2017

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 2017.

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 ~18,000 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 3 normally uses 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

None

6.0 Licensing and Regulatory Activities

6.1 NRC Items

a. The Nuclear Regulatory Commission conducted a semi-annual audit the week of 30 January 2017. No significant findings reported.
b. The Nuclear Regulatory Commission conducted an audit the week of 22 May 2017. No significant findings reported.
c. The Nuclear Regulatory Commission conducted an audit the week of 28 August 2017. No significant findings reported.

6.2 Nuclear Safety Committee (UCD/NSC)

a. The Nuclear Safety Committee held its semi-annual meetings on 12 January and 24 August 2017.
b. The Nuclear Safety Committee performed an Operations audit for 2017 on 25 February 2018.
c. The Nuclear Safety Committee performed an audit of the Radiation Safety Program on 24 August 2017.
d. The Nuclear Safety Committee performed a Security audit on 28 August 2017.

7.0 OPERATIONS

OPERATING HISTORY:

TOTAL OPERATING HOURS THIS YEAR:	1167.03
TOTAL OPERATING HOURS:	51667.17
TOTAL MEGAWATT HOURS THIS YEAR:	1078.29
TOTAL MEGAWATT HOURS:	66238.17
TOTAL NUMBER OF PULSES PERFORMED THIS YEAR:	0
TOTAL NUMBER OF PULSES PERFORMED:	484

7.1 UNSCHEDULED REACTOR SHUTDOWNS and NOTED PROBLEM AREAS:

In 2017, there were three (3) unscheduled reactor shutdowns at the MNRC reactor facility. The following is a list of the unscheduled shutdowns:

2017 UNSCHEDULED REACTOR SHUTDOWNS

Type of Failures	Total Number
CSC	0
Other	3
TOTAL NUMBER OF UNSCHEDULED SHUTDOWNS IN 2017	3

	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	2	0	0	0	0	0	0	1	0	0	0
Notes		1,2							3			

Notes:
1: Loss of Off Site Power/ Loss of the reactor CAM.
2: Fire Alarm, Scrammed the Reactor. Air regulator failure
3: Rx Room CAM fault.

January

1. There were no unscheduled shutdowns in the month of January.
2. There were two callbacks to the facility in January.
   a. Both were caused by Uninterruptable Power Supply (UPS) faults, both cleared on acknowledgement (COA).

February

1. There were two unscheduled shutdowns in the month of February.
   a. Loss of Offsite/Building electrical power which caused the loss of the Reactor Room CAM. The Reactor was manually shutdown.
   b. The facility fire alarm sounded, the Reactor was manually scrammed. Search of facility found no smoke or fire, the cause was determined to be fire suppression system air regulator failure.
2. There were no callbacks to the facility in February.

March

1. There were no unscheduled shutdowns in the month of March.
2. There were two callbacks to the facility in March.
   a. Both were due to Rod Withdrawal Prohibit (RWP) alerts, both cleared on acknowledgement (COA). Probably caused by lightning in the area.

April

1. There were no unscheduled shutdowns in the month of April.

2. There was one callback to the facility in the month of April.
   a. Rod Withdrawal Prohibit. Cleared on acknowledgement. Lighting induced.

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. Rod Withdrawal Prohibit. Cleared on acknowledgement.

July

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

August

1. There were no unscheduled shutdowns in the month of August.
2. There three callbacks to the facility in the month of August.
   a. All three callbacks were the result of spurious fire alarms, ultimately tracked down to a failing smoke detector which has been replaced.

September

1. There was one unscheduled shutdown in the month of September.
   a. Reactor Continuous Air Monitor (CAM) fault, manually shutdown the reactor. Caused by a burnt electrical lug to the air pump.
2. There was one callback to the facility in the month of September.
   a. UPS fault. Cleared on Acknowledgement.

October

1. There were no unscheduled shutdowns in the month of October.
2. There were four (4) callbacks to the facility in the month of September.
   a. One was a UPS fault. Cleared on Acknowledgement.
   b. Three (3) were Rod Withdrawal Prohibit alerts which cleared on acknowledgement.

November

1. There were no unscheduled shutdowns in the month of November.
2. There was one callback to the facility in the month of November.
   a. Rod Withdrawal Prohibit. Cleared on acknowledgement.

December

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

7.2 ANOMALIES:

During 2017, there were no anomalies at the MNRC facility and no Radiological Incident Investigations.

7.3 MAINTENANCE OTHER THAN PREVENTIVE:

January

System #	Description	Work Performed
1001	Bay CAM	Replaced failed Bay CAM fuse holder
5120	Demineralizer System	Replaced depleted makeup water resin bottles

February

System #	Description	Work Performed
5640	Building A/C	Troubleshot and repaired AC-12

March

System #	Description	Work Performed
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
5720	Security System	Replace Keypad at East Gate

April

System #	Description	Work Performed
5490	Helium Supply	Replaced expended helium supply bottle
5630	Bay Ventilation	Replaced failed Bay 1 A/C unit 4 (AC-4)

June

System #	Description	Work Performed
5330	Control System Console (CSC)	CSC fails when control Room Temp exceeds 72 ºF. Replaced CSC DIS64 and watchdog cards.
5640	Building Ventilation	Replaced both HV-1 and HV-2 sump pumps
5640	HV-1, HV-2, and HV-3.	Replaced the fan motor bearings, motor sheaves, fan sheaves and belts on HV-1, 2 and 3.
5490	Helium Supply	Replaced expended helium supply bottle
5620	AC-2	Replaced one condenser fan motor and run capacitor for AC-2.
5630	AC-3 and AC-4	Replaced the disconnect/safety switches for both AC1 and 2.

July

System #	Description	Work Performed
1001	Reactor CAM	Repaired overheated lug and wire connection for Reactor CAM blower motor.
5640	Building Ventilation	Repaired AC-11.

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: $1.87	Shim 1: $2.60	Shim 2: $2.62
Shim 3: $2.67	Shim 4: $2.97	Regulating Rod: $2.75

Control Rod Scram Drop Times:

Transient Rod: 0.34 sec	Shim 1: 0.38 sec	Shim 2: 0.37 sec
Shim 3: 0.42 sec	Shim 4: 0.39 sec	Regulating Rod: 0.38 sec

Shutdown Margin: $6.15

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: 105% indicated, NM-1000: 102% indicated.

System #	Description	Work Performed
5490	Helium Supply	Replaced expended helium supply bottle

September

System #	Description	Work Performed
5490	Helium Supply	Replaced expended helium supply bottle
1001	Reactor CAM	Replaced burnt lug and fuse holder.

October

System #	Description	Work Performed
5490	Helium Supply	Replaced expended helium supply bottle
5720	Security System	Replaced failed cooling fan in AFC unit

November

System #	Description	Work Performed
1001	Reactor CAM	Replaced blower motor, grease seal blew out on the old one.

December

System #	Description	Work Performed
5120	Demineralizer System	Replaced Demineralizer inlet conductivity analog output board.
5490	Helium Supply	Replaced expended helium supply bottle
5510	Pneumatic Transfer System	Replaced EF-3 prefilter due to high differential pressure

7.4 Training

January

1. One Senior Reactor Operator completed training on Normal, Abnormal, and Emergency Procedures.
2. Three Senior Reactor Operators completed training on several modules on Design and Operating Characteristics.
3. Two Senior Reactor Operators completed training on several document changes.
4. Completed the second half of the 2016 Emergency Drill.

February

1. Four Senior Reactor Operators completed training on several modules on Design and Operating Characteristics.

March

1. Four Senior Reactor Operators completed training on several modules on Design and Operating Characteristics.
2. Two Senior Reactor Operators completed training on document changes.

April

1. Hosted and conducted training for University of California Berkeley Nuclear Engineering classes. (Classroom and Practical Lab training)
2. Hosted and conducted training for Sacramento City College Physics group (Classroom and NAA experiment).
3. Conducted tour and training for the UCD Physics Club.

May

1. All Facility personnel completed Annual ALARA and annual safety training.
2. One Senior Reactor Operator completed training on several modules on Design and Operating Characteristics.
3. One Senior Reactor Operator completed training on document changes.
4. Hosted and conducted training for the Courtyard Middle School (Classroom and Practical Lab training).

June

1. No scheduled training in June.

July

1. MNRC conducted summer school classes for the University COSMOS program.
2. MNRC conducted summer school classes for the UC Davis Summer Math Science Honors group.
3. MNRC conducted summer school classes for Luther Burbank High School students.

August

1. All licensed operators successfully completed the Radiation Safety for Operators training.
2. All Senior Reactor Operators completed Fuel and Fuel Handling training.
3. Hosted and conducted training for University of California Davis NSSC group. (Classroom and Practical Lab training)

September

1. Three Senior Reactor Operators completed Technical Specifications training.
2. All Senior Reactor Operators completed the Annual Operators Examination.

October

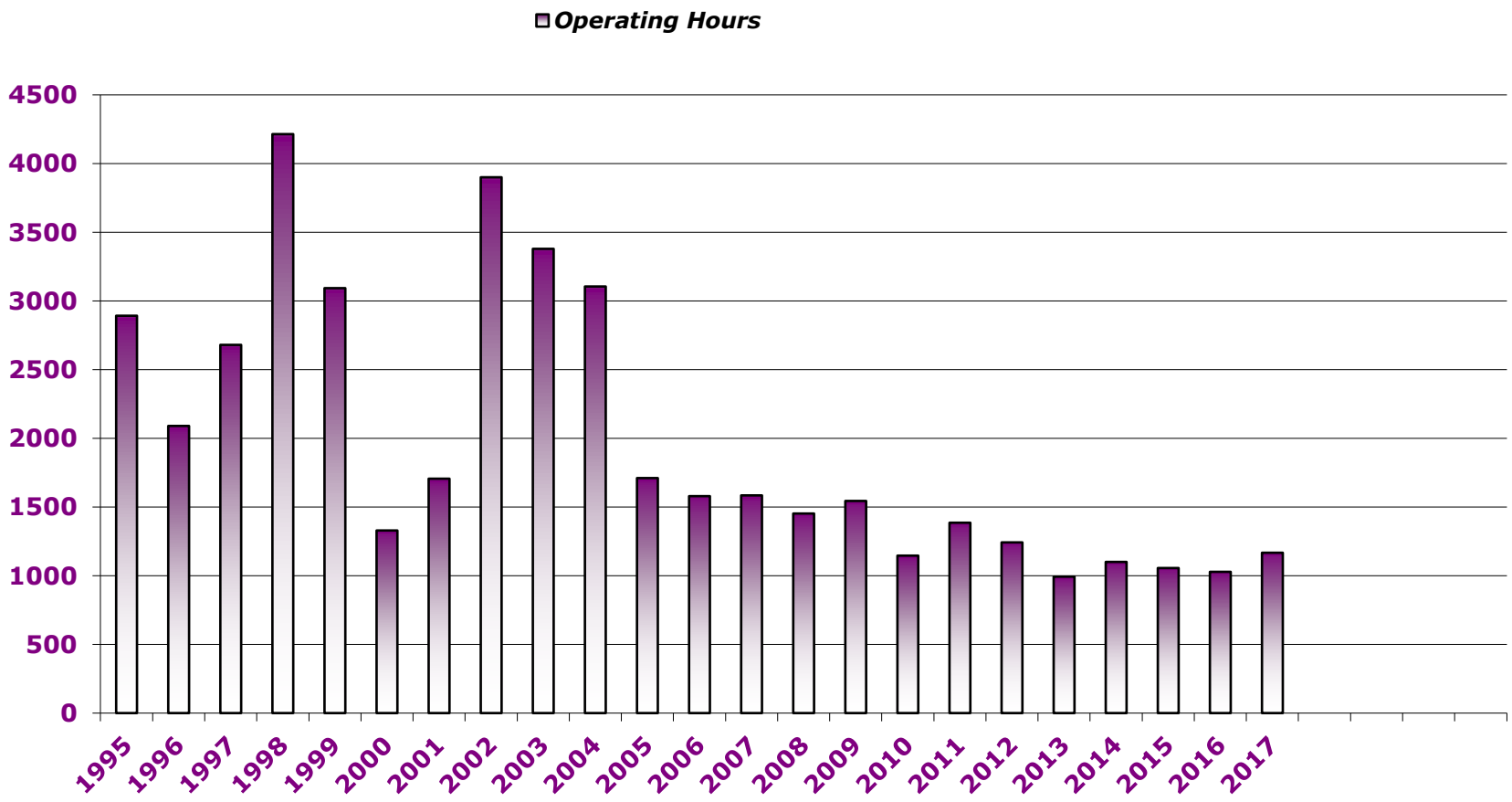
1. Two senior Reactor Operators completed Nuclear Theory training.
2. Two Senior Reactor Operators completed several modules on Nuclear Theory.

November

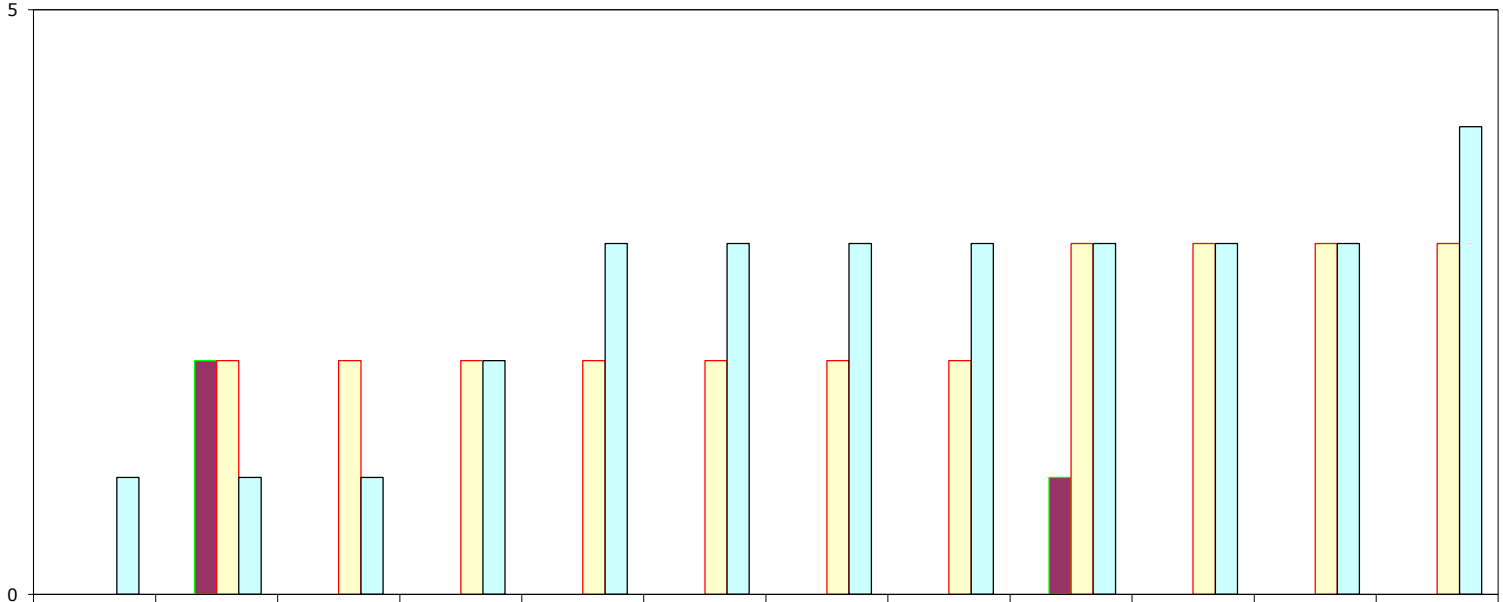
1. No training scheduled for November

December

1. Senior Reactor Operators completed training on Normal, Abnormal and Emergency Procedures.
2. Hosted ANS student chapter from University Nevada Reno for class and experiment.
3. Three Senior Reactor Operators completed their Biennial Medical Exams.


Operating Hours
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

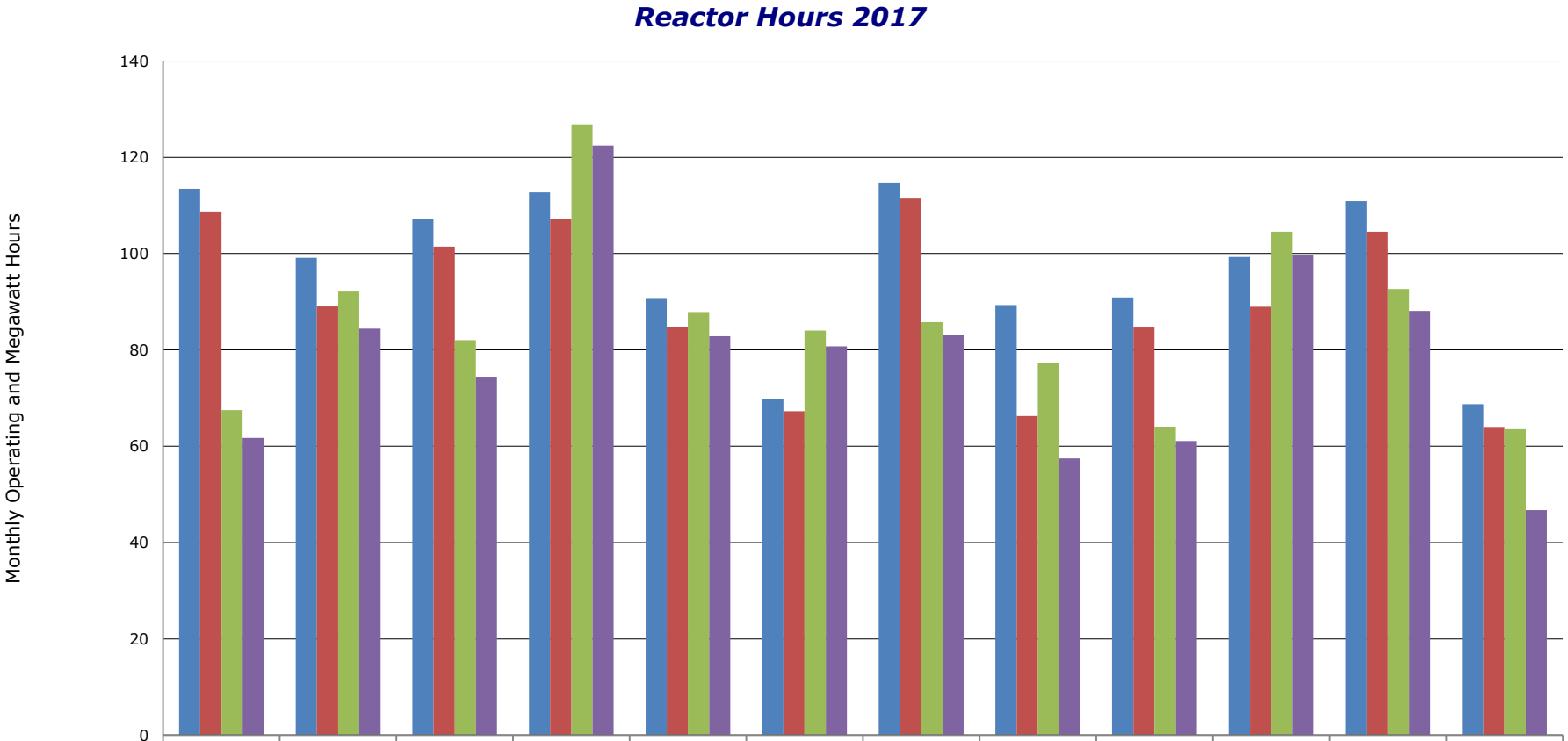
Unscheduled Reactor Shutdowns 2017



	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	2	0	0	0	0	0	0	1	0	0	0
2017 Total	0	2	2	2	2	2	2	2	3	3	3	3
2016 Total	1	1	1	2	3	3	3	3	3	3	3	4

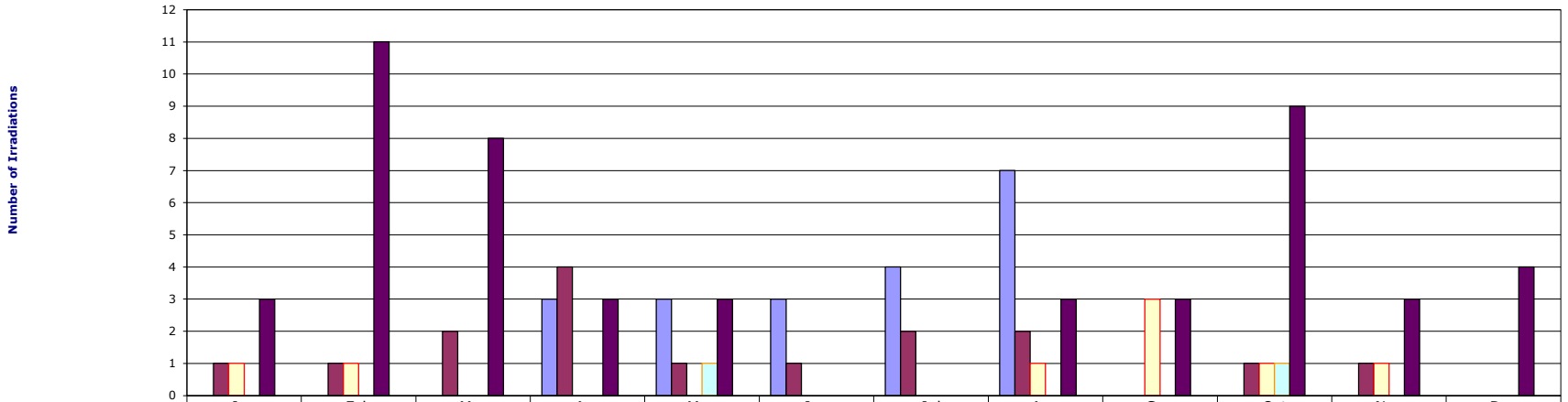
Months

Reactor Hours (2017)



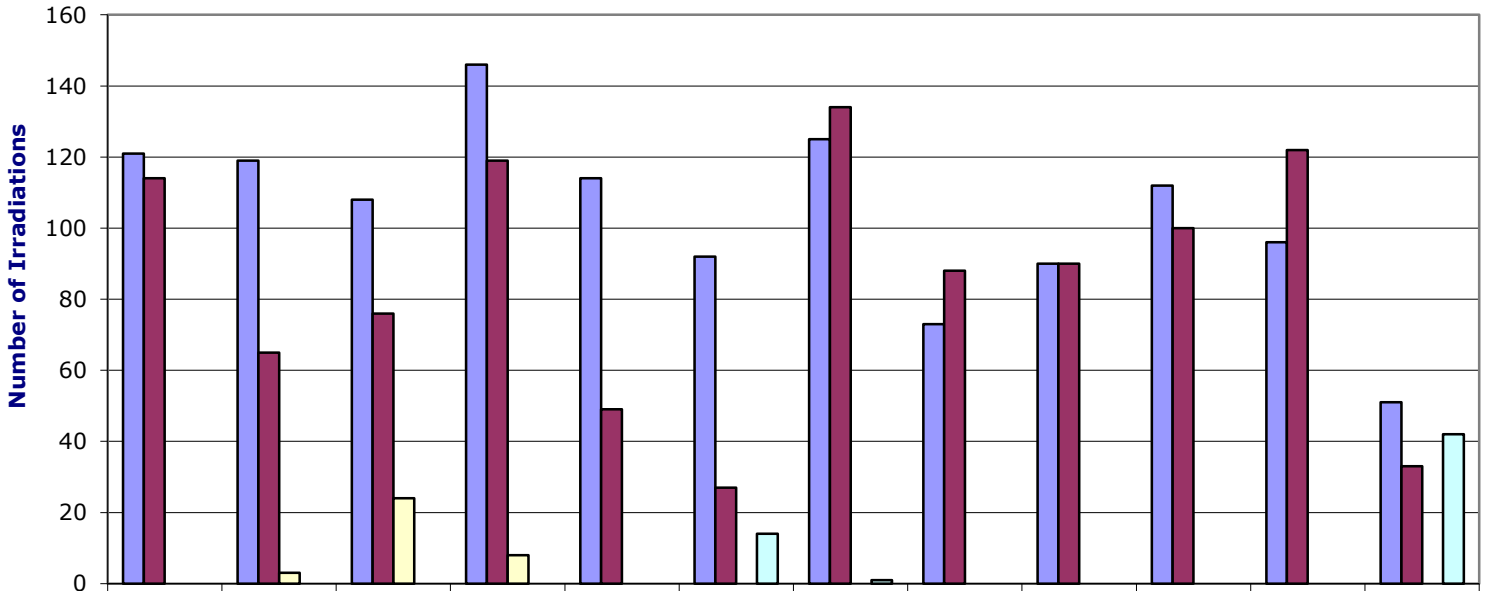
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2017 Op-Hrs	113.45	99.13	107.2	112.69	90.8	69.91	114.75	89.32	90.87	99.28	110.93	68.7
2017 Mw-Hrs	108.75	89.03	101.48	107.13	84.74	67.24	111.45	66.26	84.67	89	104.54	64
2016 Op-Hrs	67.49	92.15	82.03	126.83	87.87	84	85.78	77.2	64.04	104.54	92.64	63.51
2016 Mw-Hrs	61.7	84.4	74.44	122.44	82.86	80.73	83	57.47	61.09	99.78	88.08	46.75

Reactor Tank Irradiation Facilities 2017



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pneumatic	0	0	0	3	3	3	4	7	0	0	0	0
Silicon Fixture	1	1	2	4	1	1	2	2	0	1	1	0
Central Facility	1	1	0	0	0	0	0	1	3	1	1	0
Argon	0	0	0	0	1	0	0	0	0	1	0	0
Neutron Irradiator	3	11	8	3	3	0	0	3	3	9	3	4

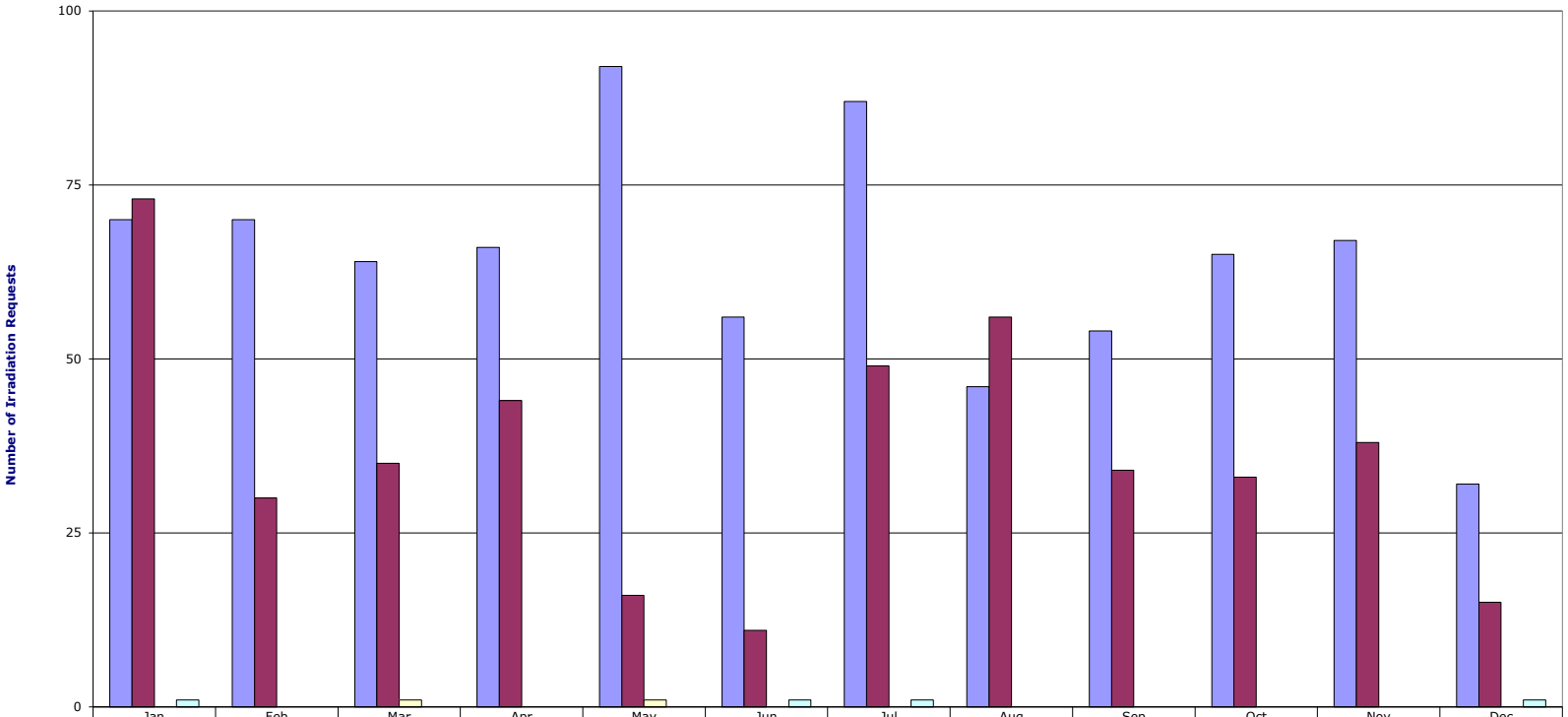
Bay Utilization (Shutter Operations) 2017



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bay 1	121	119	108	146	114	92	125	73	90	112	96	51
Bay 2	114	65	76	119	49	27	134	88	90	100	122	33
Bay 3	0	3	24	8	0	0	0	0	0	0	0	0
Bay 4	0	0	0	0	0	14	1	0	0	0	0	42

Months

Bay Irradiation Requests Completed 2017



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bay 1	70	70	64	66	92	56	87	46	54	65	67	32
Bay 2	73	30	35	44	16	11	49	56	34	33	38	15
Bay 3	0	0	1	0	1	0	0	0	0	0	0	0
Bay 4	1	0	0	0	0	1	1	0	0	0	0	1

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 2017.

8.2 Airborne Effluents

Airborne radioactivity discharged during 2017 is tabulated in Table 1 below.

TABLE 1
2017 SUMMARY OF AIRBORNE EFFLUENTS

MONTH	TOTAL EST. QUAN. Ar-41 RELEASED (Ci)	EST.MAX AVG. CONC. OF Ar-41 IN UNRESTRICTED AREA (1)(3) (uCi/ml)	FRACTION OF APPLICABLE 10CFR20 Ar-41 CONC. LIMIT FOR UNRESTRICTED AREA (1) (%)	EST. DOSE (2) FROM Ar-41 FOR UNRESTRICTED AREA (1) (mrem)	FRACTION OF APPLICABLE 10CFR20 DOSE CONSTRAINT FOR UNRESTRICTED AREA (1)(4) (%)	TOT. EST. QUANTITY OF ACT. IN PART. FORM WITH HALF-LIFE >8 DAYS (Ci)	AVERAGE CONC. OF PART. ACT. RELEASED WITH HALF-LIFE > 8 DAYS (uCi/ml)
JAN	1.50	8.39E-11	0.8%	0.51	5.10%	NONE	NONE
FEB	1.12	6.22E-11	0.6%	0.38	3.79%	NONE	NONE
MAR	1.29	7.20E-11	0.7%	0.44	4.38%	NONE	NONE
APR	1.68	9.38E-11	0.9%	0.57	5.71%	NONE	NONE
MAY	1.29	7.22E-11	0.7%	0.44	4.39%	NONE	NONE
JUN	0.93	5.47E-11	0.5%	0.33	3.33%	NONE	NONE
JUL	3.04	1.78E-10	1.8%	1.08	10.84%	NONE	NONE
AUG	1.39	8.15E-11	0.8%	0.50	4.96%	NONE	NONE
SEP	1.73	1.02E-10	1.0%	0.62	6.18%	NONE	NONE
OCT	1.94	1.14E-10	1.1%	0.69	6.92%	NONE	NONE
NOV	2.69	1.58E-10	1.6%	0.96	9.61%	NONE	NONE
DEC	0.51	6.10E-11	0.6%	0.37	3.71%	NONE	NONE
TOT	19.12					NONE	NONE
AVG	1.59	9.44 E-11	0.9%	0.57	5.74%		

(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.

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9.0 Radiation Exposure

Radiation exposure received by facility operations personnel, facility users, and visitors during 2017 is summarized in Table 2 below.

TABLE 2
2017 SUMMARY OF PERSONNEL RADIATION EXPOSURES

	NUMBER OF INDIVIDUALS	AVERAGE TEDE PER INDIVIDUAL (mrem)	GREATEST INDIVIDUAL TEDE (mrem)	AVERAGE EXTREMITY (1) (mrem)	GREATEST EXTREMITY (mrem)
FACILITY PERSONNEL	5	87.4	115	105	234
FACILITY USERS	30	<1.0	2	*	*
VISITORS	848	<1.0	2	*	*

(1) Only 3 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 2017 are summarized in Table 3 below.

TABLE 3
2017 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)
FACILITY (I/S Fence)	<0.1	<0.1	<5000(1)	<5000(1)
EQUIPMENT RM	.24 (4)	95 (5)	<800(2)	<800(2)
DEMINERALIZER AREA	12(4)	290(5)	<800(2)	<800(2)
REACTOR RM	2.2(4)	1200 (5)	<800(2)	<800(2)
RADIOGRAPHY BAYS	0.62(3)	360 (6)	<800(2)	<800(2)

(1) <5000 dpm/100 cm^2 = 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).

(4) General area dose rate.

(5) Maximum contact dose rate.

(6) 1 meter dose rate of beam port insert taken behind shielding.

11.0 Environmental Surveys

Environmental surveys performed outside of the MNRC during 2017 are summarized in Tables 4 & 5 below. The environmental survey program is described in the MNRC Facility Safety Analysis Report.

TABLE 4
2017 SUMMARY OF ENVIRONMENTAL TLD RESULTS
(WITH NATURAL BACKGROUND(1) SUBTRACTED)

	AVERAGE (mrem)	HIGHEST (mrem)
ON BASE (OFF SITE 1-20 & 64)	6	14
ON SITE (SITES 50 – 61 & 65-71)	14	22

(1) Natural background assumed to be the off base (Sites 27-42) average of 29 mrem.

TABLE 5
2017 SUMMARY OF RADIOACTIVITY IN WELL WATER

	ALPHA (pCi/l)	BETA (pCi/l)	TRITIUM (pCi/l)	Cs-137 (pCi/l)
AVERAGE	2.5	2.43	<MDA	<MDA
HIGHEST	2.5	2.79	<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	1.70	2.60
Beta	1.10	1.70
Tritium	170	241
Cs-137	1.1	2.0