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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 1998 through June 30th 1999. We regret that this report is delayed due to unforseen personal circumstances.

Sincerely,

G. E. Miller

George E. Miller
Reactor Supervisor

cc: American Nuclear Insurance, Town Center, Suite 300S, 29 South Main Street, West Hartford, CT 06107-2445, Policy NF-176
Reactor Operations Committee Members, UCI

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U. C. IRVINE

Nuclear Reactor Facility

Annual Report

for

July 1st 1998 to June 30th 1999

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 Summary

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 1999 was 48 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. This program has involved tours, class demonstrations, and analyses of samples submitted by faculty. This use continues, but a support award under the Reactor Sharing Program was not sought in 97-99. Support was granted for instrumentation upgrade from the URI program of the US Department of Energy and is being used for upgrading air monitoring instrumentation and console pushbuttons.

Operations have been at a low to modest level. Criticality was achieved for 108 hours, and the total energy generated is equivalent to 75 hours at full steady state power. Nearly 100 experiments were performed, and over 1300 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 or 1000 millicurie (for catalyst tracking) quantities. Handling of these materials during transfer for shipment has increased the perimeter dose responses to some extent. Such transfers have been done during time periods when few occupants of the building are present (prior to 8 am). No pulse operations have been performed, even for test purposes.

Significant general maintenance was carried out with the facility flooring being replaced, the walls repainted, and a new secondary cooling water control valve and controller being installed. Utilities in the rear "wet" lab were refurbished and a new cabinet top and sink installed. Also involved was contract work to remove asbestos materials in the flooring and cooling water piping insulation.

A full NRC inspection was carried out in February 1999 by Mr. Stephen Holmes of the headquarters office accompanied by Marvin Mendonca, Project Manager for the facility. No significant safety problems were encountered during this reporting period.

Section 2.

Data Tabulations for the Period July 1st, 1998 to June 30th, 1999

TABLE I.

Experiment Approvals on file	8
Experiments performed (including repeats)	94
Samples irradiated	1326
Energy generated this period (Megawatt hours)	18.7
Total, 69 element core = 127.0	
>74 element core = 1180.4	
Total energy generated since initial criticality	1307.4 Mwh
Pulse operation this period	0
Total pulses to 6/30/99	978
Hours critical this period	108.9
Total hours critical to date	7480.3
Inadvertent scrams or unplanned shutdowns	3
Visitors to reactor - as individuals or in tour groups	310
Maximum dosimeter recorded for visitors	0 mrem
Visiting researchers (dosimeter issues)	7
Maximum dose recorded at one visit	2 mrem
Visiting researchers (badged)	2

TABLE II

Reactor Status 6/30/99

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	$2.83
Control rod worths (2/10/99)	

REG	$2.79
SHIM	$3.70
ATR	$1.82
FTR	$0.70
Total:	$9.01

Maximum possible pulse insertion	$2.52
Maximum peak power recorded (no pulse operation during this period)	- Mw
Maximum peak temperature recorded in pulse (B-ring)	-. ^{o}C

Section 3.

Inadvertent Scrams and Unplanned Shutdowns

TABLE III.

Date	Time	Power	Type and Cause
1998			
07/30	14:50	250 kW	Linear Scram - @105% reading. Uneven loading of samples in rotating specimen rack and water cooling cycling caused power level swings not seen on other channels.
11/24/98 - 2/9/9		-	Facility mostly down for refurbishing of floors (including asbestos removal), paintwork, secondary water control valves, lab benches and sinks, etc. Operations conducted only on 11/27/98, and 12/3/98. Operations recommenced with rod and power calibrations on 2/9/99.
1999			
3/13	11:00	-	Pneumatic terminus removed from core to retrieve sample (in polyvial) that had been left there as a result of a broken carrier (rabbit) tube on 3/11/99. Sample retrieved and terminus reinstalled correctly.
5/12	11:05	<2.5 mw	Period scram - electrical noise apparently transmitted from rod drive switch minor arcing to log/period circuit during start-up procedures. A relay "chattering" was noted simultaneously in the scram bus. Further operation showed some further noise but not picked up by scrams.

Section 4

Maintenance and Surveillance

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

1998

7/1 - 10/12	During part of this period, one station of the six station 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. Full complement (6) stations were reinstated on October 12th 1998.
8/20	Additional security checks implemented and alert given to Campus security forces following NRC notification.
9/2	Pneumatic sample transfer container (rabbit) broke in the in-core terminus. Sample and rabbit pieces were retrieved using "sticky rabbit". Reactor not shutdown and runs resumed within 5 minutes.

11/24 - 11/25	Asbestos removal carried out for piping insulation sections to be replaced in order to replace water temp adjustment valve on secondary cooling system.
11/30 - 12/ 8	Work conducted to replace flooring and paint walls in reactor hall and adjacent labs..
12/8	Neutron generator raised to floor/hall level (0.4 mr/hr max. level found on target area (probably Co-60 residue). Instrument prepared for shipment to manufacturer for parts/disposal.
12/11	Floor replacement halted to deal with asbestos filling under old flooring. Asbestos removal crew worked Dec. 18th and 19th. New flooring completed Jan 26-28th, 1999.

1999

1/14	Continuous Air Monitor serviced - repacked bearings, new oil in pump, new V-belt.
1/23	Ion exchange resin removed. Max. radiation level 0.5 mr/hr on resin. Old resin transferred to EH&S for storage. Water shows no activity above background. Gamma-ray spectrometry done on resin - found activities expected from mild stainless steel and aluminum alloy corrosion products. No fission products observed.
1/29	New resin (SYBRON IONAC NM-60 Mixed bed form) installed - just under 6 cubic feet. New top rubber gaskets made for top of tanks. Conductivity IN is 2.07 micromhos, OUT is less than 0.1 micromho/cm.
2/8	New control valve installed in secondary water system to give better energy related performance and reduce potential leakage due to aging of old valve. Valve can be adjusted manually - awaiting controller delivery.
2/20	Pneumatic sample transfer container (rabbit) broke in the in-core terminus. Sample and rabbit pieces were retrieved using "sticky rabbit". Reactor not shutdown and runs resumed within 5 minutes.
2/22	Controller for secondary cooling water installed, using temperature probe installed directly in the pool water at pool side.

Section 5
Facility Changes and Special Experiments Approved

Facility changes made include those referenced under maintenance. The only item warranting formal approval was the replacement control valve controls the secondary coolant flow based on a new pool water temperature sensor installed in the pool. The previous valve had controlled based on the temperature in the primary outlet loop. A Watlow controller unit (electronic) series 96 was installed to substitute for the older pneumatic-mechanical controller.

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 (7/1/98-6/30/99):

a. Minutes of operation:	444 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 (7/1/98-6/30/99):

a. Total hours of operation at power (Mwh x 4) =	74.8 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)	$= 5.4 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 8.6 \times 10^{3}$ 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) $= < 1.4 \times 10^{-10}$ microcuries/mL
Since 2×10^{-9} microcuries/mL provides an annual exposure for constant immersion of 10 mrem, this corresponds to < 0.68 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.

Section 6. (continued)
(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, decay to negligible levels occurs for medium-lived radionuclides.

DRY WASTES:
2/ 12/ 99 6 ft^3 dry ion exchange resin containing 32 microcuries Co-60; 14 microcuries Mn-54; 9 microcuries Co-58; 2 microcuries Zn-65; 1 microcurie Sb-124, and 0.4 microcuries of Cr-51

LIQUIDS:
None this period

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.

Contamination surveys consisting of wipe tests and G-M surveys have shown mostly a "clean" facility with significant, removable contamination only in areas coming into direct contact with samples removed from the reactor, and on sample handling tools. All waste material especially old flooring was surveyed by EH&S before disposal and found to be free of removable and fixed contamination.

Table of Locations for Environemtnal Dosimeter Packs.

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, on the following page, shows the data as received from RDC for the period. Most levels are as expected and are similar to those reported in recent years.

TABLE IV.
Environmental Dosimetry Data.
1998-1999

Average Exposures in mrem

Location.	Quarter				Annual
	2/98	3/98	4/98	1/99	Total
1. S. Facility perimeter	14	11	27*	21	73
2. W. Facility perimeter	39	28	21	39	127
3. N Facility perimeter	9	10	9	9	37
4. Over facility	6	4	6	6	22
5. Facility Air exhaust	5	4	2	4	15
6. Bio. Sci II top floor	5	4	4	6	19
7. Library top floor	14	14	15	16	59
8. Computer Sci. top floor	2	2	2	2	8
9. Facility fume hood	6	5	4	5	20
10. Faculty housing	2	0	0	1	3

*slightly longer exposure period due to temporary misplacement.

Discussion

It has been decided that raw data should be presented here, with no attempt to compute an average "background" since the data vary significantly. Location 7 has always indicated a consistent higher level because of roof level, unshielded cement building + bright window exposure in a place remote from the facility.

Data for this year reflects three issues:

- several moderately large (5 to 1000 millicuries) shipments of Na-24 isotope were made. Production of these sources involves longer irradiations than were traditional at this facility, which contributes to increased Ar-41 levels within the facility. 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 shipments are always done in early morning (about 7 am) and no personnel other than those transferring isotopes are present.
- one experimenter has been measuring content of materials using Cl-38 activation. This has strong beta and 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. This contributes to Location 2 exposures.
- experimental work has been conducted using a modest sized Cf-252 source. This is stored within the facility when not in use, but increases somewhat the background levels in locations 1 and 2.

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.

Section 8.
Radiation Exposure to Personnel.

UCI issues TLD badges to on-campus students or researchers utilizing radiation or isotopes. 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. Neutron exposure badges are used by personnel (up to 4) who might work with the Cf-252 source. TLD and badge dosimetry are all read quarterly by Radiation Detection Company, and results are presented in Table V.

Fourteen (9) 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. 48 students and 3 teaching assistants in a radiochemistry class were also issued TLD monitors.

Certain additional monitoring was done of visiting individuals who are issued with direct-reading pocket dosimeters in addition to or instead of badges and finger dosimeter rings. Personnel included in this group were individuals working on facility asbestos removal, flooring installation, painting, piping and valve replacement, and insulation. All work was done with the reactor shut down, and none of these individuals showed readings above zero on a daily personal dosimeter.

TABLE V.

Personnel Exposure Report Summary for 4/1/98 to 3/31/99 (in mrem)

Individuals	Whole Body		Finger Ring
	Deep	Shallow	Shallow
1[1]	115	115	590
1	0	0	180
4[2]	10	10	-
7[2]	15	15	-
41	0	0	-
(48 were students in a 1 quarter class, plus 3 teaching assistants)			
Totals 54	215	215	770
	(person-mrem)		

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 source movements 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. The records are also close to the quarterly error limit on the devices (10 mrem).

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

Person days	Day accumulation
1	19
1	4
3	2
3	1
Summations 8	32

As noted earlier, 310 visitors were also monitored using self-reading dosimeters (individuals or 3-5 per group when in a group). No readings >0 were recorded for these tour events.