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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 2002 through June 30th 2003.

Sincerely,

George 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 2002 to June 30th 2003

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 2003 was 32 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. No support was obtained from the Reactor Sharing program for this year. Support was granted for instrumentation upgrade from the URI program of the US Department of Energy. A new analyzer system has been purchased for gamma ray spectrometry use with funding granted for 2003-2004 for a new HPGe detector to complete the system. Upgrades have been made to security system computer hardware, and camera surveillance systems are shortly to be installed as part of security compensatory measures.

Operations have been at a low to modest level, very similar to last year. Criticality was achieved for 87 hours, and the total energy generated was equivalent to 47 hours at full steady state power. 82 experiments were performed, and over 1500 samples were irradiated (sometimes multiple samples are included in a single capsule and are not separately logged). Only 5 low-level isotope shipments were made (Yellow II category or less). No pulse operations have been performed, even for test purposes.

The replacement rod drives installed last year have been performing satisfactorily, and the new fuel temperature monitoring circuitry has also performed well.

An NRC inspection was carried out during September (16^{th} -19^{th}). Problems were identified with shipping records and procedures, which have now been corrected. Security issues were discussed during an NRC visit in June, 2003.

A complete core fuel measurement was accomplished without incident in November 2002, according to a 5-year interval requirement. No fuel elements or control rods were identified as exceeding bend or length growth restrictions.

Monthly inspections are now routine from the EH&S Office at UCI. No significant safety or maintenance problems were encountered during this reporting period, except for continuing false alarms from the security system. This was replaced with new computer hardware and software which has dramatically reduced the false alarm rate.

Two trainee operators have commenced operations under supervision during this period. The facility has two licensed senior operators currently active. One additional trainee operated during July 2002 but returned to Cornell University after that month.

Section 2. Data Tabulations for the Period July 1st, 2002 to June 30th, 2003

TABLE I.

Experiment Approvals on file	8
Experiments performed (including repeats)	82
Samples irradiated	1576+
Energy generated this period (Megawatt hours)	11.8
Total, 69 element core = 127.0	
>74 element core = 1244.3	
Total energy generated since initial criticality	1371.3 Mwh
Pulse operation this period	0
Total pulses to 6/30/03	978
Hours critical this period	86.8
Total hours critical to date	7890.8
Inadvertent scrams or unplanned shutdowns	x
Visitors to reactor - as individuals or in tour groups – reduced after 9/11/01	272
Maximum dosimeter recorded for visitors - all less than	1 mrem
Visiting researchers (dosimeter issues)	3
Maximum dose recorded at one visit	12.5 mrem
Visiting researchers (badged)	4

TABLE II

Reactor Status 6/30/03 (no change since 6/30/02).

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			$2.61
Control rod worths (11/11/02)	REG	$2.76	
(after core fuel measurement)	SHIM	$3.52	
	ATR	$1.74	
	FTR	$0.67	
	Total:	$8.69	
Maximum possible pulse insertion			$2.41
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
2002			
7/25	~13:00		FTR fails to fire up. Rod apparently OK, so a circuit problem. Operations continued as FTR is NOT required to be removed as a safety feature.
7/25	13:16	245 kw	%Power scram at 98% of 250 kw – level lowered by rod shadowing sue to operation with FTR in core (see above).
8/07	14:15		FTR problem finally diagnosed as contact problem on console wafer key switch. Switch contacts moved to newer wafer. Now OK.
10/29	11:10	250 kw	Scram for unknown cause during trainee operation – electronic problem, no other signs of concern. Operation restarted.
12/03	09:55	250 kw	Linear scram at 104% of 250 kw. All other measures at 100% or less. Apparently due to cooling water movements around CIC chamber.
2003			
2/12	15:09	~2.5 w	Period scram during trainee start-up operation.

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.

2002

10/15	RMS unit number 4 returned from repair and reinstalled (transformer replacement). All 6 units now in operation
11/07-10	Core fuel elements unloaded, measured for bend (go-nogo) and length and returned to core. FFCR's measured, ATR removed from pool and inspected. (FTR was removed and inspected during maintenance on 3/22/02). Rod drop times verified.
11/11	Control rods calibrated.
11/12	Power calibration performed.
12/28-1/10/03	Security computer hardware revised. Change to new software on 1/10/03. Frequency of false alarms much reduced.

2003

1/11	Software revised to update reporting modes even when authorized person present.
2/22	Facility inspected following Big Bear earthquake (5.2 Richter) at 04:20. No sign of any disturbance, scram not tripped.

3/17-3/21	Minor additional physical security changes made in response to higher level (orange) national security alert declaration. Also visits and tours cancelled, card access restricted to three individuals.
6/05	RMS units (6) calibrated.
6/15	Sample carrier failed in pneumatic transfer system. Terminus temporarily removed from core in order to retrieve sample after other techniques failed. Terminus reinstalled and tested OK. Radiation level of terminus only 5 mr/hr at 1 foot at hottest point during removal.

Section 5
Facility Changes and Special Experiments Approved

Facility changes made include those referenced under maintenance. Formal approval was granted (under 10CFR 50.59) for replacement of security system computer hardware (sensor systems were not replaced or changed). Functions are equal or better than in original plan so no plan changes made.

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 (7/1/02-6/30/03):

a. Minutes of operation:	241 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) =	1.7×10^{3} microcuries

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

a. Total hours of operation at power (Mwh x 4) =	47.1 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)	$= 3.4 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 5.1 \times 10^{3}$ 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) $= < 1 \times 10^{-10}$ microcuries/mL
Since 20×10^{-10} microcuries/mL provides an annual exposure for constant immersion of 10 mrem, this corresponds to < 0.5 mrem potential additional radiation exposure to an individual standing breathing in the effluent stack for the entire year.

This is slightly less than 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 few shipments are being made from campus, decay to negligible levels occurs for all medium-lived radionuclides. Teaching course items (used for training in liquid scintillation counting techniques) may be a mixture of reactor generated and purchased materials.

DRY WASTES:
11/05/02 4 ft^3 dry waste containing approximately 2 microcuries of mixed activation products (including ^{60}Co and shorter-lived products) from irradiation experiments.

LIQUIDS:

None during 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.

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 (inside building).
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.

TABLE IV.
Environmental Dosimetry Data. 2002-2003

Average Total Exposures in mrem (including "control background")

Location.	Quarter 2/02	3/02	4/02	1/03	Annual Total 2002/3	Prior year Total 2001/2	Ratio 2003/2002
1. S. Facility perimeter	25	15	22	35	97*	125*	0.8
2. W. Facility perimeter	12	8	10	9	39	39	1.0
3. N Facility perimeter	13	8	13	11	45	46	1.0
4. Lab Room over facility	10	7	12	10	39	32	1.2
5. Facility main air exhaust	8	5	7	6	26	23	1.1
6. Bio. Sci II top floor	10	6	11	9	36	29	1.2
7. Library top floor	21	13	21	16	71	70	1.0
8. Computer Sci. top floor	7	5	8	6	26	22	1.2
9. Facility fume hood exh.	10	6	11	9	36	29	1.2
10. Faculty housing	5	4	7	5	21	12	1.8
Background RDC control	18	17	17	20	72	82	0.9

* increased exposure since 1999 due to relocation of stored Cf-252 source closer to this sensor.

Discussion

Raw data is presented here, with no attempt to compute an average local "background" since the data vary significantly.

Data for this year reflects three issues:

- some raw results have "stabilized over the previous year, while some have continued to increase, by small factors, especially the "controls" far removed from the facility. A presumption is that data processing has increased sensitivity or some recalibration has occurred; there is no explanation based on facility operations.
- experimental work has been conducted using a modest sized Cf-252 source which along with a large Cs-137 source is stored within the facility relatively close to Location 1, raising its level slightly over other areas.
- all but one area are below RDC estimated "control" background level.

Exposure estimate probability to a single individual in an uncontrolled area at this facility is still very minimal. Locations 1 and 2 are in or near hallways with minimal occupancy or travel. Location 3 is on an outside loading dock also with low occupancy. The laboratory overhead (location 4) is occupied by very few individuals (one or two at the most) with instruments in the space above the reactor core. Office space is far removed from the area immediately over the reactor. 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 had shown remarkable consistency. These global increases are interesting and it will be seen if they continue. The net conclusion is that compared to control areas (numbers 7 and 10) we are operating fully ALARA as far as public exposure potential is concerned.

Section 8.
Radiation Exposure to Personnel.

UCI issues TLD badges to most students or researchers utilizing radiation. Finger dosimetry (TLD) rings are also issued to personnel who might be regularly handling isotopes. 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.

9 persons were issued dosimeters on a continual basis; 7 were also issued with finger dosimeters (TLD). Up to 10 mrem in a quarter are randomly reported for TLD badges never exposed within the facility. 32 students and 3 teaching assistants in a radiochemistry class were also issued TLD monitors. Most, but not all reports from those badges were available for this report.

Visiting individuals and tour groups are issued with direct-reading Canary II digital monitor instruments that record in units of 0.01 mR so low exposure information is 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. Data for the second quarter 2003 were not available as of this report, so these reflect only 9 months of operations.

TABLE V.

Personnel Exposure Report Summary for 6/30/02 to 3/30/03 (in mrem)

	Individuals	Whole Body TEDE	Whole Body TODE	Finger Ring (Shallow)
	1[1]	40	40	120
	8	0	0	(6 persons) 0
	18[2]	10	10	-
	12[2]	0	0	-
Totals	39	220	220	120
		(5.6 person-mrem average)		

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. Students in radiochemistry class Jan-March 2003.

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

	Persons	accumulation
	1	12.5
	3	2.88
Summation	4	15.38 (3.8 person mrem average)

As noted earlier, 196 visitors were monitored using self-reading digital dosimeters (individuals or 3 or more per group when in a group). No readings >0.10 mrem were recorded for these tour events.

Personnel exposures continue to be very low at this facility in keeping with ALARA efforts.