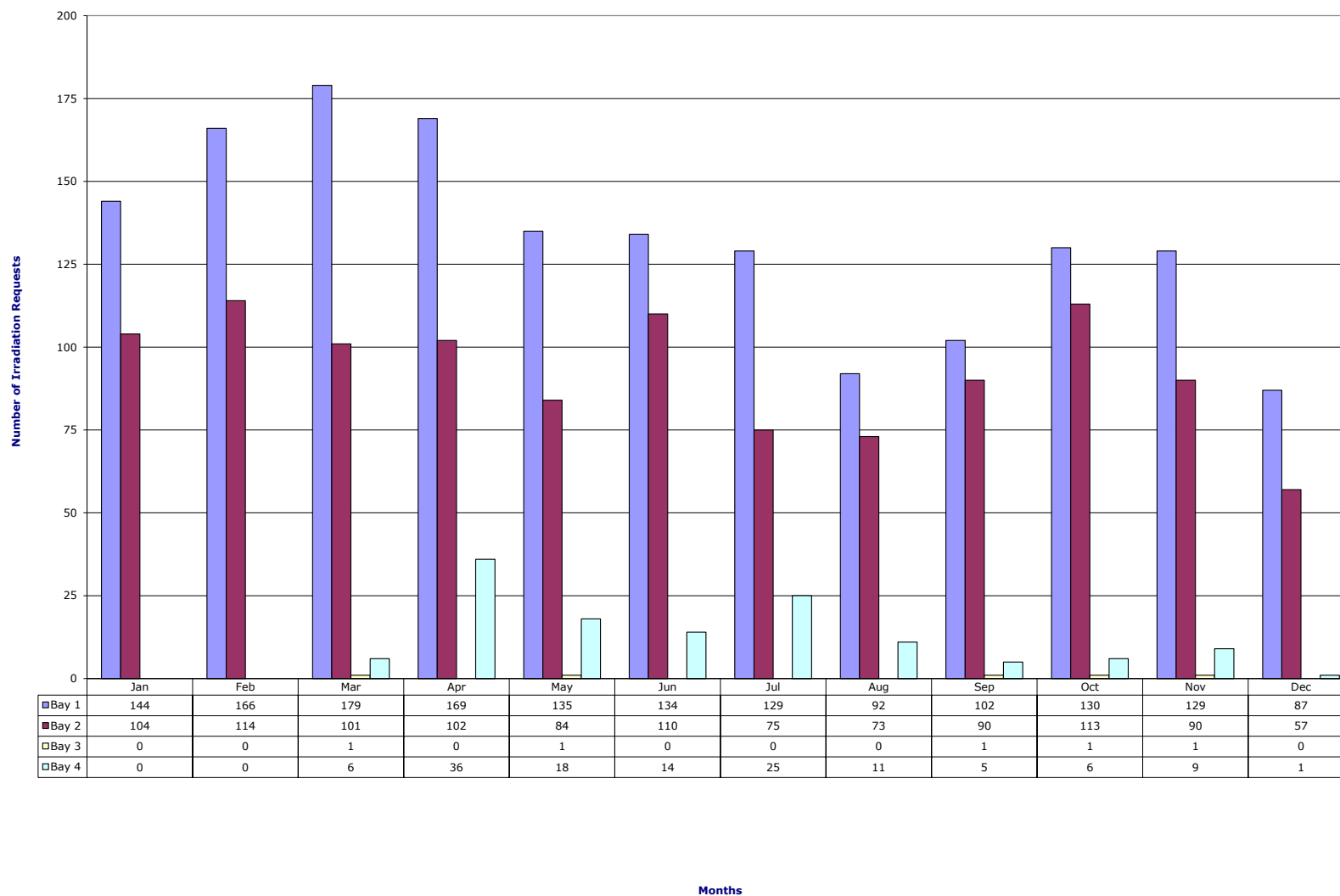


## ***Bay Utilization (Shutter Operations) 2020***





**Bay Irradiation Requests Completed 2020**





## 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 2020.

### 8.2 Airborne Effluents

Airborne radioactivity discharged during 2020 is tabulated in Table 1 below.

**TABLE 1  
2020 SUMMARY OF AIRBORNE EFFLUENTS**

MONTH	TOTAL EST. QUAN. Ar-41 RELEASED	EST. MAX AVG. CONC. OF Ar-41 IN UNRESTRICTED AREA <sup>(1)(3)</sup>	FRACTION OF APPLICABLE 10CFR20 Ar-41 CONC. LIMIT FOR UNRESTRICTED AREA <sup>(1)</sup>	EST. DOSE <sup>(2)</sup> FROM Ar-41 FOR UNRESTRICTED AREA <sup>(1)</sup>	FRACTION OF APPLICABLE 10CFR20 DOSE CONSTRAINT FOR UNRESTRICTED AREA <sup>(1)(4)</sup>	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	3.04	4.01E-07	1.8%	1.08E+00	10.75%	NONE	NONE
FEB	3.02	4.27E-07	1.9%	1.14E+00	11.44%	NONE	NONE
MAR	3.17	4.19E-07	1.8%	1.12E+00	11.23%	NONE	NONE
APR	4.72	6.23E-07	2.7%	1.67E+00	16.69%	NONE	NONE
MAY	2.14	2.83E-07	1.2%	7.58E-01	7.58%	NONE	NONE
JUN	3.99	5.28E-07	2.3%	1.42E+00	14.15%	NONE	NONE
JUL	3.24	4.30E-07	1.9%	1.15E+00	11.51%	NONE	NONE
AUG	2.35	3.11E-07	1.4%	8.34E-01	8.34%	NONE	NONE
SEP	3.30	4.38E-07	1.9%	1.17E+00	11.72%	NONE	NONE
OCT	3.35	4.44E-07	2.0%	1.19E+00	11.89%	NONE	NONE
NOV	2.36	3.12E-07	1.4%	8.37E-01	8.37%	NONE	NONE
DEC	1.22	1.62E-07	0.7%	4.33E-01	4.33%	NONE	NONE
TOT	35.91	4.78E-06		12.80		NONE	NONE
AVG	2.99	3.98E-07	1.8%	1.07	10.67%		

(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**

No solid radioactive waste was shipped this year.

### 9.0 **Radiation Exposure**

Radiation exposure received by facility operations personnel, facility users, and visitors during 2020 is summarized in Table 2 below.

**TABLE 2  
2020 SUMMARY OF PERSONNEL RADIATION EXPOSURES**

	NUMBER OF INDIVIDUALS	AVERAGE TEDE PER INDIVIDUAL  (mrem)	GREATEST INDIVIDUAL TEDE  (mrem)	AVERAGE EXTREMITY <sup>(1)</sup>  (mrem)	GREATEST EXTREMITY  (mrem)
<b>FACILITY PERSONNEL</b>	11	23	105	420	807
<b>FACILITY USERS</b>	173	<1.0	1.0	*	*
<b>VISITORS</b>	395	<1.0	1.0	*	*

(1) Only 2 individuals received extremity 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 2020 are summarized in Table 3 below.

**TABLE 3**  
**2020 SUMMARY OF RADIATION LEVELS AND CONTAMINATION LEVELS**  
**DURING ROUTINE SURVEYS**

	<b>AVERAGE (mrem/hr)</b>	<b>HIGHEST (mrem/hr)</b>	<b>AVERAGE (dpm/100cm<sup>2</sup>)</b>	<b>HIGHEST (dpm/100cm<sup>2</sup>)</b>
OFFICE SPACES	<0.1	<0.1	<5000 <sup>(1)</sup>	<5000 <sup>(1)</sup>
REACTOR CONTROL RM	<0.1	<0.1	<5000 <sup>(1)</sup>	<5000 <sup>(1)</sup>
RADIOGRAPHY CONTROL RM	<0.1	<0.1	<5000 <sup>(1)</sup>	<5000 <sup>(1)</sup>
COUNTING LAB	<0.1	<0.1	<5000 <sup>(1)</sup>	<5000 <sup>(1)</sup>
STAGING AREA	<0.1	<0.1	<5000 <sup>(1)</sup>	<5000 <sup>(1)</sup>
FACILITY (I/S Fence)	<0.1	<0.1	<5000 <sup>(1)</sup>	<5000 <sup>(1)</sup>
EQUIPMENT RM	0.75 <sup>(4)</sup>	98 <sup>(5)</sup>	<800 <sup>(2)</sup>	<800 <sup>(2)</sup>
DEMINERALIZER AREA	16 <sup>(4)</sup>	300 <sup>(5)</sup>	<800 <sup>(2)</sup>	<800 <sup>(2)</sup>
REACTOR RM	1.3 <sup>(4)</sup>	710 <sup>(5)</sup>	<800 <sup>(2)</sup>	<800 <sup>(2)</sup>
RADIOGRAPHY BAYS	0.5 <sup>(3)</sup>	270	<800 <sup>(2)</sup>	<800 <sup>(2)</sup>

(1) <5000 dpm/100 cm<sup>2</sup> = Less than the lower limit of detection for a scanning survey.

(2) <800 dpm/100 cm<sup>2</sup> = 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).

(4) General area dose rate.

(5) Maximum contact dose rate.



## 11.0 Environmental Surveys

Environmental surveys performed outside of the MNRC during 2020 are summarized in Tables 4 & 5 below. The environmental survey program is described in the MNRC Facility Safety Analysis Report.

**TABLE 4**  
**2020 SUMMARY OF ENVIRONMENTAL TLD RESULTS**  
**(WITH NATURAL BACKGROUND<sup>(1)</sup> SUBTRACTED)**

	<b>AVERAGE (mrem)</b>	<b>HIGHEST (mrem)</b>
ON BASE (OFF SITE 1-20 & 64)	3	10
ON SITE (SITES 50 – 61 & 65-71)	15	20

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



**TABLE 5**  
**2020 SUMMARY OF RADIOACTIVITY IN WELL WATER**

	<b>ALPHA (pCi/l)</b>	<b>BETA (pCi/l)</b>	<b>TRITIUM (pCi/l)</b>	<b>Cs-137 (pCi/l)</b>
AVERAGE	<MDA	1.37	<MDA	<MDA
HIGHEST	<MDA	1.92	<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	2.94	3.2
Beta	1.7	1.92
Tritium	251	281
Cs-137	10.9	17.6