UCDAVIS
MNRC
McCLELLAN NUCLEAR RADIATION CENTER

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

June 26, 2003

To: See Distribution List

Subject: UCD/MNRC 2002 Annual Report

Attached is the UCD/MNRC 2002 Annual Report. As this report shows, 2002 was a very busy year. The reactor operated for 3900 hours with a utilization factor of 89%. That was the second highest number of reactor operating hours since operation began in 1990.

The year 2002 produced a record number of research irradiations as the UCD Geology Department programs continue to progress.

The Department of Energy awarded the UCD/MNRC one of four Innovations in Nuclear Infrastructure and Education grants. The grant allows for the purchase of new research equipment plus support for four (4) graduate students.

As part of the UCD/MNRC Educational and Outreach Program, over 100 students and faculty toured the reactor facility this year.

The Iodine-125 production loop began operating for the first time in March 2002. Since that time, the demand for I-125 has steadily increased.

Wade J. Richards, Ph.D.
Director
UCD/MNRC

1 Attachment
UCD/MNRC 2002 Annual Report

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UC Davis MNRC
2002 Annual Report
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UCDAVIS

MNRC

McCLELLAN NUCLEAR RADIATION CENTER

2002

ANNUAL REPORT

UCDAVIS MNRC McCLELLAN NUCLEAR RADIATION CENTER

UCD/MNRC ANNUAL REPORT FOR 2002

1. Introduction

The University of California, Davis McClellan Nuclear Radiation Center (MNRC) consists of a research reactor and associated radiography and positioning equipment. 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 capability.

It is the 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 2002.

2. General Information

The United States Air Force (USAF) began building the reactor in 1988 and completed the project in 1990. The McClellan Nuclear Radiation Center (MNRC) achieved criticality on January 20, 1990. The reactor was operated at 1 MW from 1990 to 1997. The reactor was upgraded to 2 MW and the first 2 MW operation was done on April 14, 1997.

The USAF ran the reactor from 1990-1999 in support of their nondestructive inspection program. This program involved inspecting aircraft structures for signs of moisture and corrosion using neutron radiography.

McClellan Air Force Base closed in July 2001. Therefore, the MNRC was officially transferred to the University of California, Davis (UCD) on February 2, 2000. This transfer also included the Nuclear Regulatory Commission (NRC) operating license R-130 from the USAF to UCD.

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.

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

3. UCD/MNRC Facility Description

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 and four bays for radiography. All four bays are capable of using radiography film techniques, but Bays 1 and 3 will 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.

4. UCD/MNRC Programs

The year 2002 has been a very active building year for the facility. The research programs have increased as a result of winning one of the DOE Innovations in Nuclear Infrastructure and Education Program (INIE) grants. The commercial programs have experienced a growth in that the Iodine Loop that was being repaired for most of the year is now up and running. The number of educational visits and demonstrations has increased from last year.

4.1. Educational Programs

- Grants

(1) The DOE Innovations in Nuclear Infrastructure and Education Program (INIE) was awarded in July. This grant will allow the purchasing of research equipment, support for graduate and undergraduate students and provide for educational programs to be conducted from the UCD/MNRC site. The grant also provides for UC Berkeley students to visit and participate in classes being taught at the UCD/MNRC.

(2) The DOE University Reactor Upgrade grant provided the funds to purchase a new reactor safety channel, which is being integrated into the new reactor console.

(3) The DOE University Reactor Sharing grant provided the funds to cover the many student visits and demonstrations through out the year. These funds also support UCD researchers to a small extent.

(4) The American Nuclear Society Student Educational grant provided the funds to buy the demonstration equipment use for student visits.

(5) The UCD/MNRC grant to the UCD Geology Dept. to study the composition of rocks and soil utilizing the neutron tomography and film radiography systems is in its final year. The program has increased the collaboration between Lawrence Livermore National Laboratory and Los Alamos National Laboratory. This collaboration has resulted in grants being generated to continue the work beyond the three-year UCD/MNRC grant.

4.2. Research

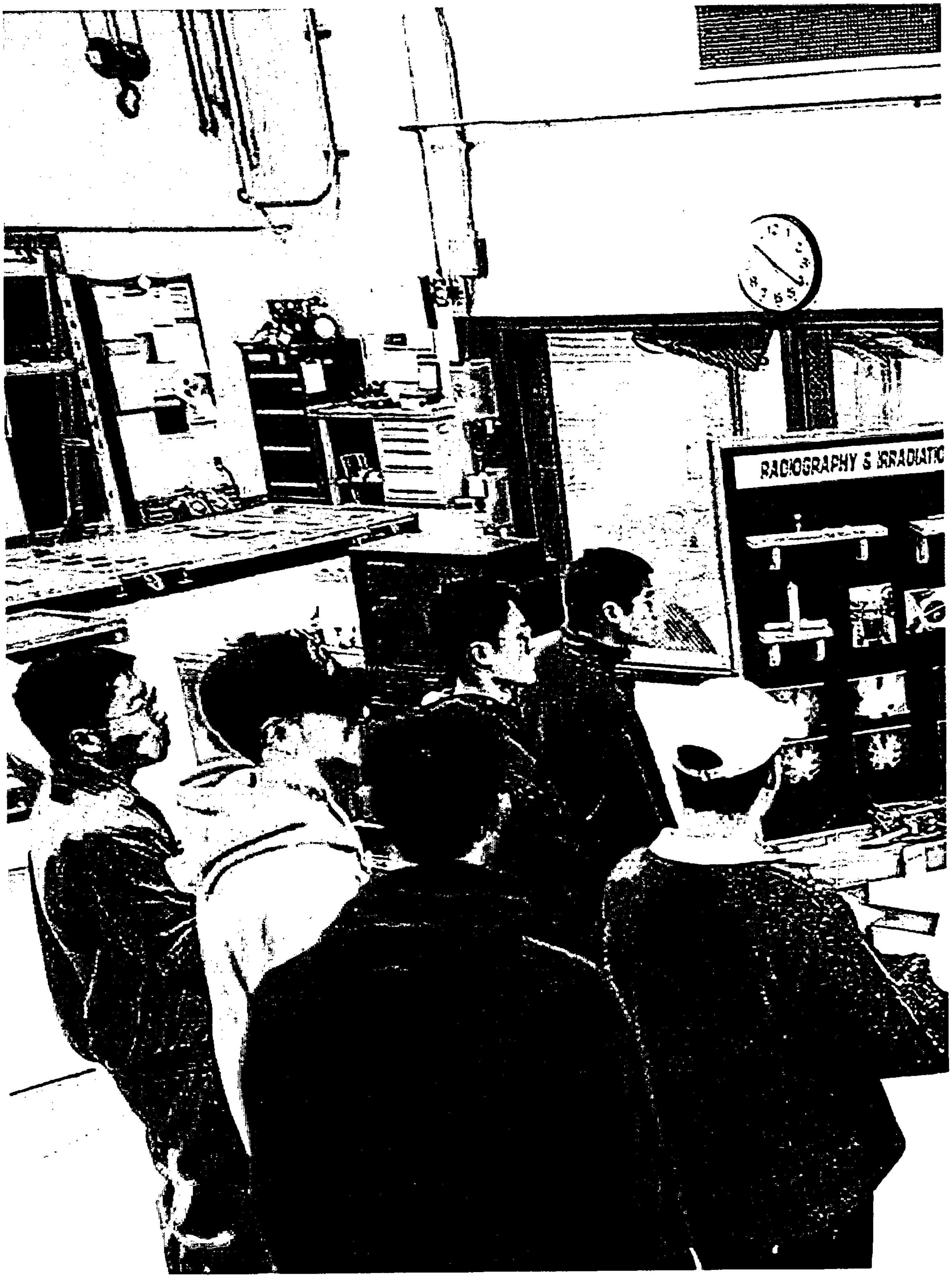
- The primary areas of research continue to be the geology, plant sciences, Vegetable Crop Dept. and Physics. The research program participants include UCD, UCB, Livermore, Los Alamos, Sandia National Laboratory, and Oregon State University.

4.3. Commercial

- The primary commercial work being done at this time is the Precision Casting Corp. (PCC) aircraft structures.

- Irradiation testing is being done for ICS.

Participating Institution	Principal Investigator	Number of Students	Number of Faculty	Description of Project
Sandia National Laboratory	Dr. Larry Posey	Three experimenters	--	Performed neutron pulsing experiments on fiber optic materials
Will C. Wood High School	Mr. Art Beauchamp	Sixty	Three	Two groups toured the reactor. High School chemistry class.
UCD Applied Science Dept	Dr. David Hwang	Ten	One	Tour of reactor. Undergraduate Energy Seminar Class
Workshop on Neutron Activation Analysis	Dr. Steve Binney	Twenty	One	One-day workshop covering neutron activation analysis principles
UCD Geology Department	Dr. Dawn Sumner	Two Graduate Students	One	Using neutron tomography to study mineralogy of oil bearing rocks
UCB	Dr. Richard McDonald	Zero	One	Irradiation studies for the Dark Matter Program
UCD Land Air & Water Resources	Dr. Jan Hopman & Wendy Silk	Two Graduate Students	Two	Study of water flow in porous media
UCD Veg & Crop Seed Department	Dr. Jan Dvorak & Dr. Ken Bradford	Two Graduate Students	Two	Study of effects of radiation on vegetable seeds
UCD COSMOS Program	Dr. Mike Meier	Forty High School Juniors and Seniors	Two	Tour of reactor and class lab experiment on radioactive decay


RADIOGRAPHY & IRRADIATIO

Neutron Beam Imaging Studies

The UCD/MNRC has world-class neutron imaging facilities. These facilities are being used more extensively by the UCD researchers and researchers outside the UC system. The most extensive use of the UCD neutron tomography capabilities has been through the Geology Department. These studies have included a variety of geological and soil samples. Neutron tomography studies have been carried out on over thirty geological samples and a similar number of soil cores. Since most of this work is a continuation from last years work the researches are at the point where they are ready to submit grants to continue the work and fund the neutron beam time. A detailed listing of the samples is included in the Annual Report for 2001.

With the award of the INIE grant from the DOE the neutron tomography system will be upgraded to allow an increase in the spatial resolution (i.e., going from 250 microns to 50 microns). This increased resolution will allow a large step in the type of analysis that the geology department researchers can accomplish. A further upgrade will be to purchase a multiplate channel neutron detector that will also allow further resolution gains to be realized.

There is continuing interest in the neutron imaging capabilities from both Lawrence Livermore National Lab and Los Alamos Lab. These participants are in the stage of putting together programs that collaborations can be started.

5.0 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.

UCD contracted with Science Applications International Corporation (SAIC) to operate the MNRC.

The UCD/MNRC is under the direction of the UCD/MNRC Director. The Director is a UCD employee that reports to the Vice Chancellor for Research.

A complete organization chart can be found in UCD/MNRC Safety Analysis Report, Chapter 13.

6.0 Licensing and Regulatory Activities

6.1 NRC Items

There were no requests to amend the facility license during this period.

6.2 Nuclear Safety Committee (UCD/NSC)

(a) The annual NSC audit of the UCD/MNRC was conducted during the month of May 28-30, 2002. All observations have been addressed. There were no Recommendations.

(b) The Nuclear Safety Committee met twice during 2002: September 30, 2002 March 15, 2002.

6.3 The Nuclear Regulatory Commission performed an inspection on August 14-16, 2002. The inspection was rated satisfactory.

6.4 The following lists contain the 50.59 actions for CY 2002.

Evaluation of Experiments or Modifications Under the Provision of 10 CFR 50.59

Experiment: Moving ^{125}Iodine Chamber from C-05 to E-06   Date: 8 August 2002

Does the proposed change, experiment or modification:	***Yes***	***No***	***Justification***
a. Result in more than a minimal increase in the ***frequency*** of occurrence of an accident previously evaluated in the FSAR (as updated).		xx	Does not result in a minimal increase in the frequency of occurrence of an accident previously evaluated in the FSAR because it has already been analyzed for placing the irradiation chamber in inner hex ring. It will require a minimal wording change in the FSAR as it now states the irradiation chamber will be conservatively located in the outer hex rings.[1]
b. Result in more than a minimal increase in the ***likelihood*** of occurrence of a malfunction of a structure, system, or component important to safety previously evaluated in the FSAR (as updated).		xx	The structure has not changed. It has just been relocated to a different position in the core.
c. Result in more than a minimal increase in the ***consequences*** of an accident previously evaluated in the FSAR (as updated).		xx	No change in the increase in the consequences of an accident previously evaluated in the FSAR because we are limited to 20 curies of iodine, below $1.75 reactivity limit for a secured experiment, and it is not a fuel temperature problem.
d. Result in more than a minimal increase in the ***consequences*** of a malfunction of a structure, system, or component important to safety previously evaluated in the FSAR (as updated).		xx	The structure has not changed. It has just been relocated to a different position in the core.
e. Create a possibility for an accident of a different type than any previously evaluated in the FSAR (as updated).		xx	There is not a possibility for an accident of a different type than any previously evaluated in the FSAR.
f. Create a possibility for a malfunction of a structure, system, or component important to safety with a different result than any previously evaluated in the FSAR (as updated).		xx	This is not a SSC.
g. Result in a design basis limit for a fission product barrier as described in the FSAR (as updated).		xx	Not a fission product barrier.

[1] Attachment 1: Proposed wording changes to the FSAR.

h. Result in a departure from a method of evaluation as described in the FSAR (as updated) used in establishing the design bases or in the safety analysis.		xx	This is not a departure from a method of evaluation as described in the FSAR (as updated) used in establishing the design bases or in the safety analysis.

[X] **Based on the evaluation conducted in the above table, it is concluded that the proposed action *does not meet* any of the 10CFR 50.59 criteria; therefore, no license amendment or change to the Technical Specifications is needed to perform the proposed action.**

[ ] **Based on the evaluation conducted on the above table, it is concluded that the proposed action *does meet one or more* of the 10CFR 50.59 criteria; therefore, a license amendment or a change to the Technical Specifications, is required to perform the proposed action.**

Performed By: Charles C. Heidel

Signature: (signed)

Date: May 01, 2001

Facility Director: Wade J. Richards (signed)

Date: 8 Aug 2002

Evaluation of Experiments or Modifications Under the Provision of 10 CFR 50.59

Experiment: Installation of Two (2) ^{125}Iodine Irradiation Chambers
Date: September 4, 2002

Does the proposed change, experiment or modification:	***Yes***	***No***	***Justification***
a. Result in more than a minimal increase in the ***frequency*** of occurrence of an accident previously evaluated in the FSAR (as updated).	xx		Two I-125 irradiation chambers installed in the reactor core minimal increase in the frequency of occurrence of an accident, due to the increase number of chamber and the increase in the number of Curies radioactive gases produced.[1]
b. Result in more than a minimal increase in the ***likelihood*** of occurrence of a malfunction of a structure, system, or component important to safety previously evaluated in the FSAR (as updated).		xx	No minimal increase in the likelihood of occurrence is expected as both irradiation chambers are of a similar design as the present irradiation facility.
c. Result in more than a minimal increase in the ***consequences*** of an accident previously evaluated in the FSAR (as updated).	xx		There is an increase in the consequences of an accident previously evaluated because this allows for the production of 40 curies of I-125 versus the present Technical Specifications limit of 20 curies.
d. Result in more than a minimal increase in the ***consequences*** of a malfunction of a structure, system, or component important to safety previously evaluated in the FSAR (as updated).		xx	No minimal increase in the likelihood of occurrence is expected as both irradiation chambers are of a similar design as the present irradiation facility.
e. Create a possibility for an accident of a different type than any previously evaluated in the FSAR (as updated).	xx		There is an increase in the consequences of an accident previously evaluated because of the production of 40 curies of I-125 versus the present Technical Specifications limit of 20 curies.
f. Create a possibility for a malfunction of a structure, system, or component important to safety with a different result than any previously evaluated in the FSAR (as updated).		xx	This has no effect on any safety system components.
g. Result in a design basis limit for a fission product barrier as described in the FSAR (as updated).		xx	No fuel limits or boundaries are affected by this modification.[1]

[1] MEMORANDUM, August 13, 2002, TO: Chuck Heidel, FROM: H. Ben Liu, Subject: Safety Analysis Report for I-125 Irradiation Chambers in the UCD/MNRC's Reactor Core

h. Result in a departure from a method of evaluation as described in the FSAR (as updated) used in establishing the design bases or in the safety analysis.	xx		The original evaluation as described in the FSAR evaluated for one iodine irradiation chamber versus the two irradiation chambers that are not being considered and the increase of the production of 40 curies of I-125 versus the present Technical Specifications limit of 20 curies.

☐ **Based on the evaluation conducted in the above table, it is concluded that the proposed action *does not meet* any of the 10CFR 50.59 criteria; therefore, no license amendment or change to the Technical Specifications is needed to perform the proposed action.**

☒ **Based on the evaluation conducted on the above table, it is concluded that the proposed action *does meet one or more* of the 10CFR 50.59 criteria; therefore, a license amendment or a change to the Technical Specifications is required to perform the proposed action.**

Performed By: Charles C. Heidel

Signature: (signed)

Date: September 4, 2002

Facility Director: Wade J. Richards (signed)

Date: September 5, 2002

7.0 OPERATIONS

OPERATING HISTORY:

TOTAL OPERATING HOURS THIS YEAR:	3,899.88
TOTAL OPERATING HOURS:	28,174.95
TOTAL MEGAWATT HOURS THIS YEAR:	6,695.68
TOTAL MEGAWATT HOURS:	36,813.47
TOTAL NUMBER OF PULSES PERFORMED THIS YEAR:	0
TOTAL NUMBER OF PULSES PERFORMED:	410
	425

7.1 UNSCHEDULED REACTOR SHUTDOWNS:

In 2002, there were sixty-nine (69) unscheduled scrams at the MNRC reactor Facility. Watchdog scrams are the largest contributor to the total number of unscheduled shutdowns (60%) followed by equipment failure/problems (30%), iodine loop problems (6%), facility electrical power loss (3%), and personnel error (1%). The following is a list of the unscheduled shutdowns:

2002 REACTOR SHUTDOWNS

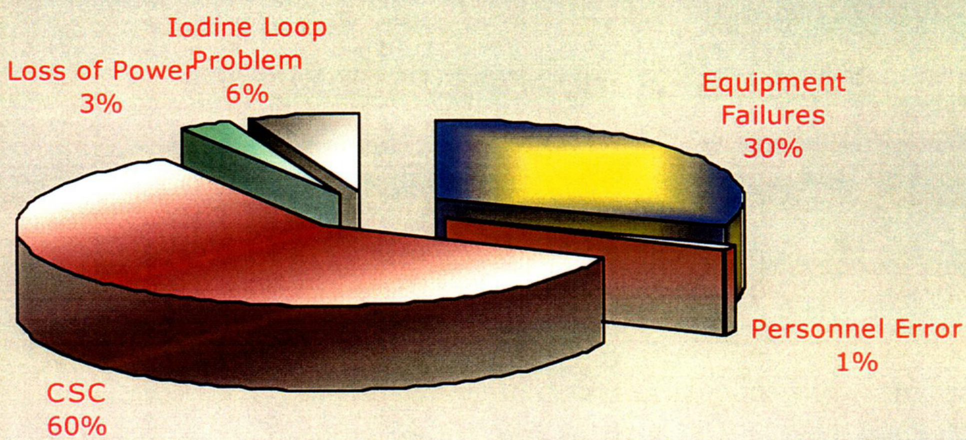
	CSC	Reactor Rm Cam	Iodine Loop Problem	Stack Cam	EF-1 Low Flow	Dropped Rod	Loss Of Elect Power	Bay 1 Interlock	Bay 2 Shutter	NM-1000	per month
Jan	1	0	0	0	0	0	0	0	0	0	1
Feb	4	0	0	0	0	0	0	0	0	0	4
Mar	6	1	1	0	0	0	0	0	0	0	8
Apr	2	0	0	0	0	0	0	0	0	0	2
May	6	0	0	1	1	0	0	0	0	0	8
Jun	3	0	0	0	2	0	0	0	0	0	5
Jul	3	1	0	0	0	1	0	0	0	0	5
Aug	4	0	0	0	0	0	2	2	0	0	8
Sep	2	0	1	0	0	0	0	0	0	0	3
Oct	5	0	1	0	0	0	0	0	2	0	8
Nov	3	0	1	0	0	0	0	0	8	0	12
Dec	2	0	0	0	0	0	0	0	2	1	5
Total	41[1]	2	4	1	3	1	2	2	12	1	69

[1] Automatic Shutdown

2002 REACTOR SHUTDOWNS

Type of Failures	Total Number
CSC	**41**
Equipment Failures	**21**
Iodine Loop Problem	**4**
Loss of Power	**2**
Personnel Error	**1**
TOTAL NUMBER OF ANOMALIES IN 2002	**69**

Reactor Shutdowns 2002 Percent of Total Number



January

1. While operating, the reactor automatically scrammed once during the month due to CSC watchdog circuit time out. Operation personnel performed the following on each occurrence:

    a. Rebooted the CSC computer.
    b. Satisfactorily performed all weekly checks on the computer.
    c. Resumed normal operation of the reactor.

February

1. While operating, the reactor automatically scrammed four times during the month due to CSC watchdog circuit time outs. Operation personnel performed the following on each occurrence:

    a. Rebooted the CSC computer.
    b. Satisfactorily performed all weekly checks on the computer.
    c. Resumed normal operation of the reactor.

March

1. While operating, the reactor automatically scrammed six times during the month due to CSC watchdog circuit time outs. Operation personnel performed the following on each occurrence:

    a. Rebooted the CSC computer.
    b. Satisfactorily performed all weekly checks on the computer.
    c. Resumed normal operation of the reactor.

2. On 8 March 2002, at 2100, the reactor was operational at 1.8 MWs. The reactor operator received a reactor room continuous air monitor fault alarm and shutdown the reactor.

    Health Physics personnel reported that the reactor room continuous air monitor printout indicated there had been a high/low flow condition but the indicated flow on the meter was within specifications. Personnel rebooted the reactor room continuous air monitor and verified the high and low flow set points. All electrical connections on the continuous air monitor were checked and verified to be properly connected.

    The Senior Reactor Operator granted permission to continue normal operations of the reactor after no cause for the alarm could be determined.

3. On 11 March 2002, at 2100, the reactor was operational at 1.8 MWs when the reactor operator shutdown the reactor as directed by the Reactor Manager, after receiving a reactor room continuous air monitor alert during ^{125}I operations[2].

[2] Refer to section 7.2 ANOMALIES: March

April

1. While operating, the reactor automatically scrammed twice during the month due to CSC watchdog circuit time outs. Operation personnel performed the following on both occurrences:

   a. Rebooted the CSC computer.
   b. Satisfactorily performed all weekly checks on the computer.
   c. Resumed normal operation of the reactor.

May

1. While operating, the reactor automatically scrammed six times during the month due to CSC watchdog circuit time outs. Operation personnel performed the following on all occurrences:

   a. Rebooted the CSC computer.
   b. Satisfactorily performed all weekly checks on the computer.
   c. Resumed normal operation of the reactor.

2. On May 09, 2002, at 1631, the reactor operator manually scrammed the reactor when he received a Stack CAM Alarm during a ^{41}Ar recovery process. A small amount of ^{41}Ar was released into the reactor room during the process of disconnecting the collection bottles from the system.

3. On May 30, 2002, at 1636, the reactor operator manually scrammed the reactor when he received an EF-1 (reactor room ventilation fan) low flow alarm. The Senior Reactor Operator investigated and found the motor on EF-1 had tripped on a thermal overload condition. Operations personnel replaced the EF-1 motor and replaced the fan belts. After operationally testing the ventilation system the Senior Reactor Operator granted permission to resume normal reactor operations.

June

1. While operating, the reactor automatically scrammed three times during the month due to CSC watchdog circuit time outs. Operation personnel performed the following on each occurrence:

   a. Rebooted the CSC computer.
   b. Satisfactorily performed all weekly checks on the computer.
   c. Resumed normal operation of the reactor.

2. On June 05, 2002, at 1714, and again on June 06, 2002, at 1551, the reactor operator manually scrammed the reactor when he received an EF-1 (reactor room ventilation fan) low flow alarm. The Senior Reactor Operator investigated and found the motor on EF-1 had tripped on a thermal overload condition. Operations personnel traced the problem to one bad thermal overload in the EF-1 controller. The Senior Reactor Operator granted permission to resume normal reactor operations after personnel replaced all thermal overloads in the EF-1 controller and operationally testing the ventilation system.

July

1. While operating, the reactor automatically scrammed three times during the month due to CSC watchdog circuit time outs. Operation personnel performed the following on each occurrence:

    a. Rebooted the CSC computer.
    b. Satisfactorily performed all weekly checks on the computer.
    c. Resumed normal operation of the reactor.

2. On July 02, 2002, at 1330, the reactor was operating at 1.8 MWs when Shim #2 dropped off its magnet. The Reactor Operator manually shutdown the reactor and notified the Senior Reactor Operator. Operations personnel visually inspected the control rod, control rod drive, and connecting rod. Operational checks performed on Shim #2, performed by operations personnel could not determine any cause for the control rod to decouple from its magnet. Operability checks performed on the control rod were within specifications with a rod scram time of 0.39 seconds. The Senior Reactor Operator granted permission to resume normal reactor operations.

3. On July 10, 2002, at 1459, the reactor was operating at 1.8 MWs when the Reactor Operator noticed the Reactor Room CAM was not indicating properly on the reactor console. The Reactor Operator manually shutdown the reactor and notified the Senior Reactor Operator. Personnel found the circuit breaker supplying the Reactor Room CAM had tripped. The Reactor Room Cam and the air conditioning unit for the CAM share the same breaker. The daytime air temperatures were over 100 OF and the breaker cannot support both units operating for extended periods. Personnel plugged the air conditioning unit into an outlet that utilized a different circuit breaker.

    After Health Physics personnel performed all daily and weekly checks on the Reactor Room CAM, the Senior Reactor Operator granted permission to resume normal reactor operations. Personnel are investigating how to wire the air conditioning unit to a separate circuit breaker.

August

1. While operating, the reactor automatically scrammed four times during the month due to CSC watchdog circuit time outs. Operations personnel performed the following on each occurrence:

    a. Rebooted the CSC computer.
    b. Satisfactory performed all weekly checks on the computer.
    c. Resumed normal operation of the reactor.

2. On August 04, 2002, at 1500, and August 06, 2002, at 1630 the reactor was operating at 1.8 MWs when there was a loss of building power. The Reactor Operator manually shutdown the reactor and notified the Senior Reactor Operator. After power was restored to the facility the Senior Reactor Operator granted permission to resume normal reactor operations.

3. On August 15, 2002, at 1416, the reactor was operating at 1.8 MWs when the reactor scrammed on External #2 indications. The Reactor Operator reported the following indication on the auxiliary panel to the Senior Reactor Operator:

   a. Bays #1 massive shutter – The open and shut indications were illuminated.
   b. Bay #1 shielding door – Open indication was illuminated.

   Personnel found the Bay #1 massive shutter's open indication limit switch had stuck in the open position. Operations personnel replaced the limit switch.

   After Operations personnel checked all of the Bay #1 external scrams and interlocks the Senior Reactor Operator granted permission to resume normal reactor operations.

4. On August 20, 2002, at 1154, the reactor was operating at 1.8 MWs when the reactor scrammed on External #2 indications. The limit switch that operations personnel replaced on August 15, 2002 needed readjustment. Operations personnel readjusted the limit switch and satisfactorily checked all of the Bay #1 external scrams and interlocks. The Senior Reactor Operator granted permission to resume normal reactor operations.

September

1. While operating, the reactor automatically scrammed twice during the month due to CSC watchdog circuit time outs. Operations personnel performed the following on each occurrence:

   a. Rebooted the CSC computer.
   b. Satisfactory performed all weekly checks on the computer.
   c. Resumed normal operation of the reactor.

2. On September 24, 2002, at 1500, at 1122 the reactor was operating at 1.8 MWs when the Reactor Operator received an alert on the Reactor Room CAM's iodine channel. Personnel had been dispensing ^{125}I since 1008. At 1132, the Reactor Operator manually shutdown the reactor and notified the Senior Reactor Operator that the iodine channel did not appear to be working. Health Physics personnel source checked the Reactor Room Cam and verified that all the channels were within specification. The Senior Reactor Operator granted permission resume normal reactor operations.

October

1. While operating, the reactor automatically scrammed five times during the month due to CSC watchdog circuit time outs. Operations personnel performed the following on each occurrence:

   a. Rebooted the CSC computer.
   b. Satisfactory performed all weekly checks on the computer.
   c. Resumed normal operation of the reactor.

2. On October 08, 2002, at 1016, at 1122 the reactor was operating at 1.8 MWs when the Reactor Operator received an alert on the Reactor Room CAM's iodine channel. Personnel had been dispensing ^{125}I since 0918. At 1017, the Reactor Operator manually shutdown the reactor and notified the Senior Reactor Operator that the iodine channel did not appear to be working. Health Physics personnel source checked the Reactor Room Cam and verified that all the channels were within specification. The Senior Reactor Operator granted permission to resume normal reactor operations.

3. On October 11, 2002, at 1335 and again on October 20, at 1940, the Reactor Operator shutdown the reactor when the Bay 2 massive shutter stop in an intermediate position (not fully shut or opened). Personnel entry into Bay 2 cannot be made if the massive shutter is not fully shut and the reactor is operating.

   Personnel found the circuit breaker for the massive shutter drive motor had tripped both cases. After resetting the circuit breaker, personnel operated the massive shutter several times with no additional failures. Reactor Operations personnel satisfactory performed all interlock check associated with the bay interlock system. The Senior Reactor Operator granted permission to resume normal operation of the reactor.

   The MNRC Electronic Engineer is evaluating the circuit breaker problem.

November

1. While operating, the reactor automatically scrammed three times during the month due to CSC watchdog circuit time outs. Operations personnel performed the following on each occurrence:

   a. Rebooted the CSC computer.
   b. Satisfactory performed all weekly checks on the computer.
   c. Resumed normal operation of the reactor.

2. On November 25, 2002, at 1346 the reactor was operating at 1.8 MWs when the Reactor Operator received an alert on the Reactor Room CAM's iodine channel. Personnel had been dispensing 125I since 1305. The Reactor Operator manually shutdown the reactor and notified the Senior Reactor Operator that the iodine channel did not appear to be working. Health Physics personnel source checked the Reactor Room Cam and verified that all the channels were within specification. The Senior Reactor Operator granted permission to resume normal reactor operations.

3. On eight occasions the Reactor Operator shutdown the reactor when the Bay 2 massive shutter stopped in an intermediate position (not fully shut or opened). Personnel entry into Bay 2 cannot be made if the massive shutter is not fully shut and the reactor is operating.

Personnel found the circuit breaker for the massive shutter drive motor had tripped both cases. After resetting the circuit breaker, personnel operated the massive shutter several times with no additional failures. Reactor Operations personnel satisfactory performed all interlock check associated with the bay interlock system. The Senior Reactor Operator granted permission to resume normal operation of the reactor.

Date of Shutdown	Time of Shutdown
November 11, 2002	2108
November 14, 2002	1922
November 18, 2002	1020
November 22, 2002	1111
November 22, 2002	1700
November 26, 2002	2153
November 26, 2002	2326
November 27, 2002	1611

December

1. While operating, the reactor automatically scrammed twice during the month due to CSC watchdog circuit time out. Operations personnel performed the following on each occurrence:

    a. Rebooted the CSC computer.
    b. Satisfactory performed all weekly checks on the computer.
    c. Resumed normal operation of the reactor.

2. Twice this month, the Reactor Operator shutdown the reactor when the Bay 2 massive shutter stopped in an intermediate position (not fully shut or opened). Personnel entry into Bay 2 cannot be made if the massive shutter is not fully shut and the reactor is operating.

    Personnel found the circuit breaker for the massive shutter drive motor had tripped both cases. After resetting the circuit breaker, personnel operated the massive shutter several times with no additional failures.[3] Reactor Operations personnel satisfactory performed all interlock checks associated with the bay interlock system. The Senior Reactor Operator granted permission to resume normal operation of the reactor.

Date of Shutdown	Time of Shutdown
December 04, 2002	1249
December 04, 2002	1521

3. On December 17, 2002 at 1652, the reactor was operating at 1.8 MWs, when the reactor automatically scrammed with the following indication:

    a. NPP-1000 Hi Voltage Lo
    b. DAC DISO64 Timeout
    c. NPP-1000 Power Hi

    Upon entering the console's history playback mode, the Senior Reactor Operator noted that at no time did the reactor power level exceed ninety percent power.

    Operations personnel inspected the DAC, performed high voltage and high power scram checks, and ran the pre-start test on the NPP-1000. No cause for the scram could be determined. The Senior Reactor granted permission to resume normal reactor operations and notified the Reactor Manager.

[3] Refer to Section 7.3. MAINTENANCE OTHER THAN PREVENTIVE: DECEMBER

March

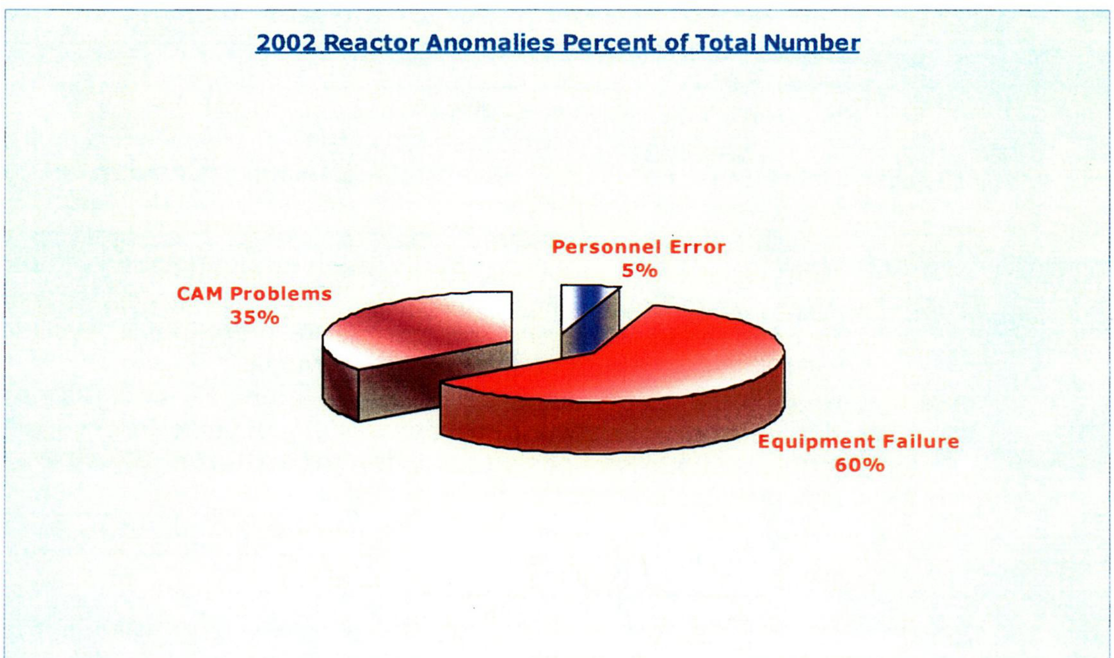
1. On 11March 2002, operations personnel started the first recovery process on the iodine loop.

TIME	**11 March 2001**
0930	Operations personnel started the ^{125}I recovery process from Decay Storage 1 (DS-1).
0944	Operations personnel shifted the reactor room ventilation system to modified recirculation. a. In this mode, the ventilation is redirected through the main charcoal filters and out the facility stack.
0954	Personnel commenced the transfer of the xenon gas from DS-1 to DS-2 by cryogenic pumping with liquid nitrogen.
1044	Personnel completed the transfer of the xenon gas from DS-1 to DS-2
2100	Personnel started the recovery process of ^{125}I from DS-1.
2116	Health Physics personnel alarmed the reactor room continuous air monitor to place the reactor room ventilation system into the full recirculation mode of operation. a. In this mode, the ventilation is redirected through the main charcoal filters and back into the reactor room.
2136	The reactor operator received a reactor room continuous air monitor alarm and shutdown the reactor. a. Particulate channel reading – 1.7×10^3 CPM b. Noble Gas channel reading – 5.2×10^2 CPM c. Iodine channel reading – < 10 CPM
2137	Operations personnel secured dispensing ^{125}I from DS-1 and evacuated the reactor room.
2138	Health Physics personnel reported that the reactor room continuous air monitor's iodine channel had failed.
2336	After numerous air samples, Health Physics personnel recommended that the reactor room ventilation system be returned to the modified recirculation mode.
2346	Health Physics personnel reported the iodine channel did not fail, but had become saturated with ^{125}Xe. When this occurred the iodine channel stopped functioning and restarted after personnel changed the charcoal collection filter.

7.2 ANOMALIES:

During 2002, there were twenty-eight (28) reported anomalies at the MNRC facility. Personnel called back are the largest contributor to the total number (16) of anomalies (82%), fuel element problems next (11%), followed by personnel error (7%).

Anomalies	Occurrences
^{125}Xenon Problem[4]	1
Dropped Irradiator[5]	1
^{125}I Loop Problem[6]	1
Failed Fuel Element[7]	1
Personnel called back to the facility during off hours	
(Failed Photohelic Stack Cam)	1
(Iodine Cam)	4
(Bay Cam)	1
(CSC)	7
(Reactor Cam)	1
(Power Loss)	2
TOTAL NUMBER OF ANOMALIES IN 2002	**20**



4 Refer to section 7.2 ANOMALIES: March
5 Refer to section 7.2 ANOMALIES: May
6 Refer to section 7.6 REPORT ON STATUS OF IODINE LOOP ATTACHMENT 3
7 Refer to section 7.2 ANOMALIES: October

TIME	12 March 2001
0015	Health Physics personnel performed a weekly test on the iodine channel with the check source. The channel's readings were out of specification. Health Physics personnel restricted personnel entry into the reactor room until they could perform additional air and contamination surveys.
1115	Health Physics personnel calibrated and satisfactorily source-checked the iodine channel on the reactor room continuous air monitor.
1130	The Senior Reactor Operator granted permission to continue normal operations of the reactor. Limited access to the reactor room was still in effect.

13 March 2001

0700 Health Physics personnel released the reactor room for unlimited access.

18 March 2001

Wayne Hamilton (SAIC cryogenic expert) from SAIC's Engineering and Logistics Solutions Division arrived to evaluate why the iodine loop expelled xenon gas. [8]

20 March 2001

Operations personnel commenced the ^{125}I recovery process from DS-1.

21 March 2001

Based on Wayne Hamilton's evaluation of the iodine loop, parts were ordered to install a xenon cryogenic trap.[9]

5 April 2001

Operations personnel installed the xenon cryogenic trap.[9]

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[8] Refer to section 7.6 OTHER: Attachment 1
[9] Refer to section 7.6 OTHER: Attachment 2

April

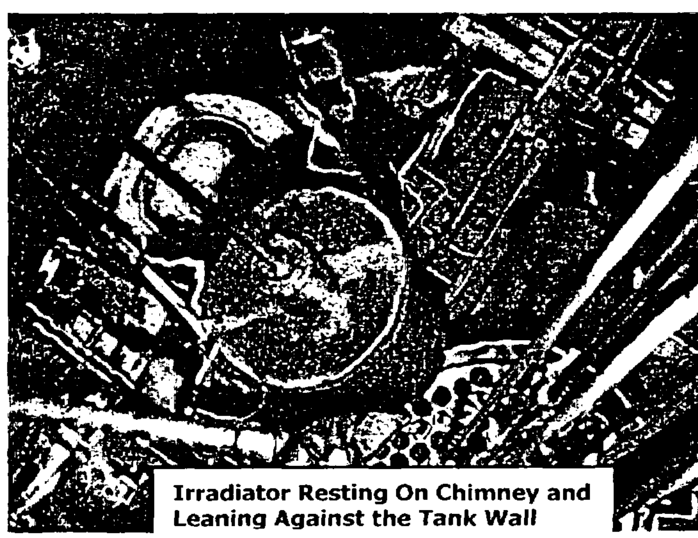
1. On 04-30-02, after receiving notification from the UCD/Police desk, operations personnel returned to the facility to find a reactor room CAM alert message on the console. The reactor room CAM was inoperative but the iodine CAM was operating. The operator noted an illuminated iodine CAM alert light on the temperature control panel.

   Operations personnel proceeded to the iodine CAM and noted the reading on the CAM was less than the alarm set point. Operations personnel acknowledged the alarm and reset the alarms to the UCD/Police desk. The Health Physics Supervisor was notified the following workday.

May

1. On May 31, 2002, the reactor had been operating at 1.8 MW for a neutron irradiator experiment. The reactor operator shut down the reactor at 1034 in preparation to remove Experiment 02-113 from the irradiator.

   Operations personnel removed the exposure vessel from the irradiator and successfully removed the first section of tubing from the exposure vessel. The Reactor Operator was bumping the reactor room chain hoist in the up direction to move the irradiator into position to remove the last two sections of tubing. During this operation, a flanged connection attached to the tubing encountered the neutron irradiator's drive table. Once the flange contacted the drive table, a weld on one of the tubing sections failed causing in the exposure vessel and lead weights to fall into the reactor tank.

   Irradiator Resting On Chimney and Leaning Against the Tank Wall

   The Senior Reactor Operator immediately contacted the Reactor Manager who suspended all reactor operations.

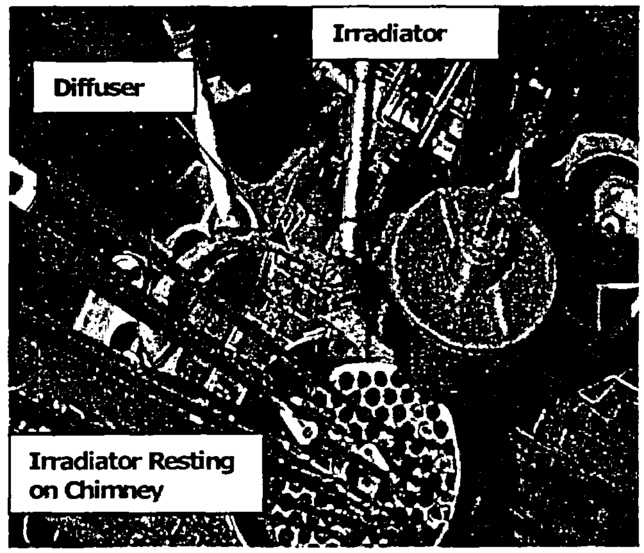
   An immediate investigation conducted by the Reactor Manager and Senior Reactor Operator noted the following:

   a. The tubing supplying helium to the neutron irradiator was bent.

   b. The exposure vessel hit the ^{16}N diffuser nozzle causing it to rotated it clockwise approximately 45° down.

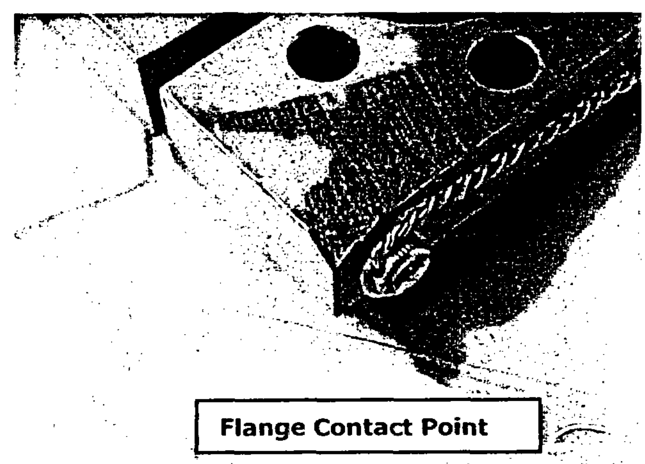
c. The exposure vessel came to rest on the chimney with its connecting pole leaning over on west side of the tank

d. The exposure vessel did not contact the reactor core or graphite reflector and there was no apparent damage to the reactor tank.



Actions taken to recover from the anomaly

Operations personnel fabricated wire snares to secure the vessel in place. One snare was looped around the top portion of the lead weights on the vessel and held in place so that the vessel would not contact the reactor tank wall when lifted. A second snare was placed near the top of the lifting porting of the vessel and then attached to the hoist to lift the vessel up. After personnel secured the vessel and connected it to the hoist, operations personnel proceeded to raise the vessel to the drive table and secure it in place. Personnel attached the normal lifting device on the vessel and it was removed from the reactor tank.

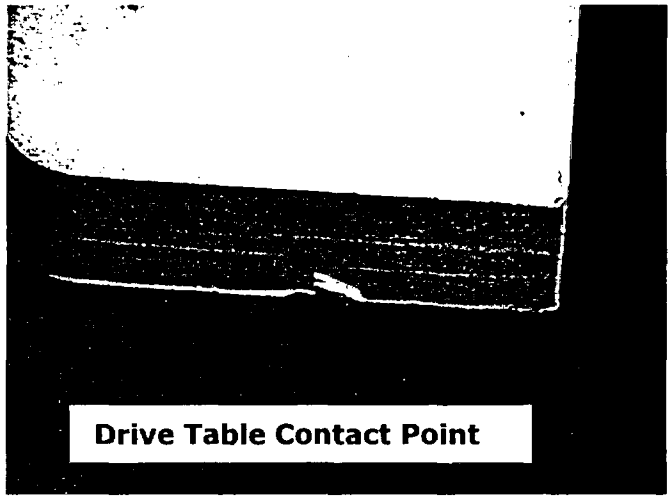


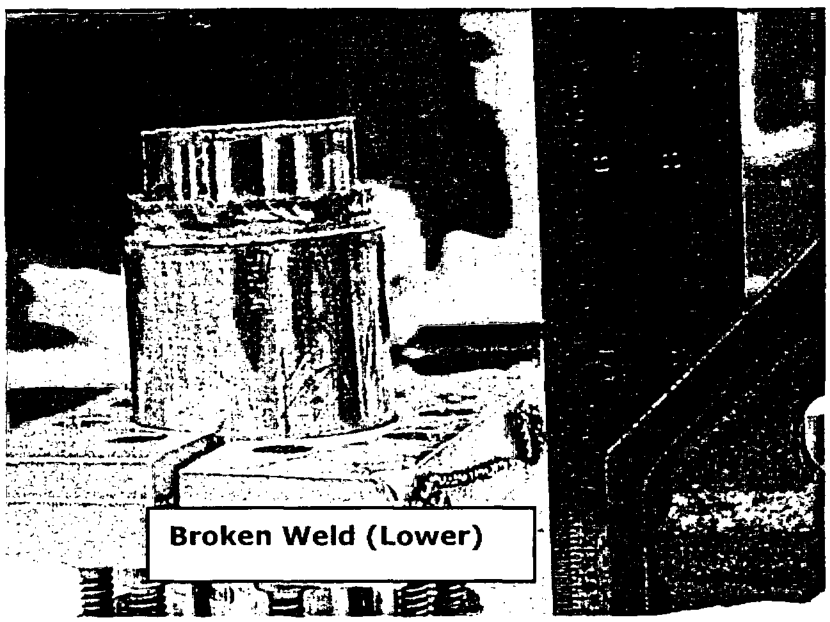
After removing the exposure vessel from the reactor tank, personnel attempted to reposition the ^{16}N diffuser nozzle. When they pushed down on the nozzle to return it to its proper position; it separated from the supply piping. A locating pin on the bottom of the diffuser held it in a vertical plane, preventing it from falling over.

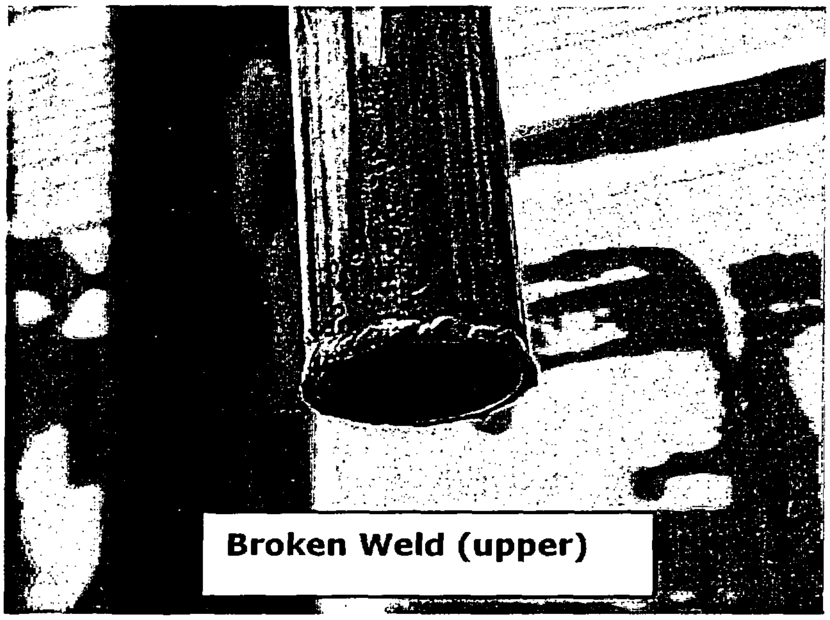
Personnel removed the ^{16}N diffuser assembly from the reactor tank. The impact from irradiator had caused the ^{16}N diffuser to rotate, but the direct cause of the of the ^{16}N diffuser separating from the supply piping, was that it had become un-threaded itself at its lowest joint. The connecting elbow and the connecting pipe were rethreads and the N^{16} diffuser reinstalled.

Actions to correct the anomaly

1. The exposure vessel (one of two) has been removed from service. The attachment pole is bent preventing the irradiator from rotating in the irradiation well.
2. The connecting pole was re-welded.
3. Several stainless steel cables are now attached to each connecting pole and the crane during lifting and lowering operations to act as safety lanyards.







June

1. Operations personnel returned to work during non-duty hours four times this month upon receiving an alarm notification from the UCD/Police desk.

   a. On June 17, 23, and 23, 2002, responding personnel found the alarms were due to CSC watchdog circuit time outs. Operation personnel rebooted the CSC computer, acknowledged the alarm, and reset the alarm panel to alarm at the UCD/Police desk.

   b. On June 02, 2002, responding personnel found a Stack CAM Fault annunciator activated. The Senior Reactor Operator notified Health Physics personnel. When Health Physics personnel arrived, it was determined that a failed Photohelic had caused the fault condition. Personnel replaced the Photohelic and cleared the Stack CAM Fault alarm. Operations personnel reset the alarm panel to alarm at the UCD/Police desk

July

1. On June 26, 2002, operations personnel experienced problems transferring activated xenon gas from the irradiation chamber to Decay Storage #1. Personnel could not get any gas to transfer through valve AV-09 (stop valve to Decay Storage #1). To place the activated gas in a safe position, the Reactor Manager decided to transfer the gas to Decay Storage #2 and commence an investigation why the gas would not pass through AV-09. A test was performed to see if gas could be passed through AV-09 and back to the irradiation chamber. This failed to produce the desired results. The decision was made to

shutdown the Iodine Loop[10], remove the secondary containment, and investigate the problem with AV-09. In addition, the Reactor Manager decided to replace the pressure transmitters with a more robust design, as the transmitters were showing degradation from continuous exposure to a high radiation field.

August

1. Operations personnel returned to work during non-duty hours four times this month upon receiving an alarm notification from the UCD/Police desk.

    a. On August 4th, 9th, and 21st of 2002, the UCD/Police desk notified the operations personnel of an alarm at the facility. Responding personnel found the ^{125}I CAM alarming. Operations personnel proceeded to the ^{125}I CAM and noted the reading on the CAM was less than the alarm setpoint. A history on the iodine channel determined there was never an actual alarm condition. The alarm most likely came in as part of a derivative alarm function of the CAM. If the CAM perceives the rate of increase is high, a derivative alarm is interpreted as a high level. Operations personnel acknowledged the alarm and reset the alarm panel to annunciate at the UCD/Police desk.

    b. On August 04, 2002, responding personnel found the alarms were due to CSC watchdog circuit time outs. Operation personnel rebooted the CSC computer, acknowledged the alarm, and reset the alarm panel to annunciate at the UCD/Police desk.

September

1. Operations personnel returned to work during non-duty hours twice this month upon receiving an alarm notification from the UCD/Police desk.

    a. On September 25, 2002, at 0330 the UCD/Police desk notified the operations personnel of an alarm at the facility. Responding personnel found the Bay CAM alarming. Operations personnel proceeded to the Bay CAM and noted the CAM was in a fault condition. Operations personnel turned the CAM off and notified Health Physics personnel. They acknowledged the alarm and reset the alarm panel to annunciate at the UCD/Police desk.

    b. On September 15, 2002, responding personnel found the alarms were due to CSC watchdog circuit time outs. Operation personnel rebooted the CSC computer, acknowledged the alarm, and reset the alarm panel to annunciate at the UCD/Police desk.

[10] Refer to REPORT ON STATUS OF IODINE LOOP -- ATTACHMENT 3 --28 July, 2002

October

1. On October 24, 2002, operations personnel were performing the annual fuel inspection. At 1052, the Senior Reactor Operator reported to the Reactor Manager that fuel element 10667 could not be removed from the reactor core. Operations personnel could extend the element through the upper grid plate approximately fifteen inches and then it would stop. The Reactor Manager informed the Senior Reactor Operator to continue with the normal fuel inspections and to additionally visually inspect fuel elements adjacent to element 10667. All adjacent fuel element inspections revealed no apparent abnormalities.

   On October 29, 2002, operations personnel arranged to remove one of the tri-flutes from fuel element 10667 (SOP 02-17 – Removing Tri-Flute on Element 10667). Operations personnel removed the tri-flute and removed the fuel element from the reactor core.

   Visual inspections of the fuel element did not reveal any apparent visual bulging. Personnel removed the element from service as a damaged fuel element.

November

1. Operations personnel returned to work during non-duty hours three times this month upon receiving an alarm notification from the UCD/Police desk.

   a. On November 03, 2002, at 0735 the UCD/Police desk notified the operations personnel of an alarm at the facility. Responding personnel found a Reactor Room CAM Fault alarm. Operations personnel proceeded to the Reactor Room CAM and noted the CAM was in a fault condition. Operations personnel turned the CAM off and notified Health Physics personnel. They acknowledged the alarm and reset the alarm panel to annunciate at the UCD/Police desk.

   b. On November 07, 2002, at 0240, and November 28, 2002, at 1610, the UCD/Police desk notified the operations personnel of an alarm at the facility. Responding personnel found the alarms were due to CSC watchdog circuit time outs. Operation personnel rebooted the CSC computer, acknowledged the alarm, and reset the alarm panel to annunciate at the UCD/Police desk.

December

1. Operations personnel returned to work during non-duty hours three times this month upon receiving an alarm notification from the UCD/Police desk.

   a. On December 14, 2002, and December 15, 2002, the UCD/Police desk notified the operations personnel of an alarm at the facility. Responding personnel found the facility was without electrical power. Operations

personnel remained at the facility until restoration of electrical power. They acknowledged all alarms and reset the alarm panel to annunciate at the UCD/Police desk.

b. On December 024, 2002, at 1610, the UCD/Police desk notified the operations personnel of an alarm at the facility. Responding personnel found the alarms were due to CSC watchdog circuit time outs. Operation personnel rebooted the CSC computer, acknowledged the alarm, and reset the alarm panel to annunciate at the UCD/Police desk.

7.3 MAINTENANCE OTHER THAN PREVENTIVE:

January

1. When operations personnel were performing the daily checklist, they noted the secondary flow was not indicating. The operator attempted to start the pump locally and he immediately secured the pump when sparks and smoke emitted from the motor housing.

   Operations personnel found the motor shorted to ground. They replaced the motor and shaft seal on the pump. After replacement of the secondary pump's motor, normal reactor operations continued.

2. During normal routine maintenance, operations personnel replaced the fan belts on the following equipment:

   a. HV-1
   b. HV-2
   c. AC-1
   d. EF-3

3. Contractor personnel replace the blower vent motor on AC-7 and AC-8, fixed a Freon leak and recharged AC-6, and replaced the thermostats on AC-4 and AC-8.

February

1. During normal routine maintenance, operations personnel replaced the fan belts on the following equipment:

   a. HV-1
   b. AC-7

2. Operations personnel install the ^{125}I irradiation facility in core position C-05.

CORE MANIPULATION	Measured Reactivity	Δ Reactivity Change
Core excess prior to installation	$4.18	$0.00
Core excess after removing fuel element from C-05	$3.94	-$0.24
Core excess with ^{125}I irradiation facility in core position C-05	$3.75	-$0.19
Total reactivity loss		-$0.43

3. Operations personnel measured the control rod drop times with the following results:

Control Rod	Rod Drop Time (Seconds)
SHIM 1	0.40
Shim 2	0.47
Shim 3	0.40
Shim 4	0.40
Regulating	0.40
Transient	0.39

March

1. Operations personnel installed an additional local area radiation monitor in the reactor room.

April

1. During normal routine maintenance, operations personnel replaced the fan belts on EF-3.

2. Operations personnel replaced all four demineralizer resin columns.

May

None

June

1. Contractor personnel replaced the emergency lights in the following locations:

   a. Control Room
   b. South Radiography Control Room
   c. Bay 1 Escape Hatch
   d. Bay 2 Escape Hatch

2. Operations personnel replaced the thermal overloads in the EF-1 controller.

July

None

August

1. On August 19, 2002, operations personnel moved the ^{125}I irradiation chamber from core position C-05 to position E-06.

2. During normal routine maintenance, operations personnel replaced the fan belts on the following equipment:

   a. EF-1
   b. EF-2

3. Operations personnel replaced sticking limit switches on Bays 1 and 4 massive shutter closed indication. After replacing the limit switches personnel satisfactorily performed all scram and interlock checks associated with both shutters.

September

1. Operations personnel repaired a small leak on the demineralizer system outlet strainer.

2. During normal reactor operations, operations personnel noted a decline in demineralizer flow and an increase in system pressure. Personnel removed and cleaned the demineralizer system outlet strainer. After cleaning the strainer the flow and pressure readings returned to normal operating parameters.

October

1. While performing the Daily Startup Checklist, Operations personnel noted that Shim Rod #3 was not indicating properly. Personnel noted that the stepping motor was rotating but the control rod was not moving. After disassembling the control rod drive assembly, they found that the roll pin attaching the pinion gear to the drive shaft had fallen out. This prevented the pinion gear from rotating and racking out the control rod. Personnel installed a new roll pin and tested Shim Rod #3 for operability. The rod drop time was measured (0.41 second) and personnel resumed normal reactor operations.

Annual Shutdown

1. Performed the annual fuel inspections, control rod calibrations, and shutdown margin calculation.

Control Rod	Old Control Rod Worth	New Control Rod Worth
Transient rod	*$ 2.31*	*$1.95*
Regulating rod	*$ 2.42*	*$2.42*
Shim rod #1	*$ 2.54*	*$2.32*
Shim rod #2	*$ 2.46*	*$2.18*
Shim rod #3	*$ 2.50*	*$2.31*
Shim rod #4	*$ 2.39*	*$2.56*

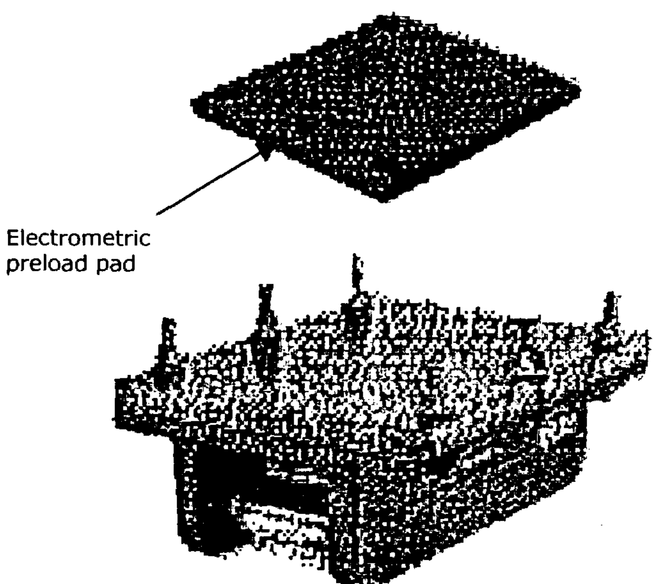
Shutdown Margin	
Old Shutdown Margin	*$4.13*
New Shutdown Margin	*$5.52*

November

1. Operations personnel replace a master key switch on Bay 2 west shielding door. After replacing the switch, personnel satisfactory checked all reactor and door interlocks associated with the Bay 2 west door.

December

1. During the investigation of the problem with the Bay 2 massive shutter, personnel noted that the shutter's guide rail appeared to be rubbing on the bottom of the massive shutter. Also, there were pieces of rubber material in the area of the of the shutter's Hilman roller bearings. This material appeared to have been flattened in the track area by the rollers of the bearing.



HILMAN ROLLER BEARING

After researching the bearing, personnel found that there is an electrometric preload pad, used on top of or built into the top of each individual roller. These replaceable pads[11] are made of a neoprene material with a durometer high enough to make them both resilient and strong. The fact that the pads are pliable under heavy loads while providing protection to the bas of the load, allow the roller footprint to conform to minor imperfection in the rolling surfaces as it remains under tension with the load. This pliability provides the user with the dual benefit of reducing the metal-to-metal slippage that can occur when moving a large piece of metal based equipment and allowing the movement of heavy loads over less than perfect floor surfaces.

Each electrometric preload pads (total of twelve) is approximately 1/4 -inch thick and is deteriorating. This lowers the massive shutter enough to come in contact with the shutter guide rail. The drag created by the massive shutter contacting the guide rail is causing the drive motor to have an over current condition and thus tripping the circuit breaker.

Personnel machined the guide rail approximately 0.100-inches to allow the shutter to operate without the contacting the guide rail. This is an interim fix to allow operations to continue in Bay 2.

Eventually personnel will have to raise the massive shutter, remove the twelve Hilman bearings, and replace the preload pads.

Personnel also inspect the massive shutters in Bays 1 and 3 and they are starting to show signs of contacting the guide rail.

---

[11] P Data Sheet, Hilman Rollers Co.

Machined Guide Rail

2. During routine maintenance, operations personnel replace the blower fan belts on AC-2 and AC-7.

3. Operations personnel shifted the demineralizer resin columns from the north set to the south set.

4. The electronics engineer replaced the voltage to current converter on the demineralizer outlet conductivity meter.

7.4 PROBLEM AREAS:

1. On 11 March 2002, at 2100, the reactor was operational at 1.8 MWs when the reactor operator shutdown the reactor as directed by the Reactor Manager after receiving a reactor room continuous air monitor alert during ^{125}I operations[12].

2. On June 26, 2002, operations personnel experienced problems transferring activated xenon gas from the irradiation chamber to Decay Storage #1.[13]

3. Technical Specifications Violation

   a. A violation occurred when a lecture and an examination covering Regulations and Administrative Controls were not completed by August 13, 2002 (ending date for the two-year requalification cycle). This category is not required by 10CFR55.59 (Requalification of Licensed Operators); however, it is required by the UCD/MNRC Selection and Training Plan (Document No. MNRC-0009-DOC). The Technical Specifications explicitly state that training shall be in accordance with the Selection and Training Plan.

   b. The NRC was notified and training with an examination administered early in September. Corrective action was to add the category of Regulations and Administrative Controls to the requalification checklist (Table 1 of the letter to the NRC detailing the facility's reactor operator requalification program).

[12] Refer to section 7.2 ANOMALIES: March

[13] Refer to REPORT ON STATUS OF IODINE LOOP, -- ATTACHMENT 1 -- 28 July 2002.

7.5 TRAINING:

January

None

February

1. All licensed Senior Reactor Operators and Reactor Operators past a written examination on the following subject:

TRAINING
1. Design and Operating Characteristics

March

1. All licensed Senior Reactor Operators and Reactor Operators attended training on the following subjects:

TRAINING
1. Iodine Production – General Training and Emergency Procedures.
2. ISO Quality Management System
3. QSP's 1, 2, 3, 7, 8, and 9
4. MNRC Document Control Plan (QSP-6)

2. All personnel operating the ^{125}I loop received additional training on the following subject:

TRAINING
1. Iodine Production – SOP 01-10, Valve lineups.

April

1. All licensed Senior Reactor Operators and Reactor Operators passed the Annual Operating Examination.

2. All licensed Senior Reactor Operators and Reactor Operators attended training on the following subjects:

TRAINING	
1.	Nuclear Instrumentation – Class I
2.	Annual ALARA Training
3.	Fitness for Duty

3. All personnel received additional training on the following subject:

TRAINING	
1.	QSP's 10 through 21

May

1. All licensed Senior Reactor Operators and Reactor Operators attended training on the following subject:

TRAINING	
1.	Nuclear Instrumentation – Class 2

June

1. All licensed Senior Reactor Operators and Reactor Operators attended training on the following subject:

TRAINING	
1.	Operating Instructions – Revision 11

2. All licensed Senior Reactor Operators and Reactor Operators passed a written examination on the following subject:

TRAINING	
1.	Nuclear Instrumentation

July

1. All licensed Senior Reactor Operators and Reactor Operators attended training on the following subject:

TRAINING	
1.	Nuclear Theory/Reactor Kinetics Review

2. All licensed Senior Reactor Operators and Reactor Operators passed a written examination on the following subject:

TRAINING	
1.	Biennial Written Re-qualification Examination

August

None

September

None

October

None

November

3. All licensed Senior Reactor Operators and Reactor Operators attended training on the following subjects:

TRAINING
1. Normal, Abnormal, and Emergency Procedures (Class 1)
2. Normal, Abnormal, and Emergency Procedures (Class 2)

December

None

7.6 OTHER:

a. Attachment 1: WAYNE HAMILTON'S REPORT FROM SAIC
b. Attachment 2: XENON CRYOGENIC TRAP
c. Attachment 3: REPORT ON STATUS OF IODINE LOOP - 28 July, 2002

Attachment 1

Wayne Hamilton's Report from SAIC

Attachment 1
Wayne Hamilton's Report from SAIC

1. Introduction

This report presents a preliminary review completed by SAIC's Engineering and Logistics Solutions Division (Div. 66) of the McClellan Nuclear Radiation Center Iodine Loop Cryogenic System.

During the first operation of the iodine loop, all operations were nominal until the iodine 125 that was produced was to be drawn off into a vial. When the sodium hydroxide was introduced into the system it apparently forced some xenon remaining in the system to be released from the vial vent line. A charcoal filter in the vial vent line inside of the glove box trapped most of the xenon. Two additional vent line charcoal filters outside of the glove box captured any remaining xenon before it could be released to the atmosphere.

1.1 Objectives

The objective of this effort was to review the cryogenic system design and operation and to recommend improvements or changes as necessary.

2.0 Review Results

An attempt was made to determine the amount of xenon gas released from the system during this first run. Using the amount of radioactive xenon trapped in the charcoal filter downstream from the Iodine 25 sample vial, it was calculated that 3.7e-8 cc of xenon was released.

A second attempt was made by using the volume of the system that was holding the xenon gas, 99cc's, and the pressure of the system just prior to introducing the sodium hydroxide solution and nitrogen gas to capture the iodine in the system. Two pressures were observed in the system, 800 mTorr in decay storage 1 and 1.05 Torr in storage 2. The actual system pressure is assumed to be somewhere between the two observed pressures. The gas temperature was assumed to be constant and at room temperature, 70 F. The calculated xenon system volume at standard conditions is between 0.104 and 0.137 cc.

A third calculation was made to determine the minimum pressure that can be obtained by cryopumping xenon gas with liquid nitrogen. Using LN2 at 77 deg K gives a xenon vapor pressure of .0024 Torr. Using the system volume of 99 cc gives a xenon quantity of 0.000313 cc.

Attachment 1
Wayne Hamilton's Report from SAIC

3.0 Recommendations

Based on the previous results, at appears that some very small amount xenon will remain in the system after the majority is cryo-pumped to and then isolated in the other decay storage vessel or cold finger.

One solution may be to use a vacuum pump to evacuate the xenon prior to drawing off the iodine. However, there are several problems with this approach:

1. The small diameter tubing in the system will result in a long pumping time to evacuate the system.
2. The mechanical vacuum pumps will not produce the "high" vacuum required.
3. The xenon that is removed from the system will need to be captured and stored until it decays.
4. The vacuum pump is exposed to radioactive xenon.

A second solution is to add a liquid nitrogen cryotrap to the vial vent line to trap any xenon that is expelled from the system while removing the Iodine 125. After the Iodine is recovered, in inlet and outlet valve on the cryotrap would be closed, the cryotrap is allowed to warm to ambient temperature and the xenon is recovered or stored until it decays. Sizing of the cold trap is based on a heat exchanger calculation. One side is at liquid nitrogen temperature (-196 C), assume stainless steel as the transfer material and adjust the tubing length to obtain an outlet temperature that will freeze xenon (-112 C).

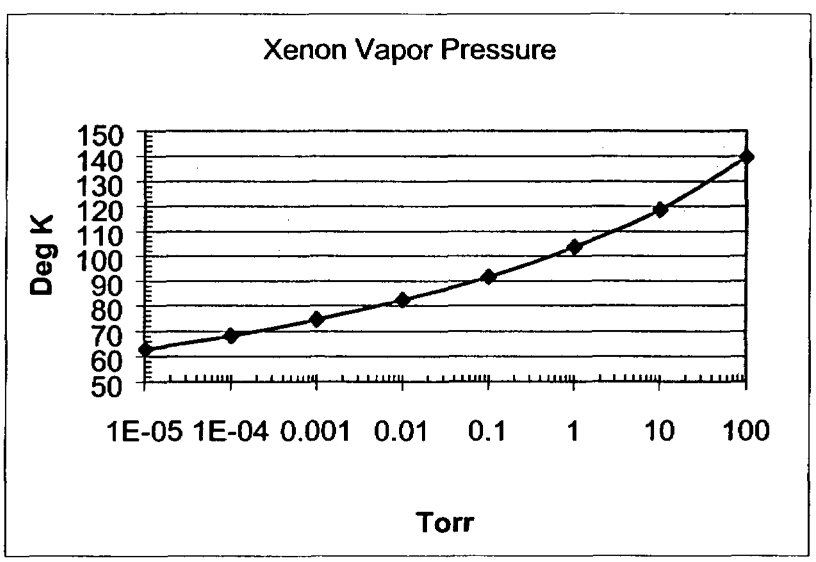
A small tubing diameter gives a better chance of a xenon atom striking the cold wall and sticking but too small and the tube may become blocked. A guess, if there is about 0.137 cc (0.0084 in 3) of xenon in the system at room temperature, a 0.25" diameter, 0.032 wall (flow area = 0.0272 in2) would be adequate and make it several feet long.

A third option is to place an evacuated tank on the vent line and use it as a storage reservoir to trap any remaining xenon in the system. The tank would then be stored until the xenon decays. This option eliminates the need to handle the liquid nitrogen needed for the cold trap and the possibility of some xenon not being caught in the cold trap.

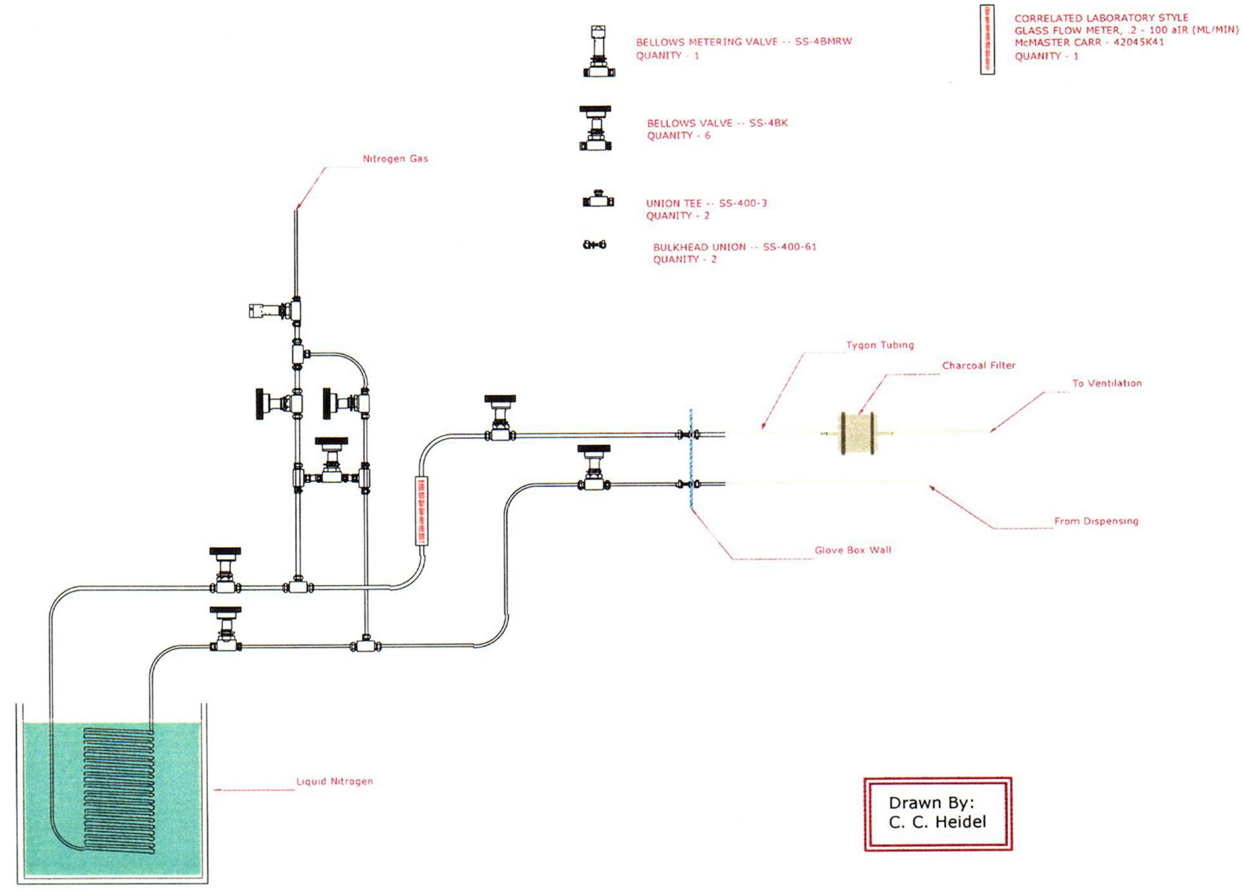
UCDAVIS MNRC McCLELLAN NUCLEAR RADIATION CENTER

Attachment 1
Wayne Hamilton's Report from SAIC

pressure 1	volume 1	pressure 2	volume 2		p1v1=p2v2		
Torr	cc	Torr	cc				
0.8	99	760	0.104211			Xenon vapor pressure	
1.05	99	760	0.136776			Torr	Deg C
1.2	99	760	0.156316			0.00001	62.7
0.0024	99	760	0.000313			0.0001	68.1
						0.001	74.4
Tube Dia	Wall	Area				0.01	82.1
0.25	0.032	0.027172				0.1	91.5
						1	103.5
						10	118.5
0.027172						100	139.5
cc	in 3						
0.104	6.346 10-3						
0.156	9.52 10-3						
0.137	8.36 10-3						



Attachment 2
Xenon Cryogenic Trap



C03

REPORT ON STATUS OF IODINE LOOP

ATTACHMENT 3

28 July, 2002

REPORT ON STATUS OF IODINE LOOP
ATTACHMENT 3
28 July, 2002

Summary

On June 26, 2002, operations personnel experienced problems transferring activated xenon gas from the irradiation chamber to Decay Storage #1. Personnel could not get any gas to transfer through valve AV-09 (stop valve to Decay Storage #1). To place the activated gas in a safe position, the Reactor Manager decided to transfer the gas to Decay Storage #2 and commence an investigation why the gas would not pass through AV-09. A test was performed to see if gas could be passed through AV-09 and back to the irradiation chamber. This failed to produce the desired results. The decision was made to shutdown the Iodine Loop, remove the secondary containment, and investigate the problem with AV-09. In addition, the Reactor Manager decided to replace the pressure transmitters with a more robust design, as the transmitters were showing degradation from continuous exposure to a high radiation field.

Findings

On July 27, 2002, operations personnel progressed to the point of removing the bonnet on AV-09 to see inside of the valve. Upon opening the valve (Figure 1), personnel discovered that the valve disk appeared melted and was blocking the exit port of the valve. The remains of the valve disk were charred and several pieces fell off the disk. These parts were highly radioactive and caused unexpected increase in the radiation levels. Personnel reassembled the valve and secured for the day.

On July 28, 2002, operations personnel removed several pieces of the valve disk from the glove bag. This reduced the radiation levels in the glove bag from approximately 100 mr/hr (contact reading in local areas) to the normal 1 to 2 mr/hr noted at the start of the evolution.

Several valves of the same type as AV-09 (AV-01, AV-03, AV-06, and AV-13) were disassembled and inspected for the same damage noted on AV-09. All valves inspected were in perfect operating condition and showed no signs of damage or wear. Because AV-09 is one of three valves that isolate the radioactive xenon gas in Decay Storage #1, operations personnel decided to remove one of the other isolation valves, AV-08. AV-08 is a different type valve (diaphragm valve) but the seat material is the same as the disk material used in AV-09. The possibility was investigated that perhaps decay heat might be the caused of the degradation of AV-09. After disassembling AV-08, personnel noted that the valve was in perfect operating condition and showed no signs of damage or wear.

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REPORT ON STATUS OF IODINE LOOP
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Conclusion

After the inspection of all the valves, mention above it is my conclusion that the stop valve (AV-09) was damaged during initial construction of the Iodine Loop. None of the other valves showed any sign of the heating damage to the valve disk that was apparent on AV-09. The damage appeared to have happened during the welding process of connecting the tubing to the valve body. The disk material, PCTFE/AMS 3650, has a normal operating temperature range of –10 °F to 150 °F. Heating the disk caused the disk material to become very brittle. During the normal cycling of the valve, a portion of the disk fractured from the bellows assembly and lodged on the outlet side of the valve, effectively closing the valve regardless of what position the disk assembly was in.

Recommendations

The following are recommendation for correcting the problem:

1. Remove the valve body of AV-09 and replace it.
2. To make the stop valves more robust, replace the valve disk/bellows assemblies in all stop valves with the with VESPEL disk.
3. This material has a higher temperature rating.
4. Harder material than PCTFE/AMS 3650.
5. Should last longer under repetitive use.
6. Leave the four dispensing diaphragm valves (AV-7, 8, 10, and 11) in place with the original seat material (PCTFE/AMS 3650).

	Operating Temperature Range
PCTFE/AMS 3650	-40 °F to 150 °F
VESPEL	-40 °F to 400 °F

Follow-up

During the replacement of the valve disk/bellows assemblies, personnel found AV-04 in a similar condition as AV-09 (See Figures 3 and 4).

REPORT ON STATUS OF IODINE LOOP
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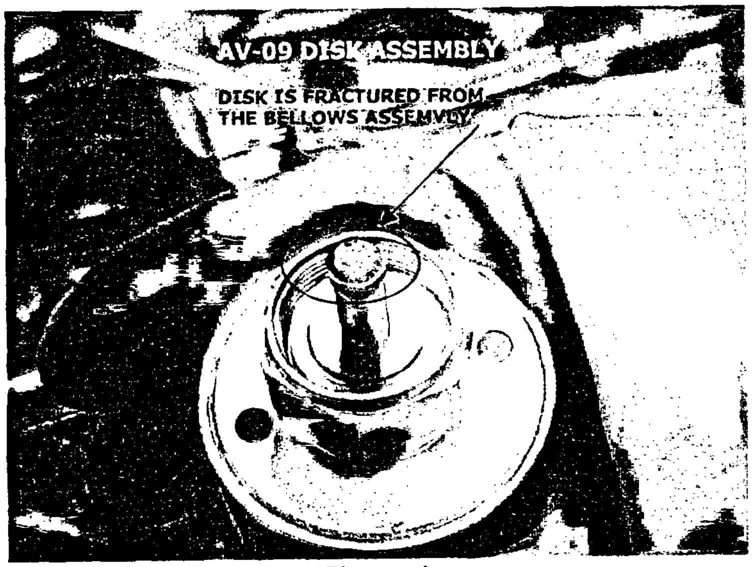


Figure 1

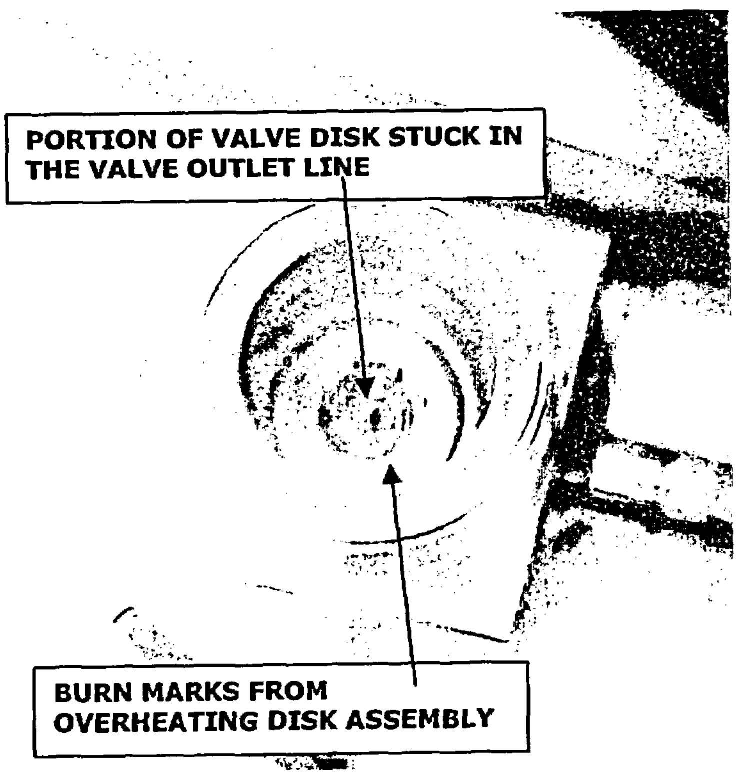


Figure 2

REPORT ON STATUS OF IODINE LOOP
ATTACHMENT 3
28 July, 2002

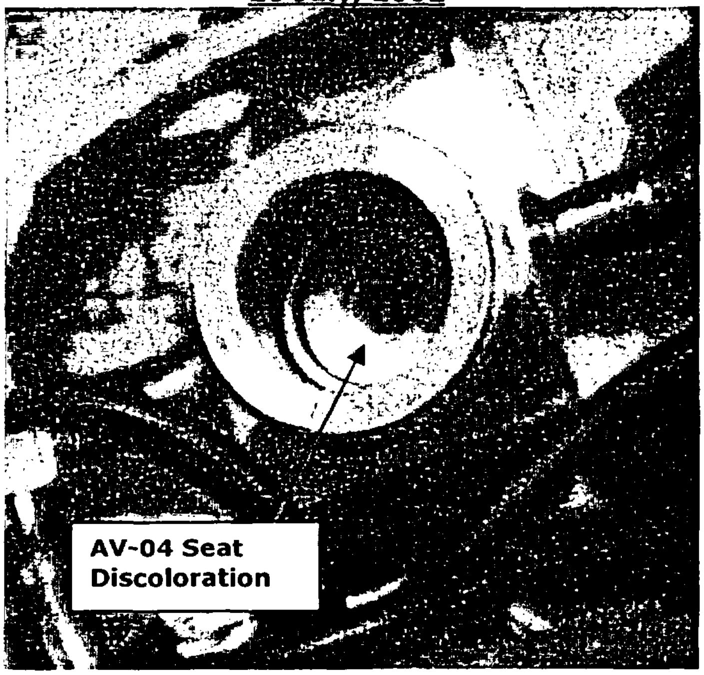


Figure 3

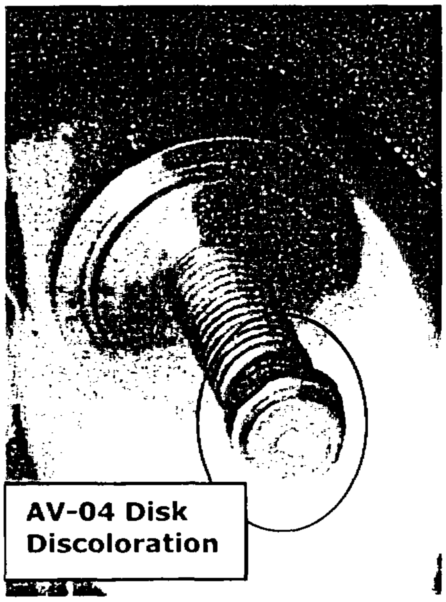


Figure 4

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

Liquid effluents released during 2002 are summarized on a monthly basis in Table 1 below. No liquid effluent releases were made in 2002.

TABLE 1
2002 SUMMARY OF LIQUID EFFLUENTS

MONTH	TOTAL ACT. RELEASED (Ci)	DETECTABLE RADIO-NUCLIDE(S)	SPECIFIC ACT. OF EACH DETECT-ABLE RADIO-NUCLIDE (uCi/ml)	TOTAL ACT. OF EACH DETECT-ABLE RADIO-NUCLIDE (Ci)	AVG. CONC. OF RAD. MATL. AT POINT OF RELEASE[(1)] (uCi/ml)	FRACTION OF 10CFR20 LIMIT	TOTAL VOL. OF EFFLUENT WATER (INCLUDING DILUENT) RELEASED (gal)
JAN	0	NONE					
FEB	0	NONE					
MAR	0.00001046	I-125	6.91E-05	0.00001046	1.29E-06	0.0645	2089
APR	0	NONE					
MAY	0	NONE					
JUN	0	NONE					
JUL	0	NONE					
AUG	0.00002988	I-125	3.37E-05	0.00002932	1.17E-06	0.0585	6816
		I-126	1.16E-06	0.00000066	2.64E-08	0.0026	6601
SEP	0.00000033	NONE	9.69E-07	0.00000033	9.69E-07	0.0484	90
OCT	0.00000020	NONE	2.25E-07	0.00000020	2.25E-07	0.0113	235
NOV	0.00000002	NONE	7.99E-08	0.00000002	7.99E-08	0.0040	50
DEC	0	NONE					

(1) This concentration is an overestimate since the total volume of effluent (including the diluent) released from the facility is not factored into calculation of the concentration.

8.2 Airborne Effluents

Airborne radioactivity discharged during 2002 is tabulated in Table 2 below.

TABLE 2
2002 SUMMARY OF AIRBORNE EFFLUENTS

MONTH	TOTAL EST. ACT. RELEASED (Ar-41, I-125 and Xe-125) (Ci)	TOTAL EST. QUAN. Ar-41 RELEASED (Ci)	EST.MAX AVG. CONC. OF Ar-41 IN UNRESTRICTED AREA (1) (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 LIMIT FOR UNRESTRICTED AREA (1) (%)	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	16.02	16.02	4.63E-10	4.6	2.35E-01	0.23	NONE	NONE
FEB	19.10	19.10	6.11E-10	6.1	3.10E-01	0.31	NONE	NONE
MAR	19.20	19.20	5.55E-10	5.5	2.81E-01	0.28	NONE	NONE
APR	18.35	18.35	5.48E-10	5.5	2.78E-01	0.28	NONE	NONE
MAY	19.42	19.42	5.61E-10	5.6	2.85E-01	0.28	NONE	NONE
JUN	9.18	9.18	2.74E-10	2.7	1.39E-01	0.14	NONE	NONE
JUL	17.95	17.94	5.20E-10	5.2	2.64E-01	0.26	NONE	NONE
AUG	15.28	15.22	4.71E-10	4.7	2.39E-01	0.24	NONE	NONE
SEP	14.55	14.55	4.65E-10	4.7	2.36E-01	0.24	NONE	NONE
OCT	14.55	13.99	4.33E-10	4.3	2.20E-01	0.22	NONE	NONE
NOV	18.38	18.30	5.85E-10	5.9	2.97E-01	0.30	NONE	NONE
DEC	32.01	14.27	4.41E-10	4.4	2.24E-01	0.22	NONE	NONE
TOT	213.99	195.54			3.01	3.01	NONE	NONE
AVG			4.94E-10	4.9				

(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).

8.3 Solid Waste

Solid waste packaged and transferred for disposal during 2002 is summarized in Table 3 below.

TABLE 3
2002 SUMMARY OF SOLID WASTE

TOTAL VOL. (cu. ft.)	TOTAL ACTIVITY (Ci)	DATE OF SHIPMENT	
0	0	NA	NA

9.0 Radiation Exposure

Radiation exposure received by facility operations personnel, facility users, and visitors during 2002 is summarized in Table 4 below.

TABLE 4
2002 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	25	312	1892	1796	17757
FACILITY USERS	0	0	0	*	*
VISITORS	1222	0.04	40	*	*

* 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 2002 are summarized in Table 5 below.

TABLE 5
2002 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	4.8	<5000[1]	<5000[1]
STAGING AREA	<0.1	0.5	<5000[1]	<5000[1]
COMPOUND	<0.1	0.2	<800[2]	<800[2]
EQUIPMENT RM	0.5	175	<800[2]	<800[2]
DEMINERALIZER AREA	30	500	<800[2]	<800[2]
REACTOR RM	10	300	<800[2]	<800[2]
ROOF	<0.1	<0.1	<800[2]	<800[2]
SILICON STORAGE SHED	<0.1	2.2	<5000[1]	<5000[1]
RADIOGRAPHY BAYS	1.0	910	<800[2]	<800[2]

(1) <5000 dpm/100 cm^2 = Less than the lower limit of detection for a direct frisk survey.

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

11.0 Environmental Surveys

Environmental surveys performed outside of the MNRC during 2002 are summarized in Tables 6-10 below. The environmental survey program is described in the MNRC Facility Safety Analysis Report.

TABLE 6
2002 SUMMARY OF PROJECTED ANNUAL DOSE (WITH NATURAL BACKGROUND(1) SUBTRACTED) BASED ON DIRECT MICROROENTGEN PER HOUR MEASURMENTS (ACTUAL DOSE PROVIDED BY TLD RESULTS IN TABLE 7 BELOW)

	AVERAGE (mrem)	HIGHEST (mrem)
ON BASE (OFF SITE 1-20 & 64)	3	26
ON SITE (SITES 50–61 & 65-69 & 71)	28	201

(1) Natural background assumed to be the off base (Sites 27-42) average of 44 mrem
*Projected for continuous occupancy.

TABLE 7
2002 SUMMARY OF ENVIRONMENTAL TLD RESULTS (WITH NATURAL BACKGROUND(1) SUBTRACTED)

	AVERAGE (mrem)	HIGHEST (mrem)
ON BASE (OFF SITE 1-20 & 64)	6	17
ON SITE (SITES 50 – 66 & 65-69 & 71)	27	60

(1) Natural background assumed to be the off base (Sites 27-42) average of 23 mrem.

TABLE 8
2002 SUMMARY OF RADIOACTIVITY IN SOIL SAMPLES

	BETA (pCi/gm)	Cs-137 (pCi/gm)	K-40 (pCi/gm)	Ra-226 (pCi/gm)	Th-232 (pCi/gm)	U-238 (pCi/gm)
AVERAGE	20.63	0.08	12.54	0.51	0.74	0.58
HIGHEST	26.80	0.17	14.40	0.54	0.96	0.71

MDA is the minimum detectable activity at the 95% confidence level.
The MDA range for the analyzed radionuclides (pCi/gm).

	MIN	MAX
Beta	16.10	26.80
Cs-137	0.04	0.17
K-40	7.21	14.40
Ra-226	0.49	0.54
Th-232	0.53	0.96
U-238	0.45	0.71

TABLE 9
2002 SUMMARY OF RADIOACTIVITY IN VEGETATION SAMPLES

	BETA (pCi/gm)	Cs-137 (pCi/gm)	K-40 (pCi/gm)	Be-7 (pCi/gm)
AVERAGE	22.99	<MDA	17.25	2.00
HIGHEST	39.9	<MDA	44.2	2.43

MDA is the minimum detectable activity at the 95% confidence level.
The MDA range for the analyzed radionuclides (pCi/gm).

	MIN	MAX
Beta	11.5	39.9
Cs-137	0.09	0.17
K-40	3.92	44.20
Be-7	1.75	2.43

TABLE 10
2002 SUMMARY OF RADIOACTIVITY IN WELL WATER

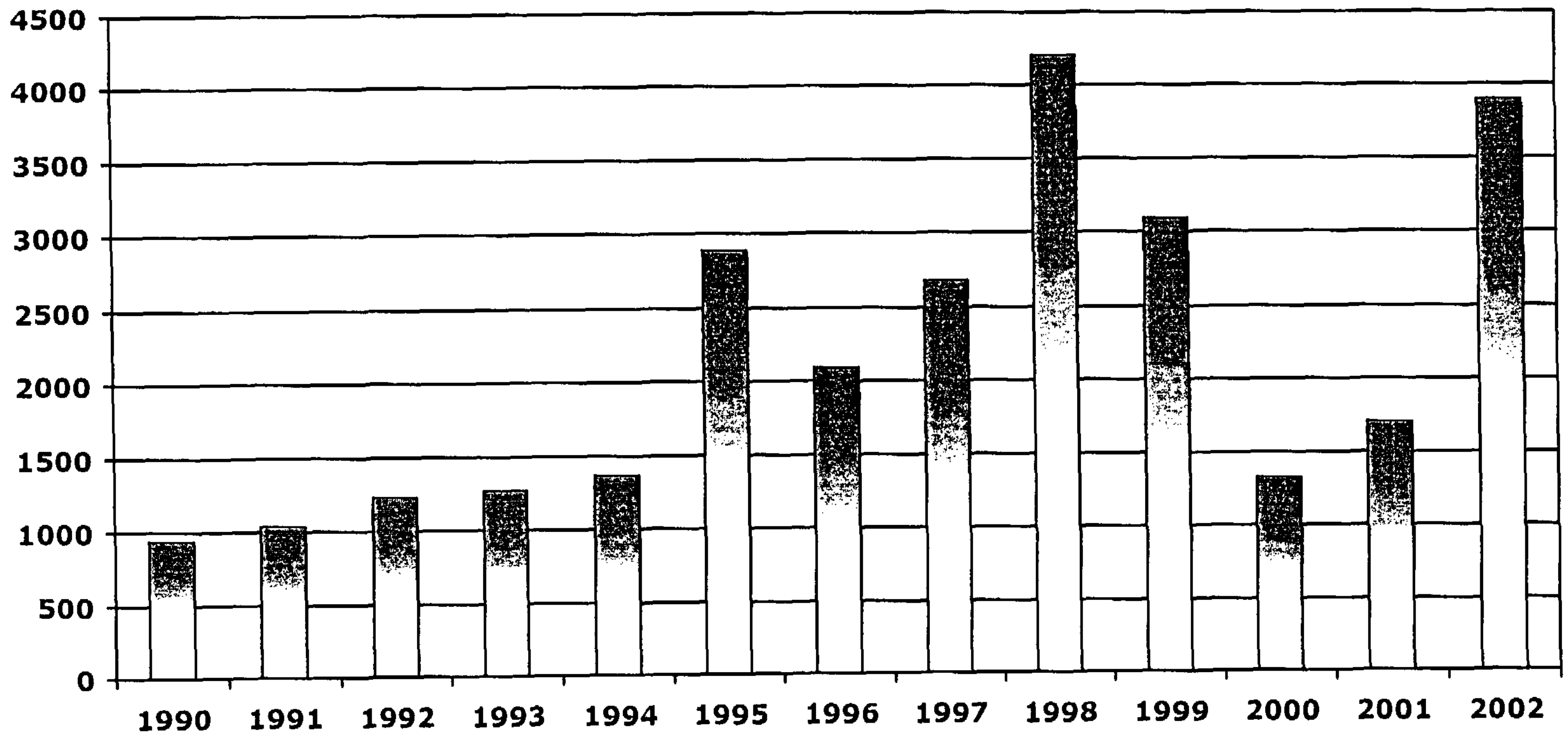
	ALPHA (pCi/l)	BETA (pCi/l)	TRITIUM (pCi/l)	Cs-137 (pCi/l)
AVERAGE	<MDA	3.2	<MDA	8.1
HIGHEST	<MDA	4.1	<MDA	10.9

MDA is the minimum detectable activity at the 95% confidence level.
The MDA range for the analyzed radionuclides (pCi/L).

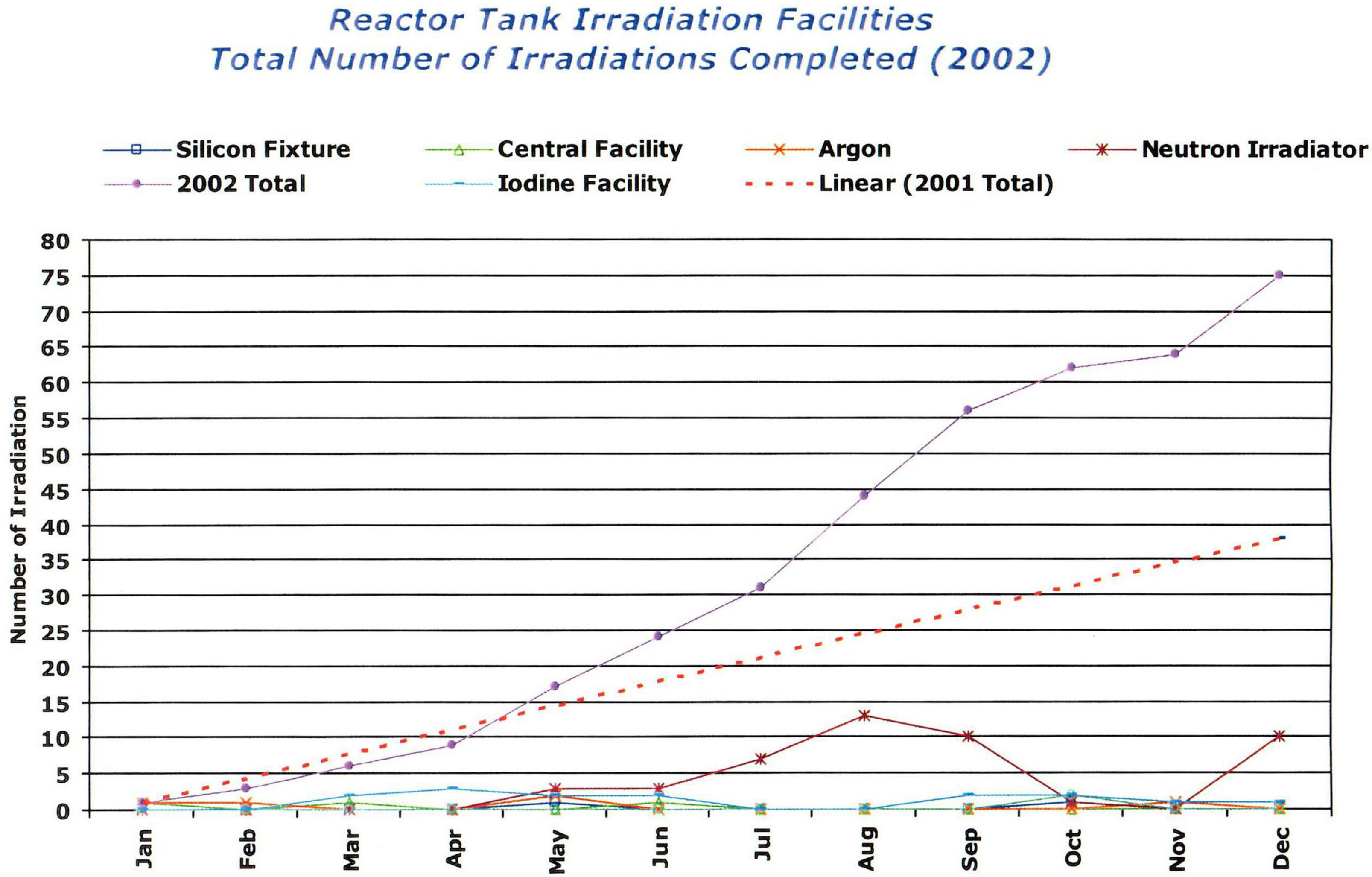
	MIN	MAX
Alpha	1.4	2.0
Beta	2.8	4.1
Tritium	289	365
Cs-137	2.5	10.9

UC DAVIS MNRC McCLELLAN NUCLEAR RADIATION CENTER

Operating Hours
UCD/MNRC ANNUAL REPORT FOR 2002

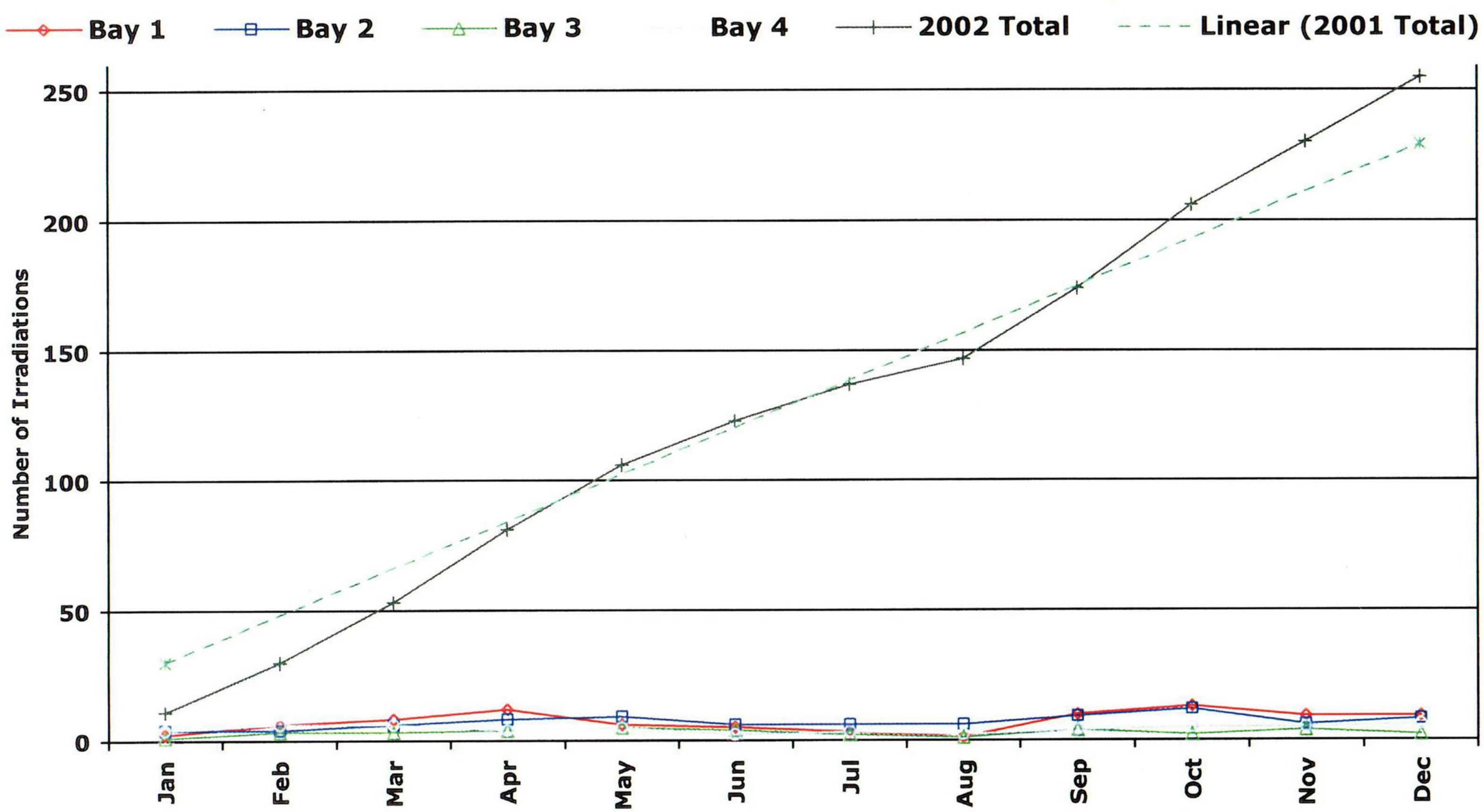


UCD/MNRC Operating History


Reactor Tank Irradiation Facilities
Total Number of Irradiations Completed (2002)
Silicon Fixture
Central Facility
Argon
Neutron Irradiator
2002 Total
Iodine Facility
Linear (2001 Total)
Number of Irradiation
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

C04

Bay Irradiations Completed (2002)



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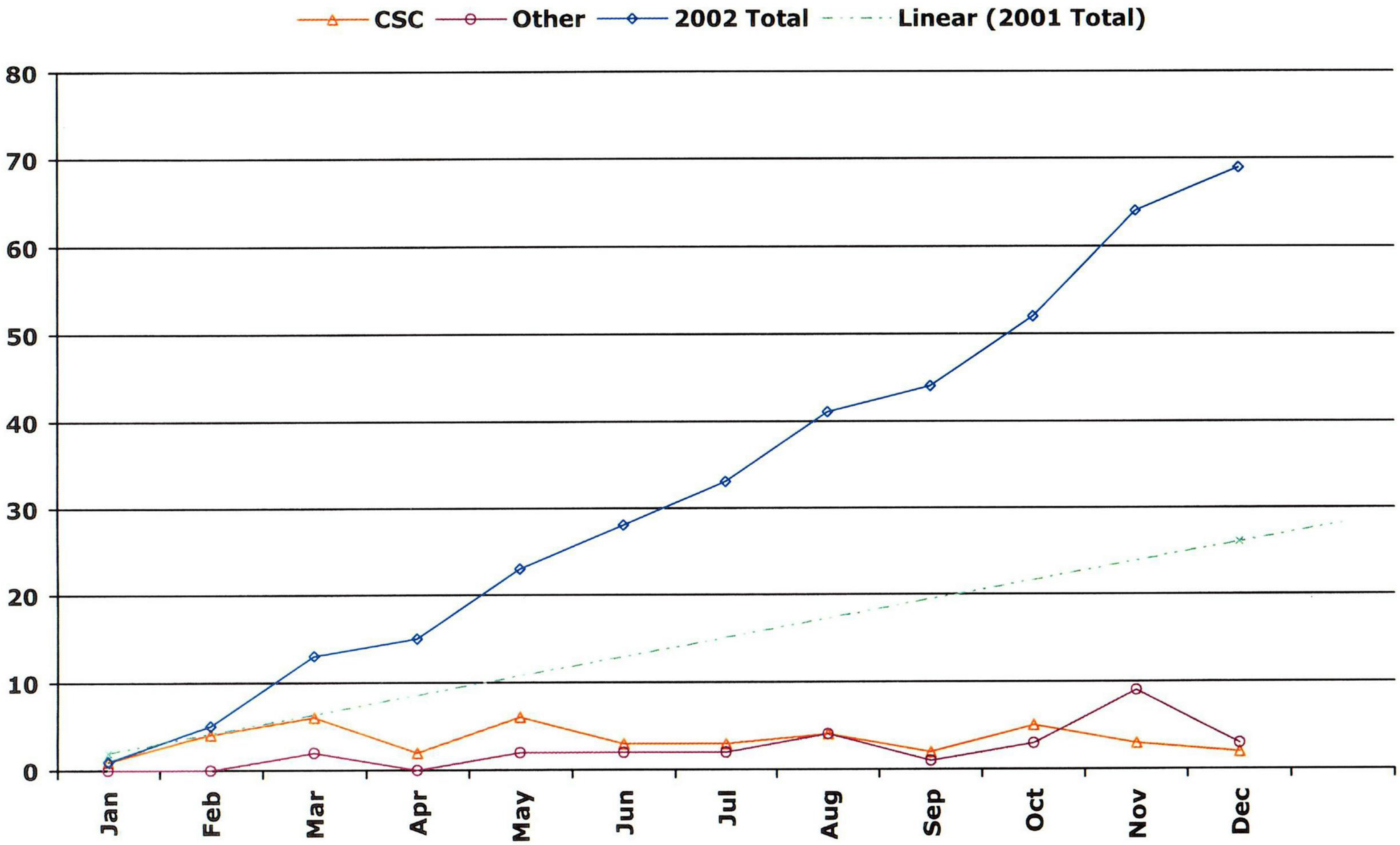
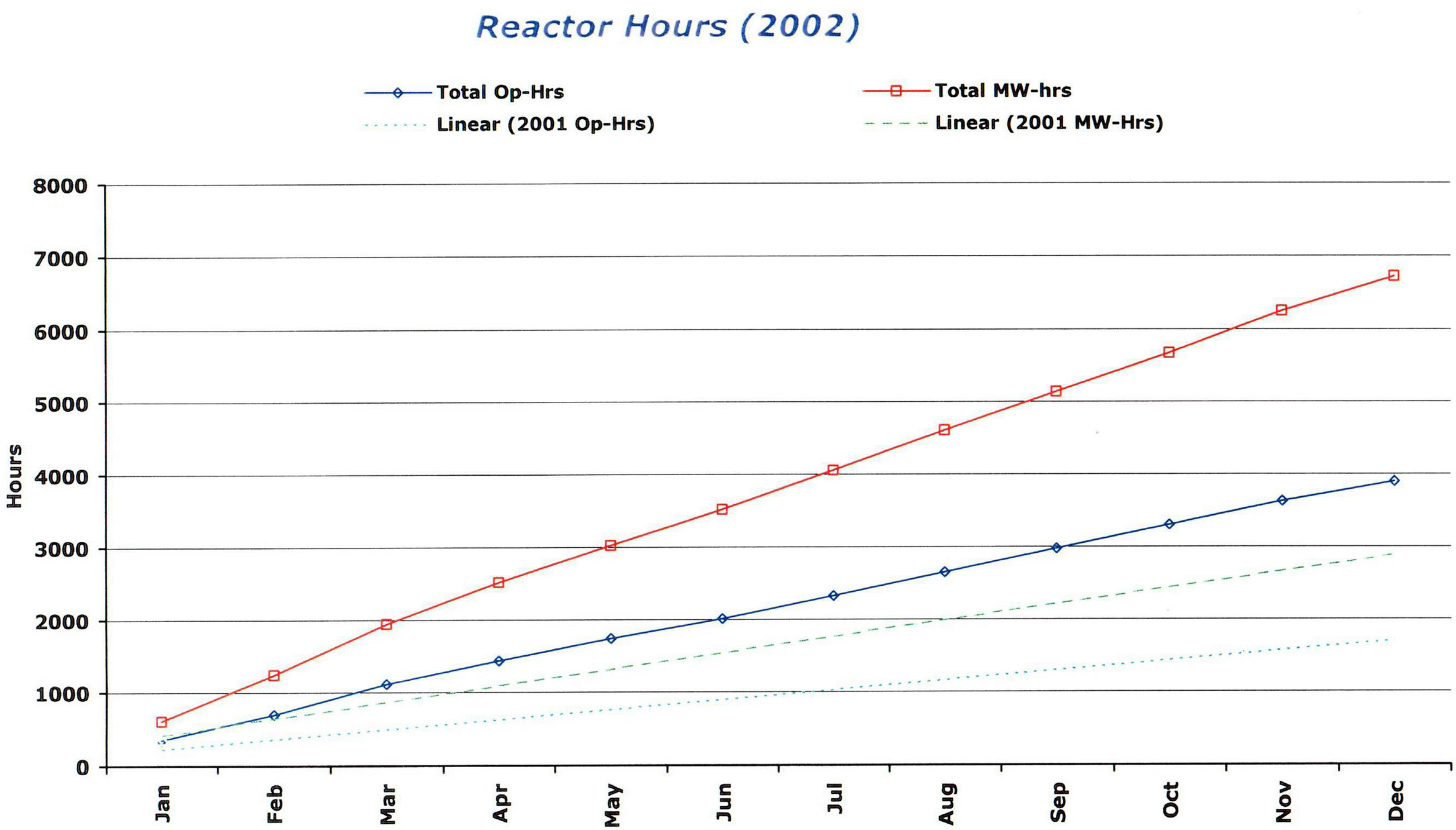
UCDAVIS MNRC McCLELLAN NUCLEAR RADIATION CENTER

UCD/MNRC ANNUAL REPORT FOR 2002

Unscheduled Reactor Shutdowns
Total -- 2002



C06


Reactor Hours (2002)
Total Op-Hrs
Total MW-hrs
Linear (2001 Op-Hrs)
Linear (2001 MW-Hrs)
Hours
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

C07