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US Nuclear Regulatory Commission
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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 2008 through June 30th 2009.

Sincerely,

G. E. Miller

George E. Miller
Reactor Supervisor

cc: American Nuclear Insurance, 95 Glastonbury Blvd, Glastonbury CT 06033,
Policy NF-176
Dean of Physical Sciences, John Hemminger

Already distributed:

Marcus Voth, US Nuclear Regulatory Commission One White Flint North,
11555 Rockville Pike, Rockville, MD 20852-2738
Reactor Operations Committee Members, UCI

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Nuclear Reactor Facility

Annual Report

for

July 1st, 2008 to June 30th, 2009

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 almost 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 the Winter Quarter 2009 laboratory course in Radioisotope Techniques using the facility was 45 students with 3 graduate teaching assistants, who also learned these techniques.
Use is also made of the facility by other educational institutions, and a modest Nuclear Science Outreach program to middle schools and high schools has been continued. This program has involved tours, class demonstrations, and analyses of samples submitted by faculty. Direct financial grant support has not been available during this period. A seismic upgrade to the building (Rowland Hall) in which the reactor is housed has been completed.

Operations have continued at a steady low rate, slightly above last year's. Criticality was achieved for 88 hours, and the total energy generated was equivalent to 47 hours at full steady state power. 67 separate experiments were performed, and over 1000 samples were irradiated (sometimes multiple samples are included in a single capsule and are not always separately logged). 7 moderate level mixed isotope shipments were made and 1 isotope tracer (^{82}Br) ,all Yellow II category. No pulse operations have been performed, even for test or demonstration purposes.

No unusual maintenance or surveillance activities were conducted during this period.
An NRC general inspection was carried out during December 2008 (2^{nd} -4^{th}). No violatons were noted.
In 2008-9, Reactor Operations Committee meetings were held on August 28^{th} 2008 and January 27^{th} 2009 in accordance with Technical Specification schedule requirements.
No follow-ups or incidents have been forthcoming regarding security or emergency response. An exercise was held March 16^{th}, 2009 for the UCI EH&S emergency response team with debriefing and evaluation and creation of an After Action Report (AAR) designed to improve training as related to response to a laboratory radiation spill event.

Inspections continue to be routinely conducted monthly and quarterly by the Radiation Protection staff of EH&S at UCI. These have identified that new reduced frequency schedules authorized last year have been properly maintained, and results justified the reduced frequencies in the light of the lower level of operations, increased instrument reliability, and the continued finding of absence of significant levels of contamination or personnel exposure.
No operator training was conducted.

Section 2. Data Tabulations for the Period July 1st, 2008 to June 30th, 2009

TABLE I.

Experiment Approvals on file	2
Experiments performed (including repeats)	67
Samples irradiated	1011+
Energy generated this period (Megawatt hours)	11.9
Total, 69 element core = 127.0	
>74 element core = 1327.3	
Total energy generated since initial criticality	1454.3 Mwh
Pulse operation this period	0
Total reactor pulses to 6/30/06	978
Hours critical this period	88.0
Total hours critical to date	8428.5
Inadvertent scrams or unplanned shutdowns or events at power	5
Visitors to reactor - as individuals or in tour groups –	184
Maximum dosimeter recorded for visitors - all less than	1 mrem
Visiting researchers (dosimeter issues)	16
Maximum exposure recorded at one visit	20.3 mrem
Visiting researchers (badged)	2
Students in class badged	48
Exposures reported for quarter (range: 23-37 mrem) average	30 mrem

TABLE II
Reactor Core Status 6/30/09 (unchanged from 6/30/08)

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 6/16/2009)		$2.64
Control rod worths (calibrated 6/01/2009)	REG $2.96	
	SHIM $3.60	
	ATR $1.81	
	FTR $0.70	
	Total: $9.07	
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)		-.^{o}C

Section 3.

Inadvertent Scrams, Unplanned Shutdowns, Events at Power

TABLE III.

Date	Time	Power	Type and Cause
2009			
2/17	16:15	50 kw	Student reported rabbit did not return on time out of pneumatic transfer system. Found shelf support had been improperly inserted in terminus. Reversed this, sample returned and placed in lead pig to decay. Irradiation of further samples continued successfully.
2/18	19:52	248 kw	Linear power scram – REG rod UP switch "hung" during adjustment causing rod to continue to rise. Failure did not repeat, and reactor power restored to 250 kilowatts with no further event.
2/24	13:34	1.5 watts	Excessive noise noted in linear channel during start-up. Cables in rear of unit re-plugged and re-tied. Cured problem.
2/25	16:25	40 kw	Rabbit sample failed to return as end cap of transfer tube broke. Sample retrieved immediately using "sticky" rabbit and operation continued with new transfer tube. Sample and parts of transfer tube were transferred to lead contained for decay (were only <10 mr/hr at surface).
3/4	09:55	2590 kw	Rabbit tube did not return. Use of manual return switch effected return. Sample removed to storage. Transfer valve system lubricated as suspected cause of problem. Continued operation with no subsequent problems.

Section 4

Maintenance and Surveillance

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

2008

July 29th 11:42	5.4 magnitude earthquake in Chino Hills felt by many. Reactor not operating. Facility inspection failed to reveal any noticeable effects. USGS Shake map indicates MM III-IV only at site. Earthquake SCRAM switch was not tripped (MM-V needed).
August 11th 10:36	Building power failure, reactor not operating. Emergency generator operated within 30 seconds to power radiation systems, etc. Power restored by 10:50.
August 21st 15:30	Console power switch failed in ON position. Microswitch responsible was replaced 8/22/08. All functions restored.
November 22-25th	Purification pump removed from service. New pump installed to improve flow in system. Pump is identical model. All functions restored.

2009

January 14,15,16th	Training tours conducted for personnel from three local fire department units (Irvine, Newport Beach, OC Airport).
May 29th	Rod drop times measured prior to rod and power calibrations. All 4 rods within specifications. SHIM, REG, and ATR rods calibrated. REG rod calibrated slightly higher (by 5.7%) than in 2007. Other rods were within 2%.
June 1st	FTR rod calibrated. Total worth for four rods was increased by 1.4% only. Power calibration preformed. Measured power agreed with all channel indications (at 200 kilowatts power) so no adjustments of channels were performed.
June 16th	Failure of Radiation Area monitor (Thermo-Eberline RMSII) station 3 by sudden spike in indicated level. No sign of unusual radiation level on any other station. Diagnosis is GM tube beginning to fail. Replaced with spare unit. All operations check as normal – monitored for over an hour period to be sure of reliability of new unit.

Section 5
Facility Changes and Special Experiments Approved

No changes or special or unusual experiments were requested or 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, considerable 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 below 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 (7/1/08-6/30/09):

a. Minutes of operation:	274 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) =	2.0×10^{3} microcuries

(2) Release from pool surface (7/1/08-6/30/09):

a. Total hours of operation at full power (Mwh x 4) =	48 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)	$= 3.5 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 5.5 \times 10^{3}$ 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) $= \sim< 0.9 \times 10^{-10}$ 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 a little higher than 07/08 owing to increased operations and assumes no dilution of the plume at or beyond the stack. It also conservatively assumes all reactor operation were at 250 kw power, whereas significant operation for student class experiments was at 100 kw or 50 kw power levels.

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 UCI Environmental Health and Safety (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:

One transfer of 1 cubic foot container of dry waste were disposed during this period (7/1/08 through 6/30/09) estimated at a total quantity in 2 cu ft of 0.30 millicuries of mixed activation products (measured as ^{60}Co equivalent at time of transfer).

LIQUIDS:

1 gallon of ^{3}H - containing liquid waste was transferred during this period measured (by LSC) as 0.1 millicuries total, in aqueous solution. This was entirely byproduct (generated by irradiation of LiOH enriched in ^{6}Li). No ^{14}C was disposed or purchased this year.

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, these are 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. GDS also runs multiple control samples. On August 22nd 2007, the locations of these monitors (following ROC discussion and approval) were changed to reflect new building construction at UCI, ease of access for quarterly exchange, and the need to demonstrate absence of effects of reactor use on the campus populations. All dosimeters are now housed in small metal lock-boxes (except for location 10). The table below lists the new locations.

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. Below window of reactor room south wall (outside the facility).
2. In hallway on exterior of west wall of facility (inside building).
3. On exterior (north) wall of reactor room - on loading dock.
4. Rowland Hall, room 156 doorway, (over reactor facility).
5. Exhaust air flow from reactor room, roof level (hung in center of duct).
6. McGaugh Hall, hall doorway to laboratory 5346.
7. Langson library across campus, Room 547 closet exterior door.
8. Reines Hall, Gas cylinder storage door, room 5001.
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.

Environmental Dosimetry Data.
2008-2009

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

Location.	Quarter				Annual	Prior year	Excess(08-09) over control
	2/08	3/08	4/08	1/09	Total 2008/9	Totals 2007/8	mr ANNUAL
1. S. Facility perimeter	22	23	29	27	101	124	-7
2. W. Facility perimeter	23	25	29	29	106	103	-2
3. N Facility perimeter	26	26	33	30	115	121	7
4. Hallway over facility	21	22	27	25	95	97	-13
5. Facility main air exhaust	21	21	23	24	89	97	-19
6. McGaugh Hall top floor	22	22	27	28	99	110	-9
7. Langson Library top floor	26	26	32	31	115	125	7
8. Reines Hall top floor	22	24	28	28	102	101	-6
9. Facility fume hood exh.	21	22	22	24	89	95	-19
10. On-campus housing	19	20	24	26	89	82	-19
Background control (GDS)	23	25	30	30	108	107	0

Discussion

Raw data is presented here, along with controls and prior year comparisons. Within this range, the data vary with significant consistency. Locations 1, 3, and 7 are usually the highest, 10 the lowest. Data for this year reflects several issues:

- all but the location 3 and 7 are less than GDS control background level.
- Location 7 is on top floor of a large building and may experience greater cosmic flux, as well as concrete releases.
- Location 3 is on a heavy concrete wall.
- Location 1 is a hallway with an extremely low occupancy rate. (See additional note below).
- In spite of somewhat increased operations, levels are statistically within range of previous year.

Exposure estimated to a single individual in an uncontrolled area at this facility is still very minimal. Locations 1 and 2 are in or hallways with extremely minimal occupancy or travel, especially since security policy is to maintain permanently locked doors to the hallways on this floor level (access only to individuals with building keys). The rooms overhead (location 4) are 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. Over many years, the data at each specific location has shown remarkable consistency. The net conclusion is that, within precision of measurement, and compared to distant control areas (numbers 7 and 10), we are operating ALARA with very minimal levels (within statistical error of zero) of potential (full 24/7 occupancy) public exposure over normal background levels.

Section 8.
Radiation Exposure to Personnel.

Personnel exposure data are summarized in Table V.

UCI issued TLD badges to UCI students or researchers regularly utilizing radiation. Finger dosimetry (TLD) rings are also issued to personnel who might be regularly handling radioactivity. Dosimeters are read quarterly by Global Dosimetry Solutions, and results are presented in Table Va. Data for the second quarter 2009 were not available as of this report, so these are for 12 months of operations since April 1, 2008. Reporting categories are DEEP, EYE, and SHALLOW. Other individuals visiting or casually working in the facility were issued DOSIMAN/R. Results are shown in Table Vb.

3 persons were issued TLD badges on a continual basis; 2 were also issued with finger TLDs. 45 students and 3 teaching assistants in a Radioisotope Techniques class were TLC badged. Reported exposures fell in a narrow range averaging 30 mrem each person for the quarter.

Table Vb. also lists all visiting individuals that were issued with DOSIMAN/R monitors that record in units of 0.1 mR. A tour visitor accumulates 0.0 or 0.1 mR during a 45 minute visit to the facility. Any reading above 0.1 is tabulated separately.

TABLE Va.

Personnel Exposure Report Summary for 12 months: 4/1/08 to 3/30/09 (in mrem)

Individuals	Whole Body			Finger Ring
	DEEP	EYE	SHALLOW	(Shallow)
1[1]	40	64	84	376
2[2]	23	44	44	131
1[3]	0	0	0	0
Totals	63	108	128	507
48[4]	23-37 (mean 30)	23-37 (mean 30)	23-37 (mean 30)	not issued
class total	1440	1440	1440	-
Totals	1503	1548	1568	507 (2 persons)

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

Persons	Admissions (per person)	Total Accumulation (mrem)
2[1]	6	1.6
1[1]	2	20.6
2[1]	4	0.4
7[1]	7	1.3
48 visitors logged	1 each	0.0 each
117 in tour groups[5]	1 each	0.0 to 0.1 each monitor
Summation (177 persons)	184	23.9 mrem

1. Individuals doing extensive or casual activation analysis and radiochemical work at the facility. Most of the exposure is a result of Cl-38 or Al-28 radioactivity production.
2. Individuals receiving exposure as a result of operator/trainee and/or calibrating activities in the facility.
3. Individual who did NOT ENTER THE FACILITY AT ALL during this period, so ring exposure reported is an indication of range of general background/precision where the badges are stored when not in use.
4. Reported for students and teaching assistants in Radioisotope Techniques class Jan-March 2009. Note badges kept 24/7 in laboratory room. All also ran samples by NAA as well as working with sealed sources.
5. 3-10 dosimeters were issued for tour groups larger than 10 persons. Policy has now been changed to issuing 1 each for groups up to 10 and 10 randomly for larger groups. No readings > 0.1 mrem were recorded.

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