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July 24, 2006

US 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 2005 through June 30th 2006.

Sincerely,

George E. Miller
Reactor Supervisor

G. E. Miller

cc: American Nuclear Insurance, 95 Glastonbury Blvd, Glastonbury CT 06033,
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Dean of Physical Sciences, John Hemminger

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U. C. IRVINE

Nuclear Reactor Facility

Annual Report

for

July 1st 2005 to June 30th 2006

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 regarding application of radioisotopes and radiochemical techniques 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 2006 was 38 students.
Use is also 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, but some support was available from participation in Western Nuclear Science Alliance (WNSA) since September 2004. Support was granted for instrumentation upgrade from the URI program of the US Department of Energy for a Compton Suppression Gamma Spectrometer System to be assembled from the grant, existing equipment and loan equipment. Upgrades have been made to security system hardware, including camera surveillance systems as part of a continued program of security compensatory measures, using UCI funding.

Operations have been maintained similar to last year. Criticality was achieved for 99 hours, and the total energy generated was equivalent to 60 hours at full steady state power. 71 experiments were performed, and nearly 1700 samples were irradiated (sometimes multiple samples are included in a single capsule and are not always separately logged). 18 low-moderate level isotope shipments were made (Yellow II category or less). No pulse operations have been performed, even for test purposes.

An NRC general inspection was carried out during November 2005 (15^{th} -18^{th}).
A follow up item concerns the lack of an Operator Requalification program now that only one operator is at the facility. Former Senior Operator, Dr. Pat Rogers last operated on May 20^{th} 2005.

A local, California, Homeland Security review was conducted on June 29^{th}, 2006. So far no recommendations or criticisms have been forthcoming regarding security arrangements.

Monthly inspections continue to be routine from the EH&S Office at UCI. These continue to identify log entries that are not fully explained and apparent lack documentation of follow-up on identified items noted. No significant safety or maintenance problems were encountered during this reporting period.

Two trainee operator continued to practice operations under supervision during this period. One left for graduate school in San Diego in September, 2005, the other, an EH&S employee, left UCI employment on June 30^{th} 2006 for a State of California position.

Section 2. Data Tabulations for the Period July 1st, 2004 to June 30th, 2005

TABLE I.

Experiment Approvals on file	8
Experiments performed (including repeats)	71
Samples irradiated	1685+
Energy generated this period (Megawatt hours)	14.9
Total, 69 element core = 127.0	
>74 element core = 1292.5	
Total energy generated since initial criticality	1419.5 Mwh
Pulse operation this period	0
Total reactor pulses to 6/30/06	978
Hours critical this period	95.2
Total hours critical to date	8189.1
Inadvertent scrams or unplanned shutdowns	3
Visitors to reactor - as individuals or in tour groups –	293
Maximum dosimeter recorded for visitors - all less than	1 mrem
Visiting researchers (dosimeter issues)	99
Maximum exposure recorded at one visit	2.89 mrem
Visiting researchers (badged)	4

TABLE II

Reactor Status 6/30/05 (unchanged from 6/30/04)

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		34
Graphite reflector elements in reactor tank storage		0
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 (as of 6/28/2006)		$2.65
Control rod worths (calibrated 1/13/05)	REG	$2.83
	SHIM	$3.60
	ATR	$1.77
	FTR	$0.66
	Total:	$8.86
Maximum possible pulse insertion		$2.43
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
2005			
7/28	10:05	ca 7.5 kw	Linear Power scram during power increase to 250 kw. Auto range changing failed to initiate. Cause unknown, not reproduced, no recurrence.
2006			
2/28	9:43	250 kw	High voltage failure scram. No identifiable origin. Not reproducible. No recurrence.
5/19	9:31	250 kw	Linear Power scram @ 105%. Log reads 95%, %P reads 100%. Probably cooling water surge increased power indication while not closely observed. Restarted to slightly lower power margin.

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.

2005

July 14: Wide Range Linear Monitor Isolation amplifier output stage was rebuilt with new electrolytic capacitors and re-installed to perform to original specifications.

July 12-14: sensor upgrades made to security reporting system. Checks performed on all systems demonstrated satisfactory reporting performance.

November 4th. micro-actuator switch replaced with a new one on RSR (Lazy Susan) "auto" rotate mechanism. The old arm fractured on Oct 26th.

December 25th: CAM hi alarm received – indicated 40% DAC "spike". Filter showed no abnormality on gamma counting (nothing above background). Concluded it was electronic problem – no recurrence found. However may have been related to problem on Jan 9th 2006 (below)

2006

January 9: CAM failure alarm reported – low flow rate observed. Replaced filter and reset.

January 21: recurrence of CAM low flow incident. Filter replaced and device OK. However air pump is probably failing to maintain good flow. The frequency of new filter installation was increased to compensate.

January 26: seismic scram found to have tripped (reactor not operating) as a result of construction/deconstruction work on outside of adjacent wall.

March 29: key locks replaced during entire building re-key. New keys issued to authorized persons.

May 13: CAM low air flow again. Installed new air pump to fix problem. Flow increased from ca. 24 to ca 45 L/min.

June 15: construction/deconstruction work loosened plaster on ceiling in rear lab. Did not affect system ability to maintain negative facility pressure. Plans set for repair by patch using steel plate to secure.

Jun 21st: power dip to RH building (and campus) caused motion alarm to be sent. Facility inspected and alarm reset.

Section 5

Facility Changes and Special Experiments Approved

All changes in security systems resulted in increased incident response capability.
No special or unusual experiments 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 (7/1/05-6/30/06):

a. Minutes of operation:	335 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) =	2.4×10^{3} microcuries

(2) Release from pool surface (7/1/05-6/30/06):

a. Total hours of operation at power (Mwh x 4) =	59.6 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)	$= 4.3 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 6.7 \times 10^{3}$ microcuries**

e. Total effluent released in 1 year (525960 minutes/yr. x c) = 6.3×10^{13} mL

Concentration averaged over 12 months (d/e) $= \sim 1.1 \times 10^{-10}$ 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 similar to values reported in previous years and assumes no dilution of the plume at or beyond the stack. It also assumes all PT operation is at full 250 kw power.

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). Disposals to this custody 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 byproducts and purchased materials (exclusively ^{14}C and ^{3}H).

DRY WASTES:
9/7/05 2 ft^3 dry waste containing less than 100 microcuries of mixed activation products (including ^{60}Co and shorter-lived products) from irradiation experiments.
02/23/06 2 ft^3 dry waste containing less than 100 microcuries of mixed activation products (including ^{60}Co, shorter-lived products, and some purchased ^{3}H and ^{14}C) from irradiation experiments.

LIQUIDS:
02/27/06 1.5 gallons LSC waste (in water) est: 20 microcuries ^{3}H and 10 microcuries ^{14}C.

Section 7.
Environmental Surveillance.

Calcium Sulfate/Dysprosium thermoluminescent dosimeters have been placed at nine locations around the UCI Campus for many years. Starting July 1 2004, the is provided by Global Dosimetry Solutions (GDS), Costa Mesa, California. The GDS packs have three chips in each pack which are averaged for exposure recording. 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. Trash is surveyed before disposal and not disposed unless 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).

*location moved inside the wall of the facility as of January 2006.

TABLE IV.

Environmental Dosimetry Data.
2004-2005

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

Location.	Quarter				Annual	Prior year	Excess over control (05-6)
	2/05	3/05	4/05	1/06	Total 2005/6	Totals 2004/5	mr
1. S. Facility perimeter	41	40	30	45	156	182*	53
2. W. Facility perimeter	26	24	21	28	99	102	-4
3. N Facility perimeter	27	24	22	xx	73	107	(-13) 3 q only
4. Lab Room over facility	25	22	22	27	96	99	-7
5. Facility main air exhaust	25	21	19	25	90	96	-13
6. Bio. Sci II top floor	26	24	21	27	98	101	-5
7. Library top floor	31	30	31	34	126	127	23
8. Computer Sci. top floor	20	20	19	21	80	87	-23
9. Facility fume hood exh.	22	24	21	25	92	96	-11
10. Faculty housing	20	19	19	22	80	83	-23
Background control	29	23	25	26	103	105	0

* exposure due to proximity of Cs-137 irradiator and stored Cf-252 source.
xx item destroyed during deconstruction work outside building

Discussion
Raw data is presented here, along with control comparisons. Within this range, the data vary significantly.
Data for this year reflects two issues:

- all but the location 1 and 7 are within control background level.
- Location 1 is a hallway with an extremely low occupancy rate. (See additional note below), location 7 is remote at the top of a 5 story building which must have a low absorbing roof?

Exposure estimated 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 extremely minimal occupancy or travel, especially since recent security changes resulted in permanently locked doors to the hallways on this floor level (access only to individuals with building keys). Location 3 is on an outside loading dock also with low occupancy. The laboratory overhead (location 4) is casually occupied by very few individuals (one or two at the most) in the space above the reactor core. 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 at the top of a 5 story building above a warm, outside, cement wall. The cement may have higher U and Th levels. The roof may have low absorbance. Over many years, the data at each specific location has shown remarkable consistency. The net conclusion is that, compared to distant 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. Dosimeters are read quarterly by Global Dosimetry Solutions, and results are presented in Table V. Reporting categories have changed since last year's report to read DEEP, EYE, and SHALLOW.

6 persons were issued dosimeters on a continual basis; 5 were also issued with finger dosimeters. 38 students and 3 teaching assistants in a radiochemistry class were also issued TLD dosimeters and used "Canary II" direct reporting dosimeters on a regular basis. The latter typically showed only 0.05 mR for background during a 3 hour period in lab exercises. Class badges were kept in the lab for the entire quarter along with small sources used in experiments. Thus class dosimeter values include background as well as the approximately 30 total hours of actual lab work done.

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 0.03-0.05 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. Individuals working on facility general maintenance were also issued Canary II Dosimeters. All work was done with the reactor shut down, and no readings >0.05 were found. Data for the second quarter 2006 were not available as of this report, so these reflect 9 months of operations.

TABLE V.

Personnel Exposure Report Summary for 7/1/05 to 3/30/06 (in mrem)

Individuals	Whole Body			Finger Ring
	DEEP	EYE	SHALLOW	(Shallow)
1[1]	43	106	162	579
1[2]	30	30	30	65
1[2]	0	0	0	32
1[2]	0	0	0	0
1[2]	0	0	0	0
1[3]	0	0	0	not issued
41[4]	0-50	0-50	0-50	not issued
	(assumed 2050 total)	(assumed 2050 total)	(assumed 2050 total)	
Totals	2123	2186	2242	676

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. Individuals receiving exposure as a result of operator/trainee and/or calibrating activities in the facility.
3. Individuals who did NOT ENTER THE FACILITY AT ALL during this period, so badge exposure is an indication of range of general background within the facility, where the badges are stored.
4. Students and teaching assistants in radiochemistry class Jan-March 2004.

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

Persons	Admissions	Accumulation (mrem)
1	7	5.15
1	5	4.18
1	2	6.75
45	45	<0.10
Summation	57	16.18

As noted earlier, 293 visitors were monitored using self-reading digital dosimeters (each individual, or 3-8 dosimeters 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.