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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 2007 through June 30th 2008.

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:
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Reactor Operations Committee Members, UCI

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Add'l copies have been sent to the PM

U. C. IRVINE

Nuclear Reactor Facility

Annual Report

for

July 1st, 2007 to June 30th, 2008

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 the Winter Quarter 2008 course in Advanced Chemical Analysis was 24 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 several years, but some support was available from participation in Western Nuclear Science Alliance (WNSA) until December 2007. Some interruptions of operations have occurred as a result of an ongoing seismic upgrade to the building (Rowland Hall) in which the reactor is housed. This period these have been relatively minor and have not resulted in suspension of operations for more than a few hours at most.

Operations have continued at a reduced rate. Criticality was achieved for 58 hours, and the total energy generated was equivalent to 35 hours at full steady state power. Only 34 experiments were performed, and 600 samples were irradiated (sometimes multiple samples are included in a single capsule and are not always separately logged). 4 low-moderate level isotope shipments were made (Yellow II category or less). No pulse operations have been performed, even for test or demonstration purposes.

All fuel elements and control rods were removed from core, inspected, and returned in a one-month period ending on November 19th, 2007 in accordance with the 5 year requirements in Technical Specifications. An underwater camera was used to verify the serial numbers of in-core elements.
An NRC general inspection was carried out during December 2007 (4th -6th). An American Nuclear Insurers inspection was conducted March 11th 2008. No errors were found although 2 loss control recommendations and 1 suggestion were made.
In 2007-8, Reactor Operations Committee meetings were held on July 20th 2007 and January 16th 2008 in accordance with Technical Specification schedule requirements.
No follow-ups or incidents have been forthcoming regarding security or emergency response. A drill was held February 11th 2008 in which UCI EH&S Radiation Safety Division conducted a table-top exercise in association with training for their non-radiation specialists in responding and assisting with a 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 former regular schedules have not been maintained during low facility use periods. Adjustments have been made to required frequencies in the light of the reduced level of operations, increased instrument reliability, and the continued finding of absence of significant levels of contamination or personnel exposure.
No operator training is currently being conducted.

Section 2. Data Tabulations for the Period July 1st, 2007 to June 30th, 2008

TABLE I.

Experiment Approvals on file	2
Experiments performed (including repeats)	34
Samples irradiated	603+
Energy generated this period (Megawatt hours)	8.6
Total, 69 element core = 127.0	
>74 element core = 1315.4	
Total energy generated since initial criticality	1442.1 Mwh
Pulse operation this period	0
Total reactor pulses to 6/30/06	978
Hours critical this period	58.2
Total hours critical to date	8340.5
Inadvertent scrams or unplanned shutdowns	2
Visitors to reactor - as individuals or in tour groups –	246
Maximum dosimeter recorded for visitors - all less than	1 mrem
Visiting researchers (dosimeter issues)	58
Maximum exposure recorded at one visit	128 mrem
Visiting researchers (badged)	2

TABLE II

Reactor Status 6/30/07 (unchanged from 6/30/06)

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 6/28/2008)		$2.66
Control rod worths (calibrated 12/15/07)	REG	$2.80
	SHIM	$3.60
	ATR	$1.84
	FTR	$0.69
	Total:	$8.93
Maximum possible pulse insertion		$2.53
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
2007			
10/12	10:26	~1.5w	Cables inadvertently moved in rear of cabinet holding WRLM while restarting security computer for test. Restarted after cables rearranged.
11/06	13:52	~7.5 w	Period scram while raising power after long run, operator watching slow rise, but missed sudden increased from higher than usual power level and xenon in core for start-up to critical.
11/10	subcritical core		17 fuel elements moved from core to storage to reduce excess well below critical with control rods removed. Other elements removed and returned after measurement and ID check. Core reassembled to critical 12/1/07.
2008			
2/11			Start-up not completed – fuel temperature channel failed daily checks. Temp hook-up to old meter and scram system while channel sent for repairs. Channel was returned to service on 2/23/08.

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.

2007

July 20th and 21st	CAM failure alarm received on several occasions. On slow alarm trip no hi level seen. Switched over to back-up unit.
August 7th	HI Rad Alarm inadvertently tripped while personnel were calibrating RMS II area alarms. Police alerted and responded within 5 mins.
August 14th	Building fire alarm (false alarm) and evacuation caused cancellation of scheduled tour.
August 15th	A new pit pump in pit in reactor room was installed at approx 23 feet below floor level. Pumping commenced for about 2 min. each run until "pool reservoir" runs dry. About 2-3 hours lapse time between pumps. Flow rate measured (9/15) to be about 40-50 gallons each "pull".
Nov 10th- Dec 9th	Reactor shut down for 5 year core fuel inspection (noted above).

Dec 8th	During start-up tests found ATR DOWN switch not actuating – repaired broken wire (broken during drive removal to enable rod inspection) on microswitch.
Dec 9th	Rod drop times measured and verified to meet Tech Specs before restart.
Dec 15th	Rod curves measured, power calibration done. All within close agreement to prior values, so no instrumentation adjustments made. Reactor use for experiments recommenced Dec 17th.
2008	
Feb 11th	Fuel Temperature channel found to have failed – would not initiate scram test. Relay failure in test/operate switch over circuit was cause. New improved model relays installed by GA. Instrument returned to service Feb 23rd. Interim measure used former channel with scram meter to allow continued operations.
June 3rd	Alarms tripped on campus-wide power loss. Reactor not in operation. Emergency generator picked up alarm ad monitoring circuits, but with electronic surge sufficient to trip alarms. Power restored after about 1.5 hours.
June 5th	Trip of high radiation alarm at about 5:25 am. No apparent cause discovered. System reset. Possibly related to prior power loss and company restoring former circuits after temporary work-around.
[July 29th]	Not technically in reporting period, but included for completeness: Moderate earthquake rated at 5.4 approx 25 miles distant at 11:42 PDT. CISN shake map shows MM III-IV movement (1% g) at reactor area. Facility not occupied. No sign of any effects upon entry and inspection, and earthquake switch (MM V) not tripped.

Section 5
Facility Changes and Special Experiments Approved

No changes or special or unusual experiments were requested or approved during this period. Note that building seismic upgrade completed during this period does not directly change anything within the facility. Some access or monitoring locations outside the facility have been impacted, and changes made to radiation monitoring and to CCTV camera positions

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 (7/1/07-6/30/08):

a. Minutes of operation:	97 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) =	7.0×10^{2} microcuries

(2) Release from pool surface (7/1/07-6/30/08):

a. Total hours of operation at full power (Mwh x 4) =	35 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)	$= 2.5 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 3.2 \times 10^{3}$ 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) $= \sim 0.5 \times 10^{-10}$ microcuries/mL
Since 20×10^{-10} microcuries/mL provides an annual exposure for constant immersion of 10 mrem, this corresponds to < 0.3 mrem potential additional radiation exposure to an individual standing breathing in the effluent stack for the entire year.

This is lower than values reported in previous years owing to reduced operation schedule and assumes no dilution of the plume at or beyond the stack. It also conservatively assumes all reactor operation is at maximum 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 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:

Two transfers of 2 cubic foot containers of dry waste were disposed during this period (7/1/07 through 6/30/08) estimated at a total quantity in 4 cu ft of 0.10 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 0.01 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, (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.
2007-2008

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

Location.	Quarter				Annual	Prior year	Excess(07-8) over control
	2/07	3/07	4/07	1/08	Total 2007/8	Totals 2006/7	mr ANNUAL
1. S. Facility perimeter	34	31	22	37	124	142	17
2. W. Facility perimeter	24	28	22	29	103	101	-4
3. N Facility perimeter	33	31	23	34	121	195	14
4. Lab Room over facility	24	25	20	28	97	99	-10
5. Facility main air exhaust	24	25	19	29	97	93	-10
6. Bio. Sci II top floor	33	28	20	29	110	93	3
7. Library top floor	33	33	25	34	125	132	18
8. Computer Sci. top floor	22	28	21	30	101	93	-6
9. Facility fume hood exh.	23	26	19	27	95	101	-12
10. Faculty housing	21	22	17	22	82	89	-25
Background control (GDS)	25	27	25	30	107	99	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 always the highest, 10 the lowest. Data for this year reflects two issues:

- all but the location 1, 3 and 7 are within GDS control background level.
- Location 3 is on top[floor of a large building and may experience greater cosmic flux, as well as concrete releases.
- Location 7 is adjacent to a heavy concrete wall.
- Location 1 is a hallway with an extremely low occupancy rate. (See additional note below).

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 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 even after moving from a window to an interior site presumably because it is at the top of a 5 story building whose concrete 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, within precision of measurement, and compared to distant control areas (numbers 7 and 10), we are operating ALARA with very minimal levels (less than 20 mr/year in 2007/2008) of potential (full occupancy) public exposure over normal background levels.

Section 8.
Radiation Exposure to Personnel.

Personnel exposure data are summarized in Table V.

UCI issues TLD badges to most 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 V. Data for the second quarter 2008 were not available as of this report, so these are for 12 months of operations since April 1, 2007. Reporting categories are DEEP, EYE, and SHALLOW. Six individuals casually working on facility fuel surveillance were issued DOSIMAN/R. All work was done with the reactor shut down, and no readings >0.1 were found.

4 persons were issued TLD badges on a continual basis; 3 were also issued with finger TLDs. 22 students and 3 teaching assistants in an advanced chemical analysis class were issued DOSIMAN/R direct reporting dosimeters and these are included in Table V. The latter typically showed only 0.1 mR or less for background during a 3 hour period in lab exercises.

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

TABLE V.

Personnel Exposure Report Summary for 12 months: 4/1/07 to 3/30/08 (in mrem)

Individuals	Whole Body			Finger Ring
	DEEP	EYE	SHALLOW	(Shallow)
1[1]	0	54	93	464
8[2]	0	0	0	0
1[3]	0	0	0	20
3[4]	0.7, 0.4, 0.4	0.7, 0.4, 0.4	0.7, 0.4, 0.4	
22[4]	0.0	0.0	0.0	not issued
	(1.5 assumed total)	(1.5 assumed total)	1.5 assumed total	
Totals (26)	1.5	55.5	94.5	484

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

Persons	Admissions	Accumulation (mrem)
1[1]	4	167
1[1]	2	36
1	2	0.1
43 visitors	1 each	0.0 each
246 in tour groups[5]	1 each	0.0 to 0.1 each monitor
Summation (289 persons)	297	203.2

1. Individuals doing extensive 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. Students and teaching assistants in advanced chemical analysis class Jan-March 2008.
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. No readings > 0.1 mrem were ever recorded for these tour events.

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