UNIVERSITY OF CALIFORNIA, IRVINE

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

George E. Miller
Senior Lecturer Emeritus
Department of Chemistry and
Nuclear Reactor Facility

IRVINE, CA 92717-2025
(949) 824-6649
FAX: (949) 824-3168 or (949) 824-7621
Internet: GEMILLER@uci.edu

September 22, 1998

U.S. Nuclear Regulatory Commission
Document Control Desk
Mail Station P1-137
Washington, D.C. 20555

Re: Docket 50-326; License R-116
Annual Report Submittal, Tech Spec 6.7f

Ladies/Gentlemen:

Please find enclosed three(3) copies of the annual report for the UCI Nuclear Reactor Facility, covering the period July 1st 1997 through June 30th 1998.

Sincerely,

George E. Miller
Reactor Supervisor

cc: American Nuclear Insurance, The Exchange, 270 Farmington Ave, Farmington, CT 06032, Policy NF-176

IE47

U. C. IRVINE

Nuclear Reactor Facility

Annual Report

for

July 1st 1997 to June 30th 1998

Facility License R-116

Docket 50-326

Prepared in Accordance with Part 6.7f

of the Facility Technical Specifications

by

Dr. G. E. Miller
Reactor Supervisor

Section 1.

Operations

Operation of this facility is in support of the Department of Chemistry program of research and education in the use and application of radiochemical techniques and radioisotopes in chemical studies.

Reactor utilization, apart from operator training and maintenance, is thus entirely for sample irradiation. Samples come from diverse origins related to forensic science, fossil fuels, geochemistry, art, and archaeological studies, chemical synthesis, industrial quality control, enzyme studies, trace element pollution studies, etc. The reactor is also used in class work by undergraduates learning tracer and activation analysis techniques using small quantities of short-lived activated materials. Enrollment in Winter Quarter 1998 was 42 students. Sodium-24 isotope in substantial quantities was supplied to UCLA for cardiology studies, and to TruTech Corporation for catalyst tracking studies.

Some use is made of the facility by other educational institutions supported by the Reactor Sharing Program of DOE from September 1st 1987 until September 1997. This program has involved tours, class demonstrations, and analyses of samples submitted by faculty. This use continues, but a support award was not sought in 97-98.

Operations have been at a low to modest level. Criticality was achieved for over 177 hours, and the total energy generated is equivalent to 85 hours at full steady state power. Nearly 300 experiments were performed, and over 1712 samples were irradiated (sometimes multiple samples are included in a single capsule and are not separately logged). Isotope production of sodium-24 was carried out in 10 millicurie (for cardiology research) and 500 millicurie (for catalyst tracking) quantities. No pulse operations have been performed, even for test purposes.

A full NRC inspection was carried out in December 1997 by Mr. Stephen Holmes of the headquarters office. NRC headquarters recently assumed all responsibility for non-power reactors.
No significant problems were encountered during this reporting period.

Section 2.

Data Tabulations for the Period July 1st, 1997 to June 30th, 1998

TABLE I.

Experiment Approvals on file	8
Experiments performed (including repeats)	294
Samples irradiated	1712
Energy generated this period (Megawatt hours)	21.2
Total, 69 element core = 127.0	
>74 element core = 1161.7	
Total energy generated since initial criticality	1288.7 Mwh
Pulse operation this period	0
Total pulses to 6/30/98	978
Hours critical this period	177.7
Total hours critical to date	7371.4
Inadvertent scrams or unplanned shutdowns	3
Visitors to reactor - as individuals or in tour groups	432
Maximum dosimeter recorded for visitors	0 mrem
Visiting researchers (dosimeter issues)	9
Maximum dose recorded at one visit	8 mrem
Visiting researchers (badged)	2

TABLE II

Reactor Status 6/30/98

Fuel elements in core (including 2 fuel followers)	82
Fuel elements in storage (reactor tank - used)	25
Fuel elements unused (4 instrumented elements + 1 element + 1 FFCR)	6
Graphite reflector elements in core	33
Graphite reflector elements in reactor tank storage	1
Water filled fuel element positions	6
Experimental facilities in core positions	4
Non-fuel control rods	2
Total core positions accounted for	127
Core excess, cold, no xenon	$2.86

Control rod worths (4/11/96)[not conducted during this period]

REG	$2.86
SHIM	$3.64
ATR	$1.83
FTR	$0.67
Total:	$8.98

Maximum possible pulse insertion	$2.50
Maximum peak power recorded (no pulse operation during this period)	- Mw
Maximum peak temperature recorded (B-ring)	-. ^{o}C

Section 3.

Inadvertent Scrams and Unplanned Shutdowns

TABLE III.

Date	Time	Power	Type and Cause
1998			
01/26	14:00	<1 kw	Linear scram when raising REG rod to increase power, due to electronic noise.
03/7	14:25	250 kw	Linear Scram - @105% reading. Uneven loading of samples in rotating specimen rack caused power level swings not seen on other channels. Run recommenced at slightly reduced power to compensate.
03/28	09:35	<10 mW.	Linear scram. Operator inadvertently commenced start-up in manual mode, not automatic range change mode.

Section 4

Maintenance and Surveillance

The following non-routine maintenance activities were carried out during this period:

July 1998- June 1999

continuous	During part of this period, one station of the Radiation Monitoring System was out of service because of failures in the detector units. No actual radiation releases were ever experienced. Sufficient units have been in service at all times to satisfy Tech. Spec. and general safety requirements.
9/25/97	The console POWER ON switch failed to actuate ON during start-up. Dirt and debris was cleaned from the inside mechanism and normal function resumed.
10/11/97	Ceased routine operations upon discovery that Technical Specification surveillance time limits on fuel element measurement had been exceeded. This was reported to NRC. Fuel measurement was commenced on Nov. 8th and completed without incident on Nov. 11th. No measurements were out of normal ranges. Control rod and power level calibrations were completed Nov. 11th -14th, and routine operations were resumed on Nov. 14th.
12/2/97	The LCD display section which indicates the trip level setting for the source interlock was replaced by the manufacturer (Gamma Metrics). This had been failing for some time, but was still readable for this non-vital level indication.
12/9/97	Neutron and gamma level surveys at full reactor power were conducted. Levels were as expected - no changes had occurred since previous surveys.

12/11/97 An experimenter reported that a glass irradiation capsule was found to be broken after removal from the reactor. Volatile submicrocurie amounts of ^{38}Cl, and ^{41}Ar would have been released in the facility air. No change in readings were observed on the CAM or the Area monitoring systems, so exposure was negligible from this incident.

1/16/98 As samples were being removed from the rotating specimen rack, the top portion of a sample capsule became separated from the bottom portion. The sample and the lower tube portion were removed with a weighted miniature suction cup device with no difficulties. The sample radiation level was close to background, so no personnel exposures were involved.

1/20/98 One repaired RMS monitoring station was returned from the instrument manufacturer (Eberline) and reinstalled. Indicated background levels were as previously recorded.

2/22/98 The facility supervisor tested the magnet current on key switch in an attempt to reproduce the effect discovered at OSU where the switch stuck in-between positions and disabled reactor scrams. No such effect could be simulated. Scrams were always active no matter how the switch was positioned, or else the switch movement itself initiated a scram (on being turned to RESET). The conclusion is that wiring to permit such incident is not part of the arrangement at this facility.

Section 5
Facility Changes and Special Experiments Approved

No special experiments or additional facility changes were approved during this period.

Section 6

Radioactive Effluent Release.

(a) Gases.

The major direct release to the environs is Argon-41 produced during normal operations. Very small amounts of other gases may be released from irradiated materials in experiments.

Releases are computed based on original estimates at point of origin within the facility and taking only dilution into account. Since much of the release is from operation of the pneumatic transfer system for samples, this is a conservative estimate in that assumption is made that all use of the PT is at full steady state power level (250 kw) when, in fact, some use is with the reactor at a lower power level. In view of the small numbers involved, and the fact that an integrated dose check is provided by an environmental dosimeter ($CaSO_4$-Dy) hanging directly in the exhaust at the point of stack discharge, it is considered unnecessary to provide further checks of these estimates. The dosimeter data confirm that an individual standing directly in the exhaust flow for one year would receive an additional submersion dose from the exhaust less than the reliability limit of the dosimeters, or less than 20 mrem per year. The dosimeter data are presented separately in Section 7, Table IV. Over the years that data have been collected, the accumulated exposure at the exhaust location have been lower than for "control" points because of lower masses of concrete structures in the vicinity. In fact the data have been consistently at 20-25 mrem per year background level, so confidence of exposure less than 5 mrem over background seems possible.

Release estimates based on operational parameters are as follows:

(1) Operation of pneumatic transfer system (7/1/97-6/30/98):

a. Minutes of operation:	441.2 minutes
b. Release rate assumed:	$6. \times 10^{-8}$ microcuries/mL
c. Flow rate of exhaust air:	1.2×10^{8} mL/min.
Total release computed: (a x b x c) =	3.2×10^{3} microcuries

(2) Release from pool surface (7/1/97-6/30/98):

a. Total hours of operation at power (Mwh x 4) =	84.8 hours
b. Release rate assumed:	$<1. \times 10^{-8}$ microcuries/mL
c. Flow rate of exhaust air:	1.2×10^{8} mL/min
Total release computed: (a x 60 x b x c)	$= 6.1 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 9.3 \times 10^{3}$ microcuries**
e. Total effluent released in 1 year (525960 minutes/yr. x c) = 6.31×10^{13} mL	

Concentration averaged over 12 months (d/e) $= < 1.5 \times 10^{-10}$ microcuries/mL
Since 2×10^{-9} microcuries/mL provides an annual exposure for constant immersion of 10 mrem, this corresponds to < 0.74 mrem potential additional radiation exposure to an individual standing breathing in the effluent stack for the entire year.

This is similar to values reported in previous years and assumes no dilution of the plume at or beyond the stack.

(b) Liquids and Solids.

Liquid and solid wastes from utilization of by-product materials are disposed through a University contract. Waste is transferred to the custody of the Campus Environmental Health and Safety Office (EH&S). Direct disposals from this facility are given below. It is important to note that activity values are estimated at the time of transfer to EH&S control. Since no shipments are currently being made from campus, so that decay to negligible levels occurs for medium-lived radionuclides.

DRY WASTES:

2 ft^3 box---> ^{24}Na and mixed activation products with <0.001 mCi on 10/21/97.
2 ft^3 box---> ^{24}Na and mixed activation products with <0.001 mCi on 3/10/98.
2 ft^3 box---> ^{24}Na and mixed activation products with <0.001 mCi on 3/24/98

LIQUIDS:

1.9 gallons mixed activation products (decayed) aqueous <0.0001 mCi on 11/24/98
1.0 gallons liquid scintillation cocktail residues <0.001 mCi ^{3}H + ^{14}C on 11/24/98
0.5 gallons ^{133}Ba aqueous <0.0001 mCi on 11/24/98
1.0 gallons liquid scintillation cocktail residues <0.001 mCi ^{3}H + ^{14}C on 3/24/98
0.5 gallons mixed activation wastes (decayed) aqueous <0.0001 mCi on 3/24/98

Section 7.
Environmental Surveillance.

Calcium sulfate/Dysprosium thermoluminescent dosimeters in packs supplied by the Radiation Detection Company, Sunnyvale, California are placed at nine locations around the UCI Campus. One pack is kept on the edge of campus in a wood frame house in University Hills. In fact, the average of the more remotely located "concrete environment" packs on campus is used as the background for comparison purposes, since a more similar microenvironment is experienced by such packs.

Table of Locations.

1. Window of reactor room east wall (inside the facility).
2. In hallway on exterior of south wall of facility.
3. Loading dock, adjacent to west wall of reactor room.
4. Laboratory 152, directly over reactor facility, approximately over core center.
5. In roof exhaust air flow from reactor room, roof level
   (hung in center of duct at final release point).
6. Biological Sciences 2 building, 5th floor, laboratory near window*.
7. Main library building across campus, 5th floor office in sunny window
8. Computer Science building, 4th floor office, in shaded window.
9. Fume hood exhaust, roof level, from reactor laboratory (hung in center of duct).
10. 12 Perkins Court, University Hills, private residence (wood frame house).

Table IV shows the data as received from RDC for the period. Most levels are as expected and are similar to those reported in recent years. Data for them last two quarters reported reflect two issues:

- several moderately large (5 to 500 millicuries) shipments of Na-24 isotope were made. Rapid transfer is necessary with brief room exposure to unshielded source as it is placed in shielding. Sources may remain partially shielded in the facility area for some time while the shipment arrangements are completed. These were always done in early morning (about 7 am) and no personnel other than those transferring isotopes were present.
- one experimenter has been measuring content of materials using Cl-38 activation. This has strong gamma radiation, and his work involves radiochemical separation of significant quantities (several microcuries) of Cl-38 in the lab area at the rear of the facility.

Exposure to a single individual in an uncontrolled area at this facility is still very minimal since occupancy of the areas monitored by these dosimeters is very low. The air released from the facility (measured by locations #5 and #9) continues to give no detectable exposure above background for dosimeters immersed in it. Location 7 consistently shows higher readings presumably because it is in a window above a warm, outside, cement wall. Over many years, the data at each specific location show remarkable consistency. An appreciable change would be easily noticeable.

TABLE IV.
Environmental Dosimetry Data.
1997-1998

Average Exposures in mrem

Location.	Quarter				Annual	Total less
	2/97	3/97	4/97	1/98	Total	background (33± 22)
1	0	2	12	24	38	5
2	3	7	29	47	86	53
3	5	9	9	12	35	2
4	1	6	7	6	20	-13
5	0	2	4	5	11	-22
6	2	4	5	5	16	-17
7	12	19	29*	15	75	42
8	0	2	3	3	8	-25
9	2	5	5	5	17	-16
10	0	0	1	1	2	-31

*longer exposure period due to temporary misplacement.
Average of locations 6, 7, and 8 used for "background" (= 33)

Section 8.
Radiation Exposure to Personnel.

A change was made in UCI's practices for personnel monitoring as of July 1st 1997. Instead of monthly film badges, TLD badges are issued and read quarterly. Data in the table below from 5/1/97 through 6/30/97 are thus from monthly films, those since that time are from quarterly TLD's. Finger dosimetry (TLD) rings are also issued to all personnel who are on the annual monitoring list and who might be handling isotopes on a regular basis. Results of badge dosimetry are presented in Table V.

Fourteen (14) persons were issued monitors on a continual basis, and all of these were also issued with finger dosimeter rings. These were required to be worn while handling isotopes. 39 students in a radiochemistry class were issued badges.

Certain additional monitoring is done of visiting individuals who are issued with direct-reading pocket dosimeters in addition to or instead of badges and finger dosimeter rings.

Contamination surveys consisting of wipe tests and G-M surveys have shown significant, removable contamination only in areas coming into direct contact with samples removed from the reactor, and on sample handling tools.

TABLE V.

Personnel Exposure Summary for 5/1/96 to 4/30/97 (in mrem)

Individuals	Whole Body		Finger Ring
	Deep	Shallow	Shallow
1[1]	165	210	1120
1	20	20	40
1	35	35	0
28[2]	15	15	0
22 (39 were students in class)	0	0	0
Totals 53	235	280	1160

1. This individual does extensive activation analysis and radiochemical work at the facility. Most of the exposure is a result of Cl-38 radioactivity production.
2. These exposures are thought to be from a large source movement adjacent to the badge storage area. This is concluded since several of the badged individuals with recorded exposures did not even visit the facility during the monitoring period.

Additional aggregated data from self-reading pocket dosimeters issued to researchers:

1	–	16	(2 visits)
1		2	(7 visits)

As noted earlier, 432 vistors were also monitored using self-reading dosimeters (3-5 per groups when in a group). No readings >0 were recorded for these events.