UNIVERSITY OF CALIFORNIA, DAVIS

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SANTA BARBARA · SANTA CRUZ

McClellan Nuclear Research Center
UNIVERSITY OF CALIFORNIA
Davis
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July 6th, 2020

Linh Tran
US Nuclear Regulatory Commission
11555 Rockville Pike
MS 12-D3
Rockville, MD 20852-2738

SUBJECT: UC Davis McClellan Nuclear Research Center 2019 Annual Report

Attached is the UC Davis McClellan Nuclear Research Center 2019 Annual Report for reactor operations. If you have any questions concerning the report, please feel free to contact me directly. To the best of my knowledge the data presented in the report is accurate and truthful.

I declare under penalty of perjury that the foregoing is true and correct.

Sincerely,

Wesley Frey PhD
Facility Director

2019

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 2019.

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 and 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 inspection the week of 28 January 2019. No findings reported.
b. The Nuclear Regulatory Commission conducted an inspection the week of 8 April 2019. No findings reported.
c. The Nuclear Regulatory Commission also visited the MNRC during the week of 8 April 2019 for the purpose of discussing issues related to facilities relicensing.
d. The Nuclear Regulatory Commission conducted an inspection the week of 12 August 2019. No findings reported.

6.2 Nuclear Safety Committee (UCD/NSC)

a. The Nuclear Safety Committee held its semi-annual meetings on 21 February and 29 August 2019.
b. The Nuclear Safety Committee performed an Operations audit for 2019 on 29 August 2019.
c. The Nuclear Safety Committee performed an audit of the Radiation Safety Program on 14 November 2019.
d. The Nuclear Safety Committee performed a Security audit on 12 December 2019.

7.0 OPERATIONS

OPERATING HISTORY:

TOTAL OPERATING HOURS THIS YEAR:	1522.49
TOTAL OPERATING HOURS:	54548.26
TOTAL MEGAWATT HOURS THIS YEAR:	1435.06
TOTAL MEGAWATT HOURS:	68934.71
TOTAL NUMBER OF PULSES PERFORMED THIS YEAR:	0
TOTAL NUMBER OF PULSES PERFORMED:	484

7.1 UNSCHEDULED REACTOR SHUTDOWNS and NOTED PROBLEM AREAS:

In 2019, there were two (2) unscheduled reactor shutdowns at the MNRC reactor facility. The following is a list of the unscheduled shutdowns:

2019 UNSCHEDULED REACTOR SHUTDOWNS

Type of Failures	Total Number
CSC	0
Other	2
TOTAL NUMBER OF UNSCHEDULED SHUTDOWNS IN 2019	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	1	0	0	0	0	0	0	1	0	0	0
Notes		1							2			

Notes:
1: Object dropped in the Rx Tank during facility tour
2: Inadvertent Operation of the Rx Room Manual Scram Button

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 was one unscheduled shutdown in the month of February.
   a. During a tour of the Facility, an item was dropped into the reactor Tank. The Reactor was shutdown to recover the item. See the Anomaly Report.

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 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 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. Security Transmit Fail.

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 no callbacks to the facility in the month of August.

September

1. There was one unscheduled shutdown in the month of September.
   a. The Reactor was scrammed due to the inadvertent operation of the Reactor Room Manual Scram Button. Operator Error.

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 was one callback to the facility in the month of September.
   a. Scram Database Timeout. Cleared on Acknowledgement.

November

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

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 Acknowledgement

7.2 ANOMALIES:

During 2019, there was one anomaly at the MNRC facility and no Radiological Incident Investigations.

Anomaly Report

Date: 7 February, 2019

Time: 1308 hrs

Describe the reactor conditions prior to the anomaly and what occurred during the anomaly:

The reactor was operating normally at 1 MW supporting radiography operations in Bays 1 and 2, and for a facility tours by a large group of High School Science students.

At 1308 hours it was noted by the tour guide in the Reactor Room that a couple of the students were acting a little strangely and upon inquiring what was the issue, they indicated to the tour guide that they might have dropped a “fit bit watch” into the reactor tank.

The tour guide notified the Reactor Operator in the control room, the reactor was shut down.

What actions were taken to correct the anomaly:

The facility tours were immediately stopped and all visitors were escorted from the facility.

After the reactor was shutdown, primary and demineralizer pumps were secured.

Facility staff performed a visual inspection of the reactor tank from the top of the tank and could not find the dropped object.

The underwater camera was set up and the object was located on the tank bottom under the Bay 1 insert to tank wall flange.

Using the aluminum pole and underwater camera assembly, the object was moved from under the flange to a more accessible location for recovery.

The object was recovered from the tank bottom utilizing a “tape ball” on the bottom of the underwater camera pole.

What corrective actions are needed to prevent this anomaly from recurring in the future:

As part of the pre-tour briefing, additional emphasis will be placed on reminding tour participants to remove all objects that could inadvertently detach from a person and fall into the reactor tank.

7.3 MAINTENANCE OTHER THAN PREVENTIVE:

February

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

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
5330	DAC Computer	Replaced Hard Drive

April

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

May

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

June

System #	Description	Work Performed
5640	HV-2	Replaced failed HV-2 Blower Motor

July

System #	Description	Work Performed
5620	Reactor Ventilation	Replaced failed Reactor Ventilation Recirc Damper Actuator

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: $1.90	Shim 1: $2.57	Shim 2: $2.48
Shim 3: $2.71	Shim 4: $2.92	Regulating Rod: $2.70

Control Rod Scram Drop Times:

Transient Rod: 0.34 sec	Shim 1: 0.40 sec	Shim 2: 0.37 sec
Shim 3: 0.43 sec	Shim 4: 0.38 sec	Regulating Rod: 0.40 sec

Shutdown Margin: $6.35

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: 104% indicated.

System #	Description	Work Performed
5330	NM-1000	Replaced Trimpot R102 for Mode 4 in the Campbelling module.
5490	Helium Supply	Replaced expended helium supply bottle

September

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

November

System #	Description	Work Performed
1001	Reactor CAM	Replaced failed Crimp connector
5330	NM-1000	Adjusted R102 for Mode 4.
5490	Helium Supply	Replaced expended helium supply bottle

7.4 Training

January

1. Senior Reactor Operators completed training on Facility Design and Operating Characteristics.
2. One person (trainee) completed training of Spill procedures and on donning and removal of Anti-C's.
3. Hosted and conducted training for a UC Davis Physics Class (Classroom and Practical Lab training).
4. Hosted and conducted training for Public Safety Academy Classes (Classroom and Practical Lab training).

February

1. Three Senior Reactor Operators completed training on Instrumentation and Control.
2. Hosted and conducted training for Franklin High School students (Classroom and Practical Lab training).
3. Hosted and conducted training for Maidu Virtual Charter Academy (Classroom and Practical Lab training).

March

1. One Senior Reactor Operators completed training on several modules on Design and Operating Characteristics.
2. One Senior Reactor Operators completed training on Instrumentation and Control.

April

1. Facility personnel completed Annual ALARA and annual Safety/Security training.
2. Hosted and conducted training for members of the California Highway Patrol.
3. Hosted and conducted training for a UC Berkeley NE Class (Classroom and Practical Lab training).
4. Hosted and conducted training for a UC Merced Class (Classroom and Practical Lab training).
5. Hosted and conducted training for a Tracy High School Class (Classroom and Practical Lab training).

May

1. Hosted and conducted training for a UC Davis Class (Classroom and Practical Lab training).
2. Conducted training and tours foe EAOP Classes.

June

1. Two Senior Reactor Operators completed Radiation Safety for Operators Training.
2. Hosted and conducted training for a California Aerospace Summer School Program Class (Classroom and Practical Lab training).
3. Hosted and conducted training for a Mesa High School (Classroom and Practical Lab training).
4. Hosted and conducted training for a UCD Physics Class (Classroom and Practical Lab training).
5. Conducted training and tours for Continuing Education Classes

July

1. Two Senior Reactor Operators completed Radiation Safety for Operators Training.

2. MNRC conducted summer school classes for the SMASH group.
3. MNRC conducted summer school classes for the University COSMOS program.
4. 3 Facility personnel completed Neutron Radiography specific training.

August

1. All Senior Reactor Operators and one trainee completed Fuel and Fuel Handling training.
2. Hosted and conducted training for a UCD NAA Class (Classroom and Practical Lab training).

September

1. Two Senior Reactor Operators completed Technical Specifications training.

October

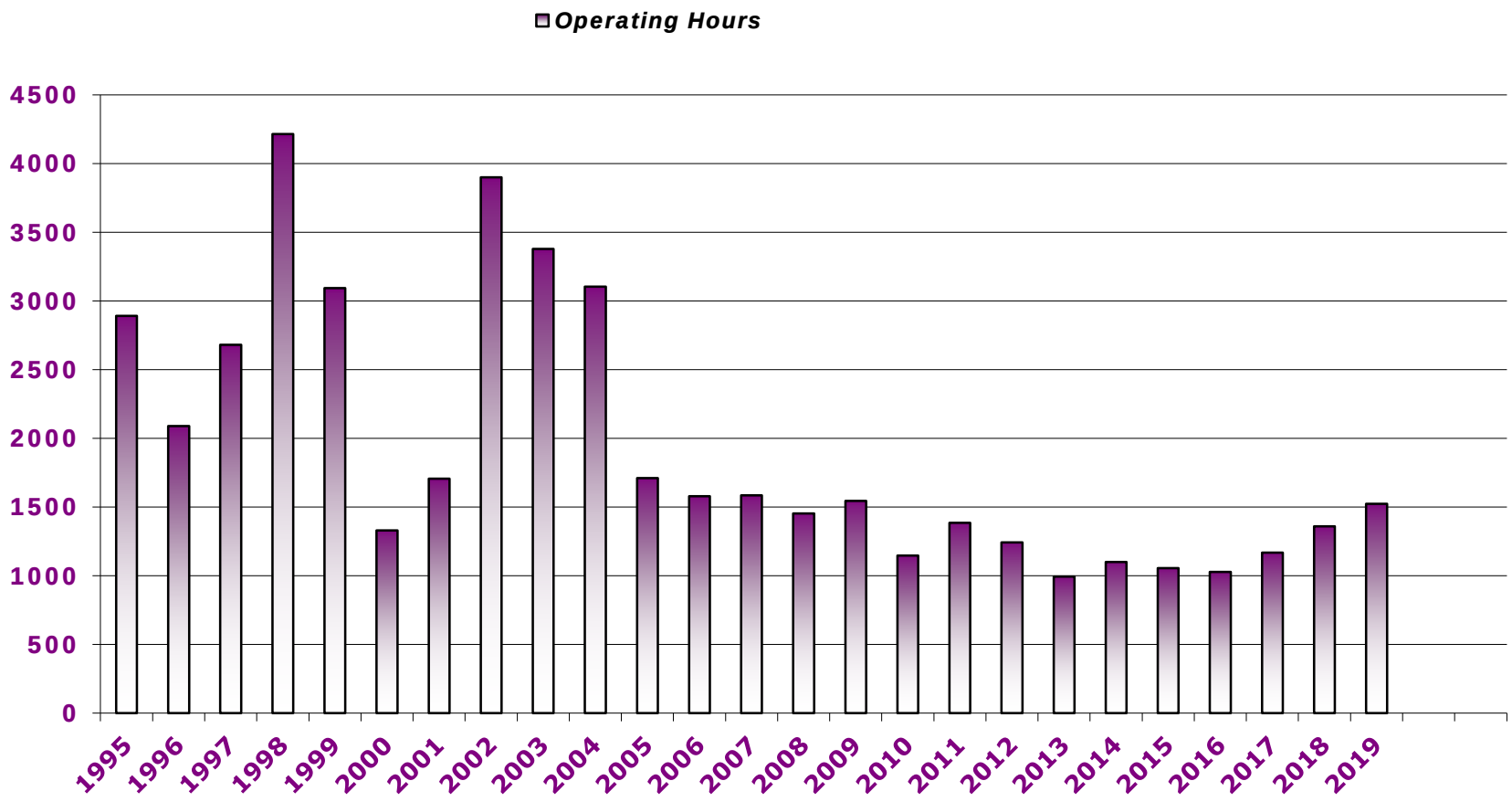
1. Two Senior Reactor Operators completed Technical Specification training.
2. One Senior Reactor Operator completed Nuclear Theory training.
3. All Senior Reactor Operators completed the Annual Operators Examination.
4. Hosted and conducted training for a Douglass Middle School (Classroom and Practical Lab training).

November

1. One Senior Reactor Operator completed Normal, Abnormal, and Emergency procedures training.
2. Two Senior Reactor Operators completed Nuclear Theory training.

December

1. Three Senior Reactor Operators completed training on Normal, Abnormal and Emergency Procedures.
2. One Senior Reactor Operator completed Nuclear Theory training.
2. 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
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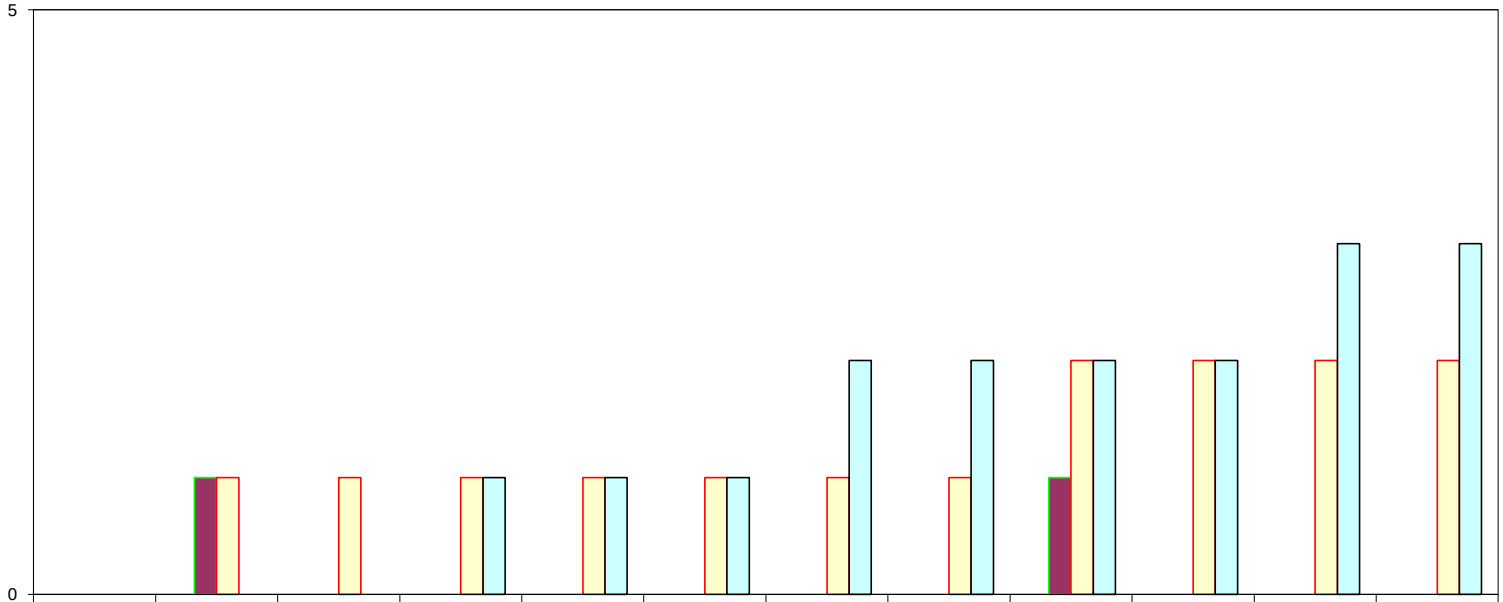
2011
2012
2013
2014
2015
2016
2017
2018
2019

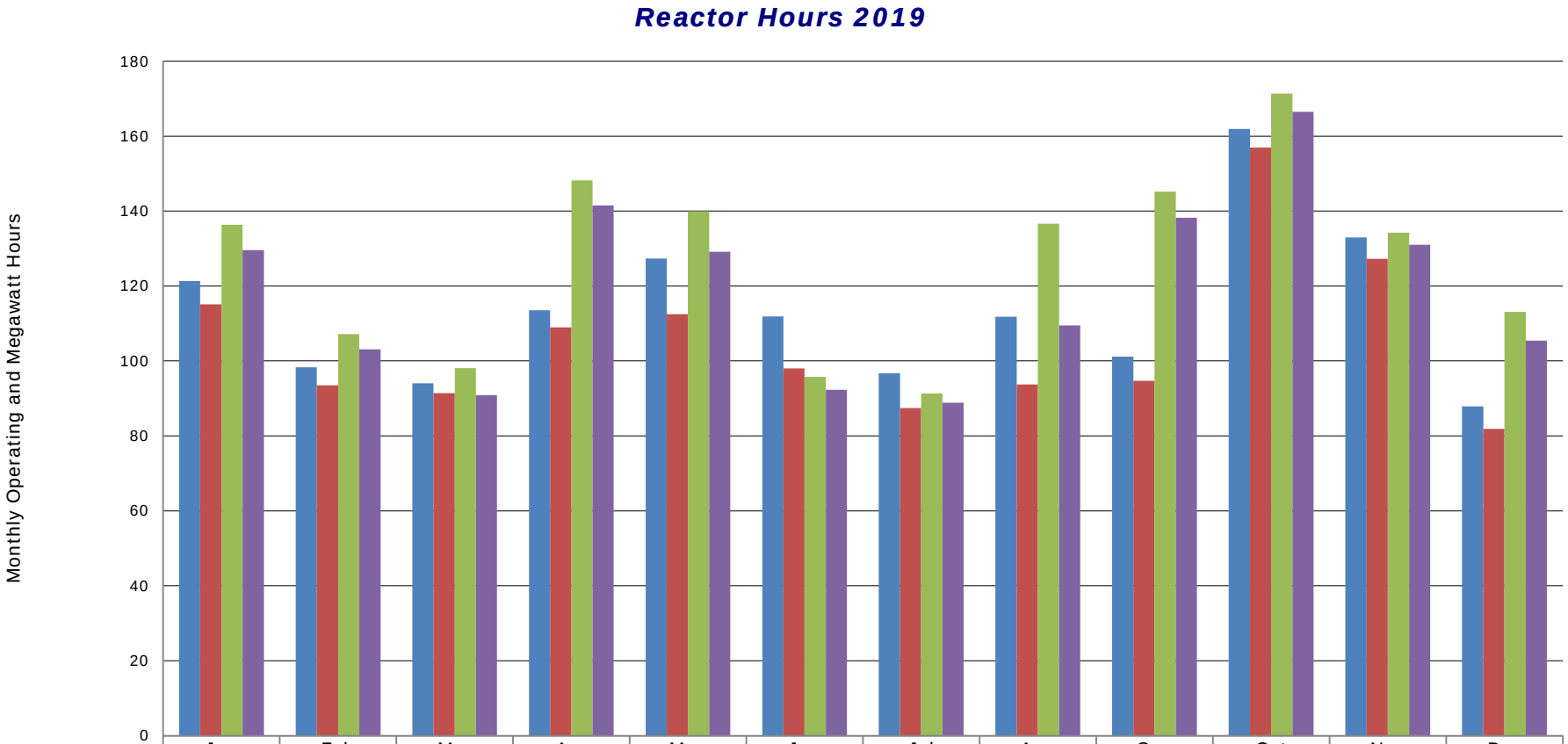
Unscheduled Reactor Shutdowns 2019



	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	1	0	0	0	0	0	0	1	0	0	0
2019 Total	0	1	1	1	1	1	1	1	2	2	2	2
2018 Total	0	0	0	1	1	1	2	2	2	2	3	3

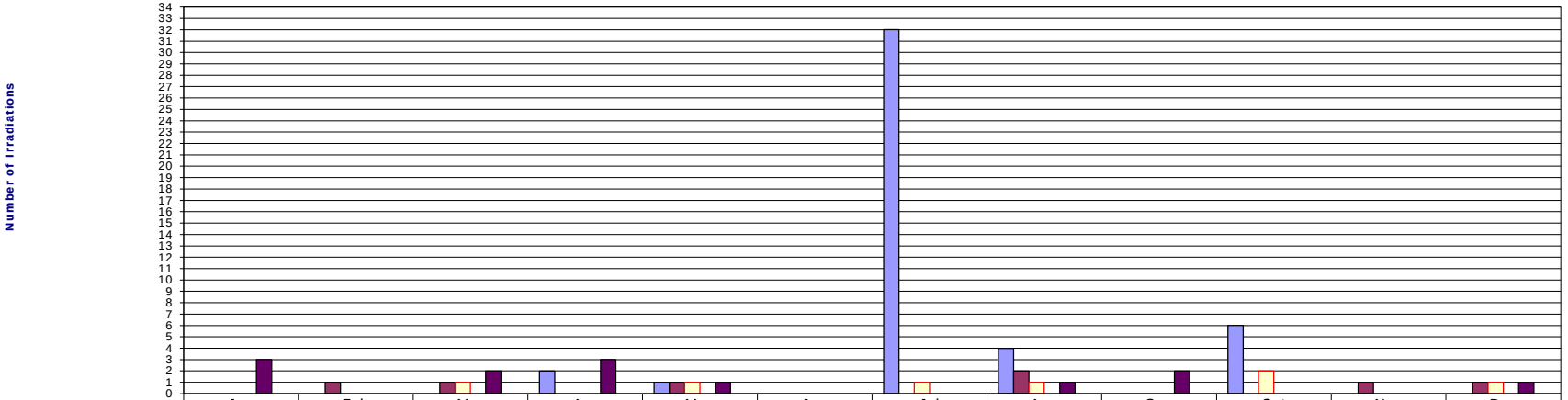
Months

Reactor Hours (2019)



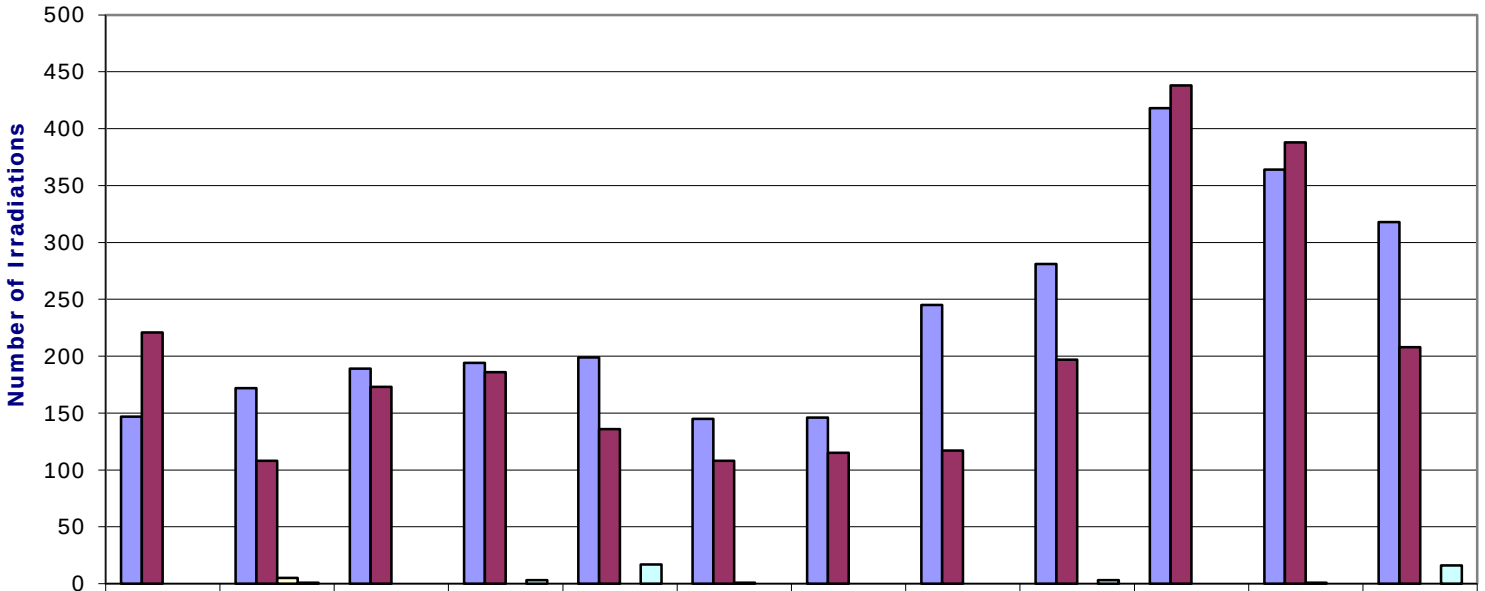
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2018 Op-Hrs	121.365	98.3	94.03	113.55	127.32	111.88	96.7	111.8	101.17	161.93	132.95	87.89
2018 Mw-Hrs	115.09	93.5	91.41	108.98	112.49	98	87.46	93.71	94.71	156.98	127.26	81.89
2019 Op-Hrs	136.35	107.13	98.09	148.2	139.93	95.73	91.35	136.62	145.18	171.39	134.22	113.1
2019 Mw-Hrs	129.6	103.14	90.88	141.55	129.14	92.27	88.86	109.48	138.19	166.47	131.01	105.47

Reactor Tank Irradiation Facilities 2019



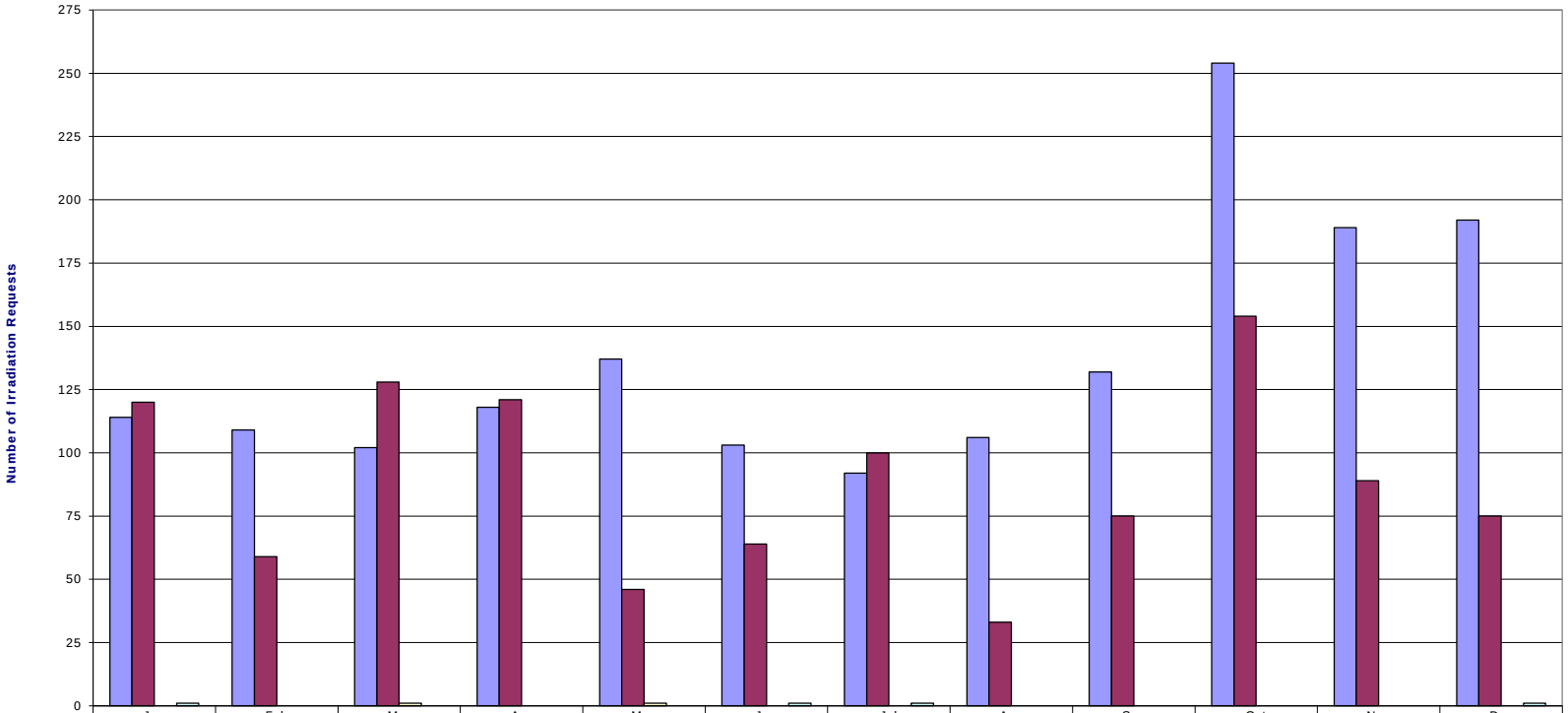
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pneumatic	0	0	0	2	1	0	32	4	0	6	0	0
Silicon Fixture	0	1	1	0	1	0	0	2	0	0	1	1
Central Facility	0	0	1	0	1	0	1	1	0	2	0	1
Argon	0	0	0	0	0	0	0	0	0	0	0	0
Neutron Irradiator	3	0	2	3	1	0	0	1	2	0	0	1

Bay Utilization (Shutter Operations) 2019



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bay 1	147	172	189	194	199	145	146	245	281	418	364	318
Bay 2	221	108	173	186	136	108	115	117	197	438	388	208
Bay 3	0	5	0	0	0	1	0	0	0	0	1	0
Bay 4	0	1	0	3	17	0	0	0	3	0	0	16

Bay Irradiation Requests Completed 2019



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bay 1	114	109	102	118	137	103	92	106	132	254	189	192
Bay 2	120	59	128	121	46	64	100	33	75	154	89	75
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 2019.

8.2 Airborne Effluents

Airborne radioactivity discharged during 2019 is tabulated in Table 1 below.

TABLE 1
2019 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	2.57	1.50E-10	1.5%	0.91	9.13%	NONE	NONE
FEB	1.73	1.02E-10	1.0%	0.62	6.19%	NONE	NONE
MAR	2.54	1.49E-10	1.5%	0.91	9.06%	NONE	NONE
APR	2.63	1.54E-10	1.5%	0.94	9.40%	NONE	NONE
MAY	1.56	9.05E-11	0.9%	0.55	5.51%	NONE	NONE
JUN	1.32	7.67E-11	0.8%	0.47	4.67%	NONE	NONE
JUL	1.72	9.99E-11	1.0%	0.61	6.08%	NONE	NONE
AUG	1.62	9.40E-11	0.9%	0.57	5.72%	NONE	NONE
SEP	1.97	1.14E-10	1.1%	0.70	6.96%	NONE	NONE
OCT	3.21	1.87E-10	1.9%	1.14	11.37%	NONE	NONE
NOV	4.85	2.82E-10	2.8%	1.71	17.14%	NONE	NONE
DEC	1.87	1.09E-10	1.1%	0.66	6.62%	NONE	NONE
TOT	27.58					NONE	NONE
AVG	2.30	1.34 E-10	1.3%	0.82	8.15%		

(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 2019 is summarized in Table 2 below.

TABLE 2
2019 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	7	46	107	76	380
FACILITY USERS	45	<1.0	1.0	*	*
VISITORS	1007	<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 2019 are summarized in Table 3 below.

TABLE 3
2019 SUMMARY OF RADIATION LEVELS AND CONTAMINATION LEVELS DURING ROUTINE SURVEYS

	AVERAGE (mrem/hr)	HIGHEST (mrem/hr)	AVERAGE (dpm/100cm²)	HIGHEST (dpm/100cm²)
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	25	<5000(1)	<5000(1)
FACILITY (I/S Fence)	<0.1	<0.1	<5000(1)	<5000(1)
EQUIPMENT RM	0.6 (4)	134 (5)	<800(2)	<800(2)
DEMINERALIZER AREA	11(4)	300(5)	<800(2)	<800(2)
REACTOR RM	3.2(4)	560(5)	<800(2)	<800(2)
RADIOGRAPHY BAYS	0.5(3)	290(5)	<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).

(4) General area dose rate.

(5) Maximum contact dose rate.

11.0 Environmental Surveys

Environmental surveys performed outside of the MNRC during 2019 are summarized in Tables 4 & 5 below. The environmental survey program is described in the MNRC Facility Safety Analysis Report.

TABLE 4
2019 SUMMARY OF ENVIRONMENTAL TLD RESULTS
(WITH NATURAL BACKGROUND(1) SUBTRACTED)

	AVERAGE (mrem)	HIGHEST (mrem)
ON BASE (OFF SITE 1-20 & 64)	5	9
ON SITE (SITES 50 – 61 & 65-71)	17	29

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

TABLE 5
2019 SUMMARY OF RADIOACTIVITY IN WELL WATER

	ALPHA (pCi/l)	BETA (pCi/l)	TRITIUM (pCi/l)	Cs-137 (pCi/l)
AVERAGE	<MDA	1.91	<MDA	<MDA
HIGHEST	<MDA	2.40	<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	1.38	2.63
Beta	1.42	1.92
Tritium	219	275
Cs-137	1.54	1.87