2015

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 2015.

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.

1. Performed 50.59 review for Experiment K-4-46 to include Bi-Directional Destruct Charges for Neutron Radiography.

2. Performed 50.59 review for Experiment K-4-52 to perform Neutron Irradiation of Special Nuclear Material.

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 09 February 2015. No significant findings reported.
b. The Nuclear Regulatory Commission conducted an audit the week of 6 July 2015. No significant findings reported.
c. The Nuclear Regulatory Commission conducted an audit the week of 19 October 2015. No significant findings reported.
d. Nuclear Regulatory Commission Examiner granted one Reactor Operator License effective 28 January 2015.
e. One Reactor Operator License terminated effective 26 May 2015.
f. On 3 June 2015 the Nuclear Regulatory Commission requested additional information concerning the LAR submitted 15 July 2011.

6.2 Nuclear Safety Committee (UCD/NSC)

a. The Nuclear Safety Committee held its semi-annual meetings on 26 February and 23 July 2015.
b. The Nuclear Safety Committee performed an Operations audit on 28 October 2015.
c. The Nuclear Safety Committee performed an audit of the Radiation Safety Program on 23 November 2015.
d. The Nuclear Safety Committee performed a Security audit on 14 December 2015.

7.0 OPERATIONS

OPERATING HISTORY:

TOTAL OPERATING HOURS THIS YEAR:	1055.73
TOTAL OPERATING HOURS:	49472.06
TOTAL MEGAWATT HOURS THIS YEAR:	961.70
TOTAL MEGAWATT HOURS:	64217.14
TOTAL NUMBER OF PULSES PERFORMED THIS YEAR:	0
TOTAL NUMBER OF PULSES PERFORMED:	484

7.1 UNSCHEDULED REACTOR SHUTDOWNS and NOTED PROBLEM AREAS:

In 2015, there were three(3) unscheduled shutdowns at the MNRC reactor facility. The following is a list of the unscheduled shutdowns:
2015 UNSCHEDULED REACTOR SHUTDOWNS

Type of Failures	Total Number
CSC	1
Other	2
TOTAL NUMBER OF UNSCHEDULED SHUTDOWNS IN 2015	3

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

Notes:
1: Loss of off-site power due to weather (lightning strikes in the area)
2: Control Room Overheated due to loss of air conditioning

January

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

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 was one unscheduled shutdown in the month of March.
   a. Loss of building power. (Off Site Power).
2. There were two callbacks to the facility in March.
   a. Both were Rod Withdrawal Prohibit (RWP)alerts that cleared on acknowledgement

April

1. There was one unscheduled shutdown in the month of April.
   a. Loss of Off Site Power due to lightning.
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. Stack CAM blower power failure.

July

1. There were no unscheduled shutdowns in July.
2. There were two callbacks to the facility in the month of July.
   a. Cooling Tower High Water Level due to switch failure.

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. Rod Withdrawal Prohibit alert. Cleared on acknowledgement.
   b. Stack CAM fault, cleared on acknowledgement.

September

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

October

1. There was one unscheduled shutdown in the month of October.
   a. Control Room Overheat, Anomaly - Loss of Rod control.
2. There were two callbacks to the facility in the month of October.
   a. CSC-DISO64 timeout.
   b. Rod Withdrawal Prohibit alert, cleared on acknowledgement.

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. UPS fault. Cleared on acknowledgement
   b. Loss of Site Power.

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 2015, there was 1 reported anomaly at the MNRC facility and no Radiological Incident Investigations. The specifics are listed below:

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

Anomaly Report For: AC-10 Failure

Time: Unknown 10/4/15 (Sunday)

Reactor conditions prior to the anomaly and what occurred during the anomaly:

Rx was shut down for the weekend. At 2151 on Sunday, 10/4, the console alarmed for "Scram CSC-DISO64 Timeout". SRO responded (see log entry 10/4/15 2300).

Upon opening on Monday morning, the control room was 84°F instead of 72°F and the console was alarming; alarms would not acknowledge; rebooting the console did not fix the problem; placed the console in Utilities mode. It was noted at the Temperature Control Panel that AC-10, the unit that cools the Control Room, was not running.

A portable fan was brought in to provide temporary cooling. Inspection of AC-10 showed the unit on, the condenser fan was not running and fan and housing were very hot to the touch. The unit was shut off at its local disconnect. After about 30 seconds, it was attempted to restart the unit, which it did not. The unit was left off.

After discussion with the building manager, it was suggested to try restarting after the unit had been off for 10 minutes. At this time, the unit had been off approximately 20 minutes. Before restarting, the fan was spun manually to be sure it would move, which it did. The unit was restarted successfully. The control room immediately began to cool off. When the temperature reached 76°F, the console was returned to normal. All unusual alarms cleared.

A Startup Checklist was performed successfully.

The reactor was started at 0922 to 1 MW for radiography. At 1330, the contractor arrived to repair the AC unit. After determining that radiography required only about 15 minutes more, the AC unit was shut off for repairs. At 1400, prior to hourly readings, the control rods were leveled successfully. At 1430, the reactor was attempted to be shutdown normally. At this time, the temperature in the control room was up to 79°F.

The reactor mode was switched to Manual, and all six control rods Down buttons were pressed. Shim 2 began to drive in, but the other rods did not appear to move. The reactor was manually scrammed from the console, and the direct reading instruments showed the reactor was shut down. Visual inspection confirmed the magnets were indeed all down, but the indications on the console were frozen.

At 1545, the repairs on AC-10 were competed, the unit restarted, and the control room was cooled down to normal. The console responded normally, and once the key was used to energize the magnets, all indications returned to normal. A Prestart Check was performed successfully.

Actions to correct the Anomaly:

Contractor was sent to troubleshoot unit. Portable fan was used to cool the control room during repairs.

Actions to prevent reoccurrence:

Contractor replaced units' condenser motor/starting capacitor and controller.

7.3 MAINTENANCE OTHER THAN PREVENTIVE:

January

System #	Description	Work Performed
5350	Electrical Power Distribution	Repair/Replace Emergency lights in several places

February

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

March

System #	Description	Work Performed
5120	Demineralizer System	Changed out Makeup Water Tank inlet resin bottles.
5170	Auxiliary Makeup Water System	Changed out AMUWS system resin bottles
5490	Helium Supply System	Replaced expended He supply bottle
1803	Rad-Vac	DOP test Radiological Vacuum Cleaner
1800	Reactor Ventilation	DOP test Reactor Room Exhaust HEPA filters

May

System #	Description	Work Performed
1001	Stack CAM	Replaced Stack CAM Photohelic, replaced O-ring and tightened mechanical joints in airstream piping to resolve flow issue.
5750	Facility General	Replaced faulty Reactor Room entry door lock mechanism.

June

System #	Description	Work Performed
1001	Stack CAM	Replaced Stack CAM motor fuse holder
5750	Facility General	Replaced broken light fixture on roof (stack)

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: $1.88	Shim 1: $2.70	Shim 2: $2.49
Shim 3: $2.87	Shim 4: $2.98	Regulating Rod: $2.80

Control Rod Scram Drop Times:

Transient Rod: 0.37 sec	Shim 1: 0.39 sec	Shim 2: 0.37 sec
Shim 3: 0.40 sec	Shim 4: 0.39 sec	Regulating Rod: 0.39 sec

Shutdown Margin: $5.96

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: 104% indicated, NM-1000: 104% indicated.

System #	Description	Work Performed
5720	Security System	Replaced broken threaded rod in latching mechanism on Reactor Room door.
5310	Control System Console (CSC)	Replaced CSC HiRes monitor

September

System #	Description	Work Performed
5490	Helium Supply	Replace expended He supply bottle
5640	Building Ventilation System	Replaced the through wall fan between the Demin Cage and the CAM room.

October

System #	Description	Work Performed
5640	Building Ventilation System	Troubleshot and repaired AC-10 (Control Room unit)
5640	Building Ventilation System	Replaced HV-3 fan belt.

December

System #	Description	Work Performed
5640	Building Ventilation System	Replaced EF-3 Prefilter
5720	Security System	Replaced failed Keypad at East gate
5490	Helium Supply	Replaced expended He supply bottle
5120	Demineralizer System	Replaced depleted resin bottles

7.4 Training

January

1. All licensed operators and trainees completed Administrative Controls, Procedures and Regulations training.

February

1. All licensed operators completed Facility Design and Operating Characteristics and Instrumentation and Control Training.

March

1. No scheduled training in March.

April

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

May

1. No scheduled training for May.

June

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

July

1. All licensed and candidate operators successfully completed the Annual Operators Examination.
2. MNRC conducted summer school classes for the University COSMOS program.
3. One Senior Reactor Operator completed Radiation Safety Training for Operators.
4. All personnel completed Explosives Material Safety Training.

August

1. One Senior Reactor Operator completed Radiation Safety training for Operators.

September

1. 3 licensed operators completed training on Technical Specifications.

October

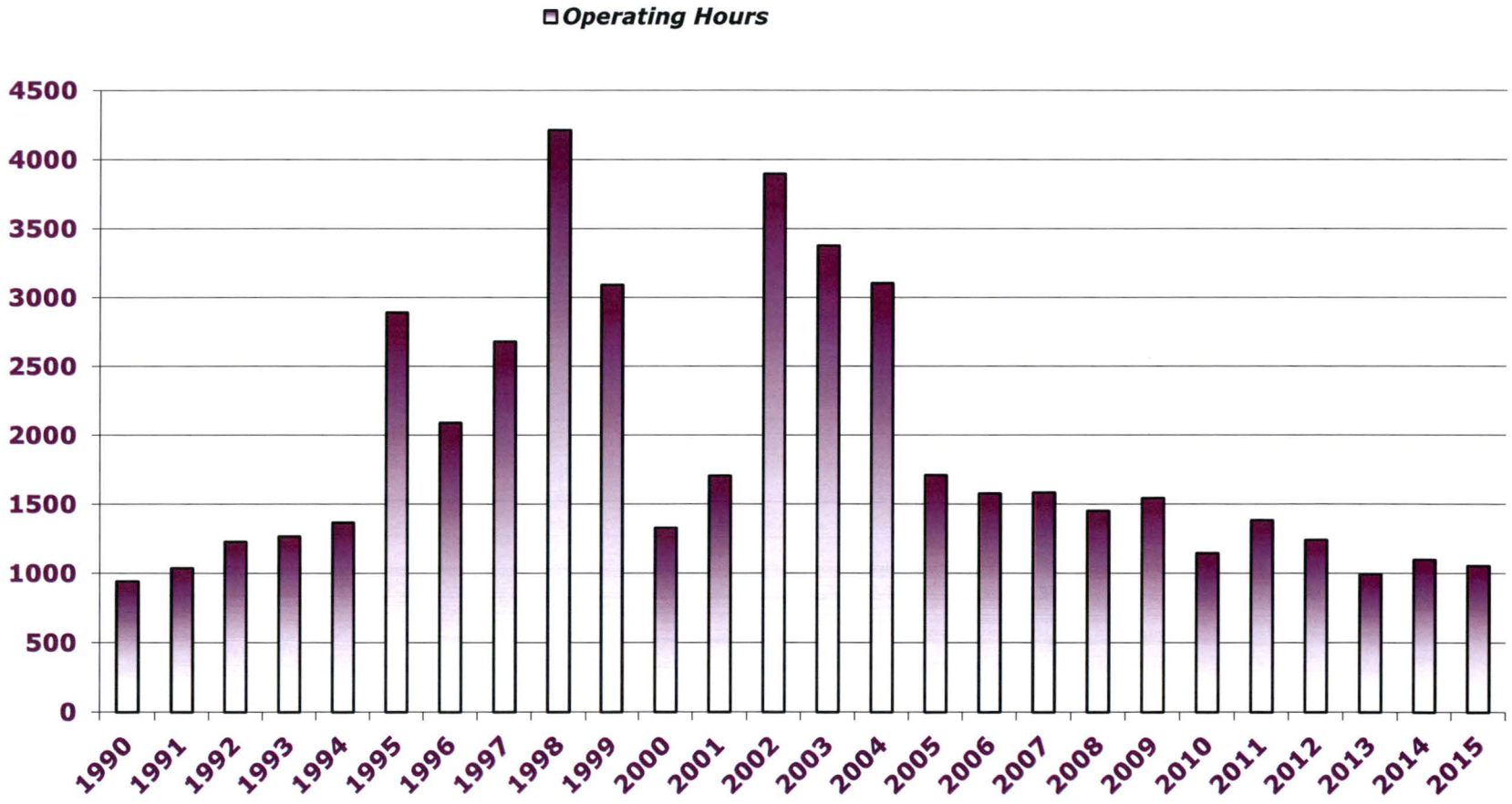
1. One Licensed Senior Reactor Operator completed training on Technical Specifications.

November

1. 3 Senior Reactor Operators completed training on Nuclear Theory
2. All Senior Reactor Operators participated in the 2015 Security drill.

December

1. One Senior Reactor Operator completed training on Technical Specifications.
2. One Senior Reactor Operator completed training on Nuclear Theory.


Operating Hours
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
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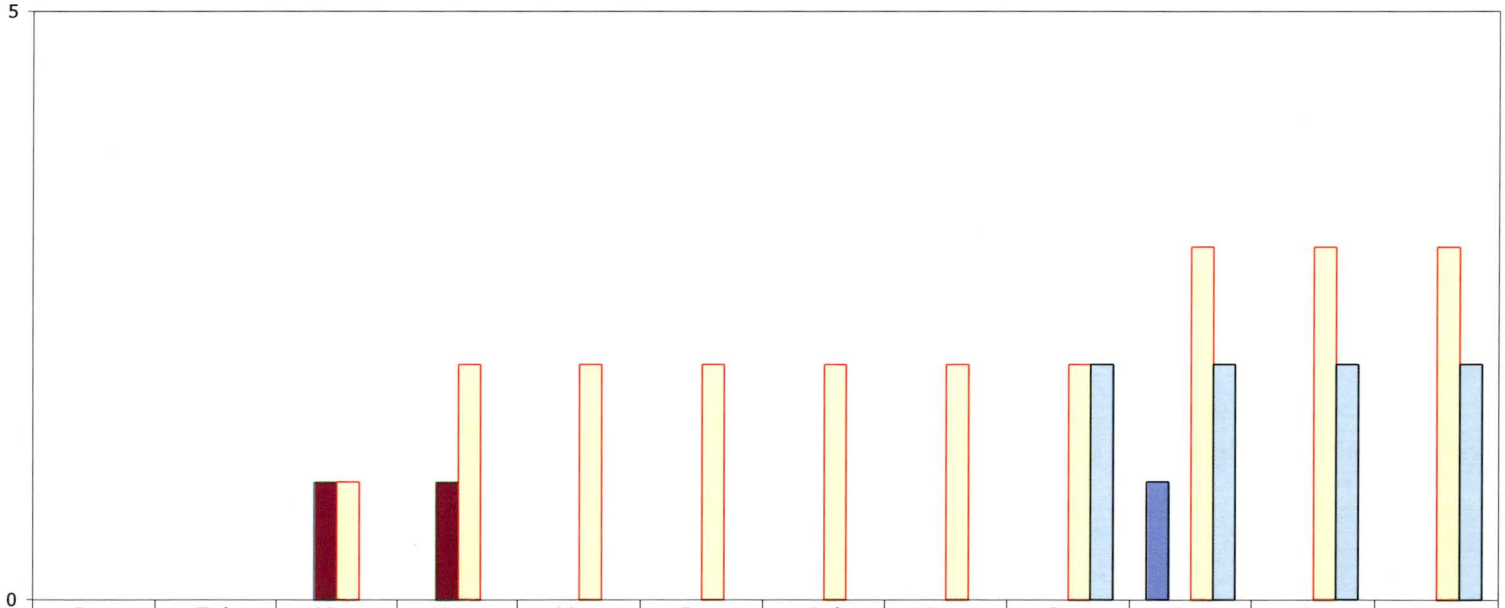
2010
2011
2012
2013
2014
2015

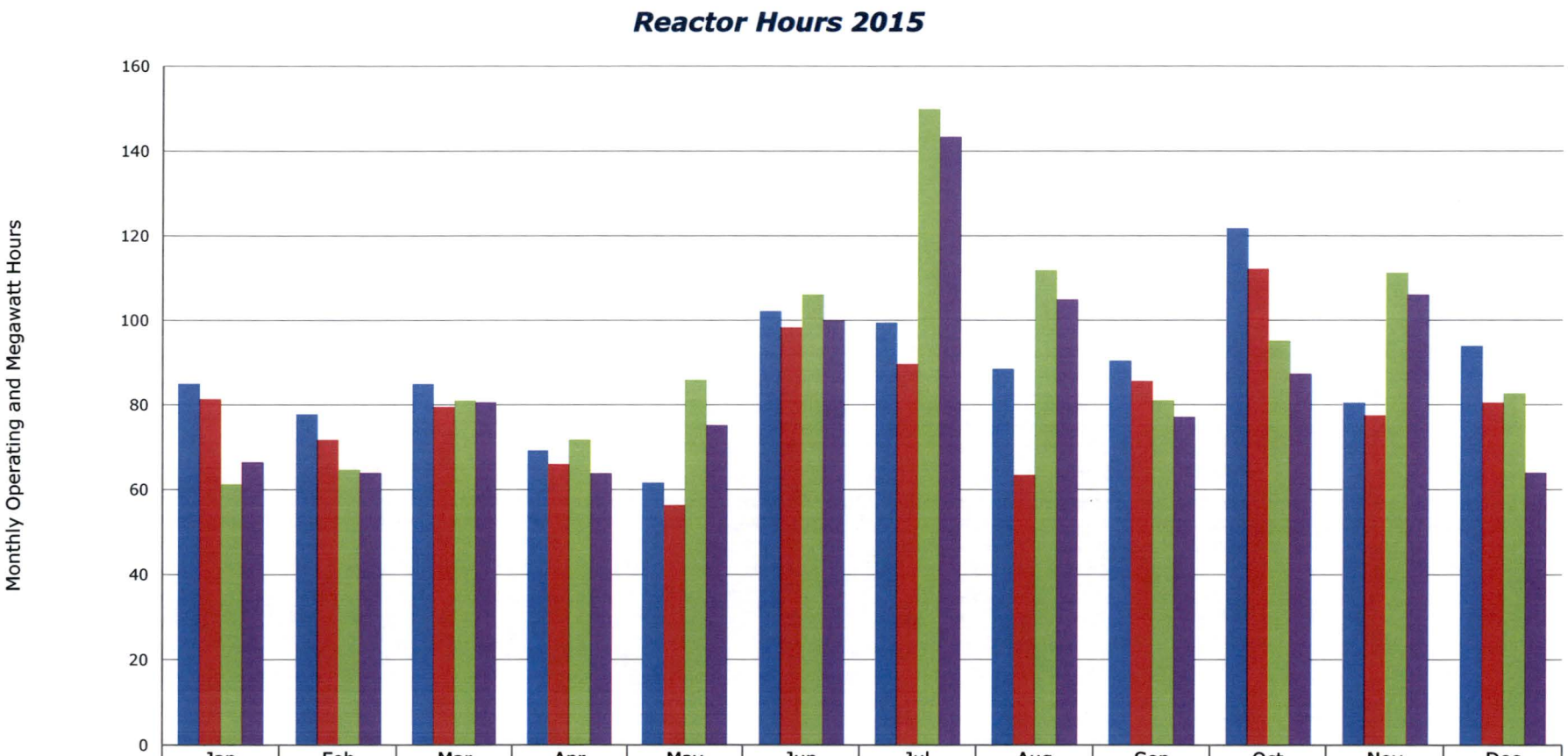
Unscheduled Reactor Shutdowns 2015



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
CSC	0	0	0	0	0	0	0	0	0	1	0	0
Other	0	0	1	1	0	0	0	0	0	0	0	0
2015 Total	0	0	1	2	2	2	2	2	2	3	3	3
2014 Total	0	0	0	0	0	0	0	0	2	2	2	2

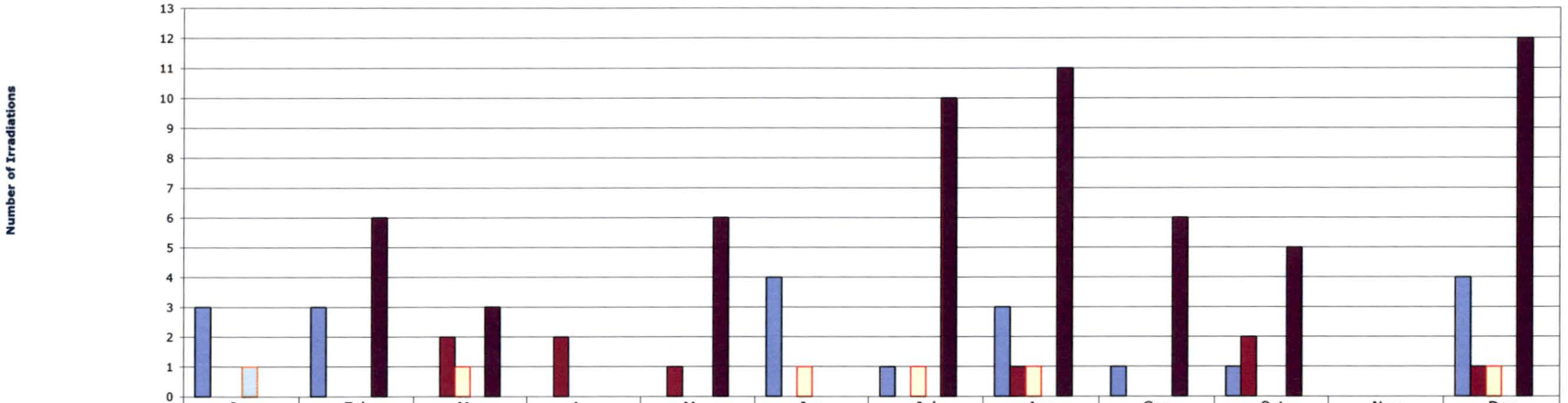
Months

Reactor Hours (2015)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2015 Op-Hrs	84.98	77.8	84.94	69.25	61.7	102.2	99.51	88.52	90.5	121.85	80.53	93.95
2015 Mw-Hrs	81.33	71.66	79.47	65.99	56.31	98.3	89.62	63.39	85.58	112.12	77.45	80.48
2014 Op-Hrs	61.3	64.67	81.01	71.8	85.92	106.17	149.89	111.9	81.07	95.13	111.3	82.77
2014 Mw-Hrs	66.46	63.92	80.64	63.89	75.2	99.86	143.34	104.96	77.15	87.37	106.09	63.98

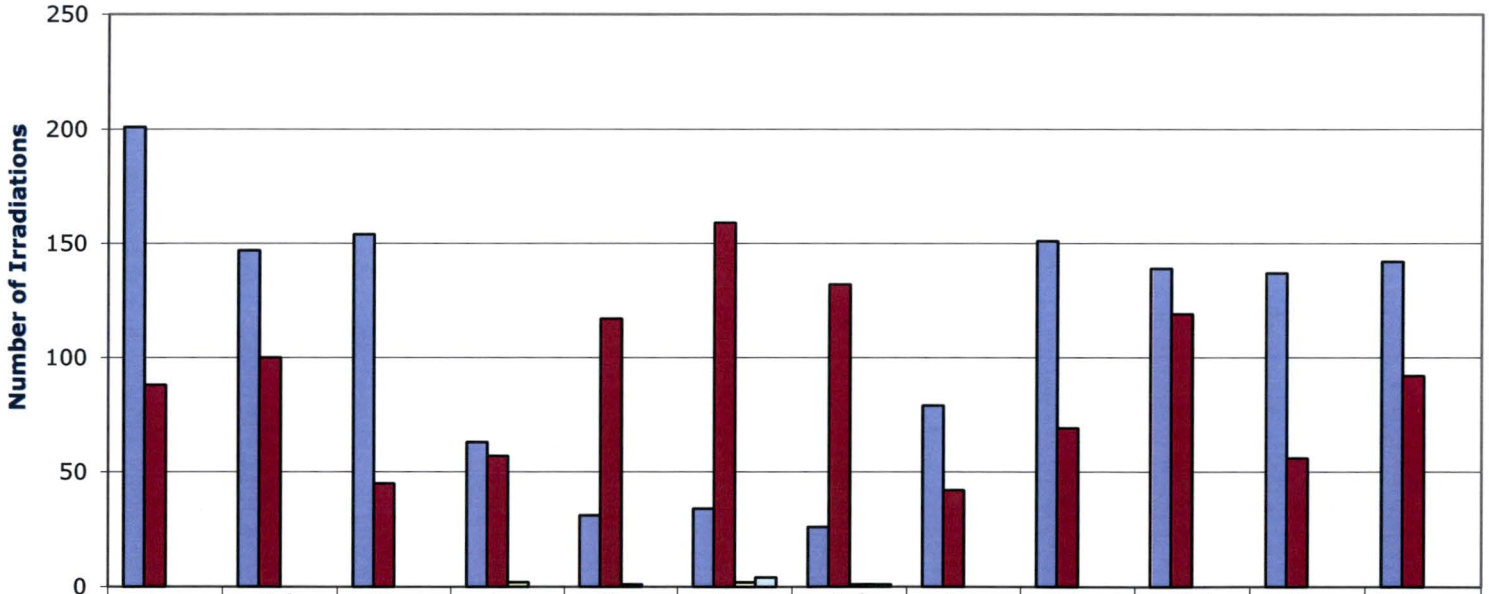
Reactor Tank Irradiation Facilities 2015



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pneumatic	3	3	0	0	0	4	1	3	1	1	0	4
Silicon Fixture	0	0	2	2	1	0	0	1	0	2	0	1
Central Facility	0	0	1	0	0	1	1	1	0	0	0	1
Argon	1	0	0	0	0	0	0	0	0	0	0	0
Neutron Irradiator	0	6	3	0	6	0	10	11	6	5	0	12

Months

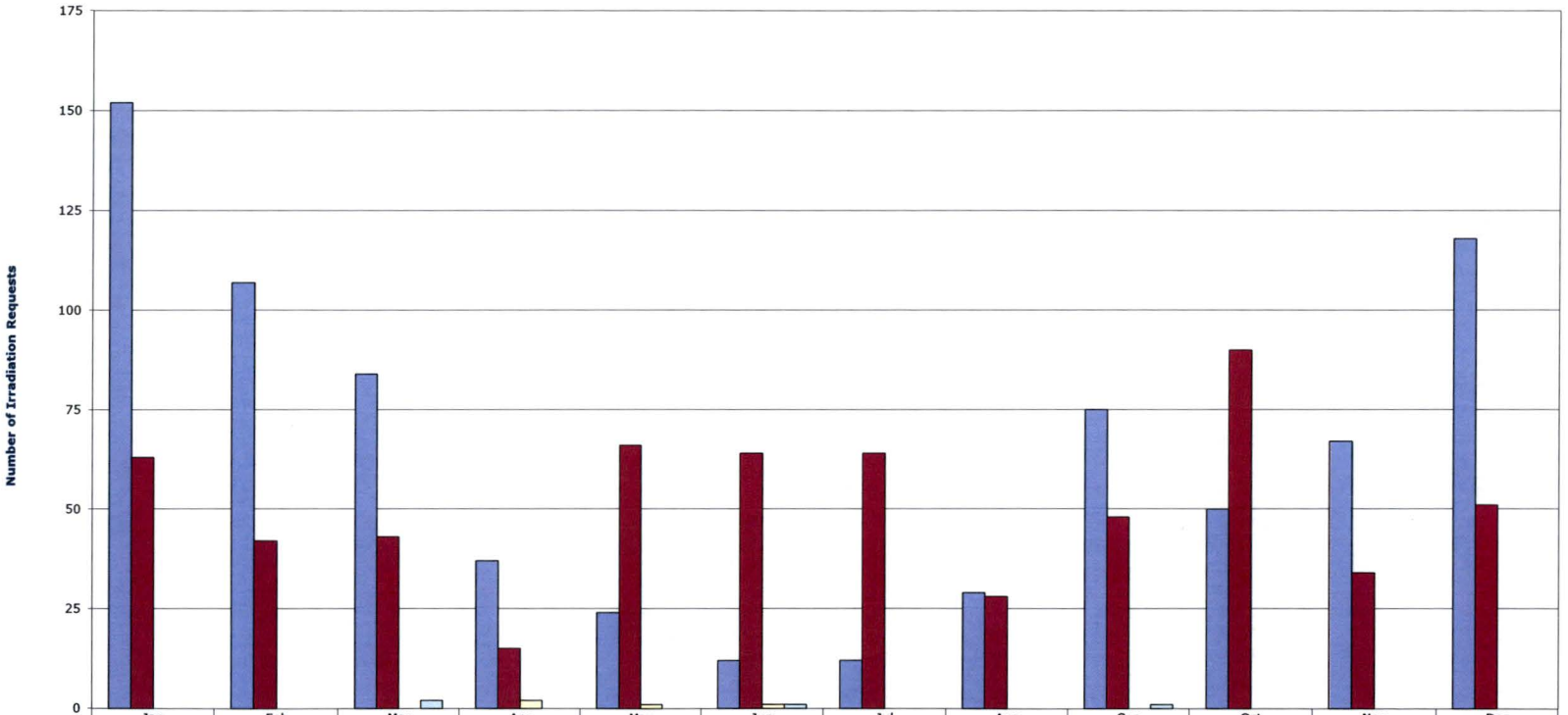
Bay Utilization (Shutter Operations) 2015



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bay 1	201	147	154	63	31	34	26	79	151	139	137	142
Bay 2	88	100	45	57	117	159	132	42	69	119	56	92
Bay 3	0	0	0	2	1	2	1	0	0	0	0	0
Bay 4	0	0	0	0	0	4	1	0	0	0	0	0

Months

Bay Irradiation Requests Completed 2015



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bay 1	152	107	84	37	24	12	12	29	75	50	67	118
Bay 2	63	42	43	15	66	64	64	28	48	90	34	51
Bay 3	0	0	0	2	1	1	0	0	0	0	0	0
Bay 4	0	0	2	0	0	1	0	0	1	0	0	0

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 2015.

8.2 Airborne Effluents

Airborne radioactivity discharged during 2015 is tabulated in Table 1 below.

TABLE 1
2015 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	2.18	1.23E-10	1.2%	7.48E-01	7.48%	NONE	NONE
FEB	1.97	1.23E-10	1.2%	7.51E-01	7.51%	NONE	NONE
MAR	1.80	1.01E-10	1.0%	6.17E-01	6.17%	NONE	NONE
APR	1.84	1.03E-10	1.0%	6.30E-01	6.30%	NONE	NONE
MAY	1.11	6.17E-11	0.6%	3.76E-01	3.76%	NONE	NONE
JUN	1.65	9.19E-11	0.9%	5.60E-01	5.60%	NONE	NONE
JUL	1.92	1.07E-10	1.1%	6.53E-01	6.53%	NONE	NONE
AUG	0.93	5.16E-11	0.5%	3.14E-01	3.14%	NONE	NONE
SEP	1.20	6.67E-11	0.7%	4.06E-01	4.06%	NONE	NONE
OCT	1.82	1.01E-10	1.0%	6.17E-01	6.17%	NONE	NONE
NOV	1.02	5.69E-11	0.6%	3.46E-01	3.46%	NONE	NONE
DEC	1.07	5.98E-11	0.6%	3.64E-01	3.64%	NONE	NONE
TOT	18.50					NONE	NONE
AVG	1.54	8.75E-11	0.9%	0.53	5.32%		

(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 2015 is summarized in Table 2 below.

TABLE 2
2015 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	19	55	53	210
FACILITY USERS	27	<1.0	1	*	*
VISITORS	661	0.3	2	*	*

(1) Only 7 of the 9 facility radiation workers were employed at MNRC at the end of 2015.

* 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 2015 are summarized in Table 3 below.

TABLE 3
2015 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(4)	60(5)	<800(2)	<800(2)
DEMINERALIZER AREA	12.9(4)	320(5)	<800(2)	<800(2)
REACTOR RM	2.7(4)	665(5)	<800(2)	<800(2)
SILICON STORAGE SHED	<0.1	<0.1	<5000(1)	<5000(1)
RADIOGRAPHY BAYS	0.75(3)	480(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 its shielding.

11.0 Environmental Surveys

Environmental surveys performed outside of the MNRC during 2015 are summarized in Tables 4 & 5 below. The environmental survey program is described in the MNRC Facility Safety Analysis Report.

TABLE 4
2015 SUMMARY OF ENVIRONMENTAL TLD RESULTS
(WITH NATURAL BACKGROUND(1) SUBTRACTED)

	AVERAGE (mrem)	HIGHEST (mrem)
ON BASE (OFF SITE 1-20 & 64)	4	23
ON SITE (SITES 50 – 61 & 65-71)	12	31

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

TABLE 5
2015 SUMMARY OF RADIOACTIVITY IN WELL WATER

	ALPHA (pCi/l)	BETA (pCi/l)	TRITIUM (pCi/l)	Cs-137 (pCi/l)
AVERAGE	<MDA	3.37	<MDA	<MDA
HIGHEST	<MDA	3.81	<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	1.35	2.19
Beta	1.75	2.00
Tritium	302	390
Cs-137	4.24	7.69