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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, 2000 through June 30th, 2001.

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
Dean of Physical Sciences, Ron Stern

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U. C. IRVINE

Nuclear Reactor Facility

Annual Report

for

July 1st 2000 to June 30th 2001

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 2001 was 48 students.

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. Modest support was obtained from the Reactor Sharing program for 2000-2001. Support was also granted for instrumentation upgrade from the URI program of the US Department of Energy and is being used to upgrade both electro-mechanical control rod drives to stepper motor systems; to add to beta counting capabilities (liquid scintillation counter), a new portal exit monitor; and upgrade security system computer hardware.

Operations have been at a low to modest level, somewhat reduced from last year. Criticality was achieved for 98 hours, and the total energy generated was equivalent to 58 hours at full steady state power. 61 experiments were performed, and over 1000 samples were irradiated (sometimes multiple samples are included in a single capsule and are not separately logged). 30 low level isotope shipments were made (all Yellow II category or less). No pulse operations have been performed, even for test purposes.

A new air monitoring system has been acquired. While experience is gained with this system the older CAM (NMC system) is still employed to operate emergency ventilation, etc. Changes in key personnel at GA have delayed installation of new rod drive motors and controls, but both will be installed in the next few months. Wipe tests are now being routinely measured by liquid scintillation counting using a new counter acquired with DOE improvement funds. Students have also learned how to determine tritium, carbon-14 and natural potassium radioactivity using this counter.

A full inspection was carried out in March 2001 by Mr. Stephen Holmes of the NRC headquarters office. One notice of violation, severity level IV, was issued with respect to the inspection - for failure to perform Tech. Spec. required surveillance of the pool water level alarm on the appropriate schedule. Responses were made to these notices in late May 2001. No other significant safety problems were encountered during this reporting period.

Section 2. Data Tabulations for the Period July 1st, 2000 to June 30th, 2001

TABLE I.

Experiment Approvals on file	8
Experiments performed (including repeats)	61
Samples irradiated	918
Energy generated this period (Megawatt hours)	14.5
Total, 69 element core = 127.0	
>74 element core = 1331.6	
Total energy generated since initial criticality	1344.3 Mwh
Pulse operation this period	0
Total pulses to 6/30/01	978
Hours critical this period	98.0
Total hours critical to date	7702.0
Inadvertent scrams or unplanned shutdowns	3
Visitors to reactor - as individuals or in tour groups	394
Maximum dosimeter recorded for visitors	0 mrem
Visiting researchers (dosimeter issues)	7
Maximum dose recorded at one visit	11 mrem
Visiting researchers (badged)	2

TABLE II

Reactor Status 6/30/01 (no change since 6/30/00).

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			$2.75
Control rod worths (8/24/00)	REG	$2.78	
	SHIM	$3.62	
	ATR	$1.82	
	FTR	$0.69	
	Total:	$8.91	

Maximum possible pulse insertion	$2.51
Maximum peak power recorded (no pulse operation during this period)	- Mw
Maximum peak temperature recorded in pulse (B-ring)	-.°C

Section 3.

Inadvertent Scrams and Unplanned Shutdowns

TABLE III.

Date	Time	Power	Type and Cause
2000			
08/09-08/22			Reactor not run as eighteen month calibration period exceeded. Reactor operated just to calibrate on 8/24/2000 and 8/27/2000. All values in close agreement (within 2%) with previous calibrations.
12/21	14:10	0w	Period scram fails to reset after startup test. Appears to be sticking Hg switch used in scram circuit. Replugging the mounting board cured problem. After a further occurrence on 2/17/2001, a new HG switch was installed.
2001			
1/10	07:17	0w	REG rod fails to raise at start-up. DOWN microswitch adjusted to cure problem.
2/06	17:00	0w	A failed lamp replaced in the ATR DOWN button indicator.
2/07	14:35	250 kw	Linear scram at 105% power – operator failed to observe drift of power level as pool cooling initiated. WRM and %P were below 100%.
3/16	13:24	250kw	Linear scram at 105%, UP button did not release properly while making fine power adjustments.
5/22	07:15	0w	Seismic trip found to be tripped at startup attempt. No knowledge of any recent seismic activity so operator assumed that a slip occurred after improper reset. Trip reset and startup continued.

Section 4

Maintenance and Surveillance

The following non-routine maintenance activities were carried out during this period. Some reactor operation related items have been included above and are not repeated here.

2000

7/21 – 2/01/01 Occasional "false" security alarms received, or failures of zones noted during trip and walk tests. Some may have been due to liquid nitrogen tank release, others to loose terminals in the connector box for the sensor systems. The latter were eventually tightened and remade for all sensors.

12/13 An emergency drill was held to train EH&S personnel on radioactive chemical spill cleanup in the facility.

2001

1/11 An early morning test of the building emergency power generator tripped the security alarm system which is connected to the emergency power change over circuit.

2/1-2/10 Flow sensor installed in emergency exhaust fan duct with readout in control room. Measures pressure relative to control room. Unit not absolutely calibrated. Reads –4 to –5 on normal flow indicating inflow through the system. Reads +17 (2) on emergency trip indicating proper outflow. Test and record made part of daily checklist.

2/15 Pool skimmer unit repaired by replacing corroded screw holding the top on.

During part of this period, one station of the six station Radiation Monitoring System was out of service because of a failure in the detector unit. No actual radiation releases were ever experienced. Sufficient units have been in service at all times to satisfy Tech. Spec. and general safety requirements. The failed station was repaired and reinstalled on February 25th, 2001.

Section 5
Facility Changes and Special Experiments Approved

Facility changes made include those referenced under maintenance. Formal approval was granted (under 10CFR 50.59) in December 2000 for replacement of control rod drive motors with stepper motors (not yet implemented) and replacement of the CAM with three new Eberline AMS-4 air monitor units (two beta particulate and one for noble gas monitoring). The latter are currently operating in parallel with the older CAM while comparative data are evaluated.

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 (7/1/00-6/30/01):

a. Minutes of operation:	359 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) =	2.6×10^{3} microcuries

(2) Release from pool surface (7/1/98-6/30/99):

a. Total hours of operation at power (Mwh x 4) =	58.0 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)	$= 4.2 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 6.8 \times 10^{3}$ 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) $= < 0.66 \times 10^{-10}$ microcuries/mL

Since 20×10^{-10} microcuries/mL provides an annual exposure for constant immersion of 10 mrem, this corresponds to < 0.33 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 all medium-lived radionuclides.

DRY WASTES:

8/22/00 2 ft^3 dry waste containing approximately 1 microcurie of ^3H + ^{14}C waste from lab experiments (not produced by the reactor), and less than 1 microcurie of ^{24}Na as byproduct from the reactor.

2/13/01 2 ft^3 dry waste containing approximately 1 microcurie of mixed activation products (including ^{60}Co and shorter-lived products) from irradiation experiments.

LIQUIDS:

2/13/01 1 gallon liquid aqueous waste including approx 1 microcurie ^3H reactor generated by ^6LiOH irradiation.

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.

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 Environmental 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.

<u>TABLE IV.</u>
<u>Environmental Dosimetry Data.</u>
<u>2000-2001</u>

<u>Average Exposures in mrem</u>

Location.	Quarter 2/00	3/00	4/00	1/01	Annual Total
1. S. Facility perimeter	17	15	19	26	77*
2. W. Facility perimeter	9	8	8	7	32
3. N Facility perimeter	7	6	7	8	28
4. Room Over facility	6	3	6	5	20
5. Facility Air exhaust	3	6	3	4	15
6. Bio. Sci II top floor	5	3	4	5	17
7. Library top floor	15	13	14	12	34
8. Computer Sci. top floor	2	2	3	4	11
9. Facility fume hood	4	4	4	5	17
10. Faculty housing	1	0	0	2	3

* increased exposure due to relocation of stored Cf-252 source closer to this sensor.

<u>Discussion</u>
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 two issues:
- the experimenter that had been measuring content of materials using Cl-38 activation processed very few such samples this year, thus Location 2 exposures are reduced.
- experimental work has been conducted using a modest sized Cf-252 source. This is stored within the facility when not in use, and the new location is relatively close to Location 1, raising its level slightly.

Exposure to a single individual in an uncontrolled area at this facility is still very minimal. The perimeter of the facility is hallways or outside loading dock so occupancy rate of the areas monitored by these dosimeters is extremely low. The laboratory overhead (location 4) is occupied by very few individuals (one or two at the most). 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. The appreciable change at 1. and the drop at 2 are thus easily noticeable. The net conclusion is that we are operating completely ALARA as far as public exposure potential is concerned.

Section 8.
Radiation Exposure to Personnel.

UCI issues TLD badges to students or researchers utilizing radiation. Finger dosimetry (TLD) rings are also issued to all personnel 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 read quarterly by Radiation Detection Company, and results are presented in Table V.

Twelve (10) persons were issued monitors and finger dosimeters on a continual basis. 49 students and 3 teaching assistants in a radiochemistry class were also issued TLD monitors.

Visiting individuals are issued with direct-reading dosimeters. **A change from earlier years is the use of Canary II digital monitor instruments that record in units of 0.01 mR in place of the analog pocket dosimeters. Much lower exposure information is now available. Background levels during a tour visit typically accumulates 0.04-0.06 mR during a 45 minute visit to the facility. In the past this was recorded as "0", so it will continue to be referred to in that way. Any reading of 0.10 or above will be tabulated.** In the past only readings in excess of 1 mR would have been noted. Personnel included in this group were individuals working on facility general maintenance. All work was done with the reactor shut down, and no readings >0.10 were found.

TABLE V.
Personnel Exposure Report Summary for 4/1/00 to 3/31/01 (in mrem)

Individuals	Whole Body Deep	Whole Body Shallow	Finger Ring Shallow
1[1]	105	105	460
1[2]	30	30	50
1[3]	0	0	60
1[4]	35	35	0
1[4]	25	25	0
1[4]	20	20	0
1[4]	15	15	0
2[4]	10	10	0
3	0	0	0
1[5]	20	20	0
22[5]	15	15	0
2[5]	10	10	0
Totals 60	240	240	570

(620 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. This individual does occasional activation analysis work on meteorites at the facility.
3. Some extremity exposure from handling high activity (1 curie level) samples for delivery to reactor customers.
4. These exposures were from a combination of handling low level isotopes during calibrations and source movements adjacent to the badge storage area. This is concluded since one of the badged individuals with recorded exposures did not visit the facility during the monitoring period.
5. 549 were students in a 1 quarter class, plus 2 teaching assistants).

Aggregated non-zero data from self-reading dosimeters used by researchers in addition to TLD badges are:

	Person-days	Day accumulation
	1	12.1
	7	11.1
Summations	8	23.2

As noted earlier, 394 visitors were also monitored using self-reading digital dosimeters (individuals or 3 per group when in a group). No readings >0.10 mrem were recorded for these tour events.