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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 2006 through June 30th 2007.

Sincerely,

George E. Miller
Reactor Supervisor

cc: American Nuclear Insurance, 95 Glastonbury Blvd, Glastonbury CT 06033,
Policy NF-176
Marcus Voth, US Nuclear Regulatory Commission One White Flint North,
11555 Rockville Pike, Rockville, MD 20852-2738
Reactor Operations Committee Members, UCI
Dean of Physical Sciences, John Hemminger

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Marcus Voth NRR

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Nuclear Reactor Facility

Annual Report

for

July 1st 2006 to June 30th 2007

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. Final Enrollment in Winter Quarter 2007 was 46 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) from September 2004 -2007. A grant was made 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. This has been completed and is under trials. Operations were made in support of SBIR defense contracts through Mirmar Sensors of Goleta.
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 involved water incursion to the rear laboratory, and to the ground surrounding the reactor pool, and disabling of exhaust ventilation fans. In both cases reactor operations were temporarily suspended until full recovery was experienced.

In spite of interruptions, operations have been only slightly reduced. Criticality was achieved for 93 hours, and the total energy generated was equivalent to 57 hours at full steady state power. 67 experiments were performed, and nearly 1500 samples were irradiated (sometimes multiple samples are included in a single capsule and are not always separately logged). 11 low-moderate level isotope shipments were made (Yellow II category or less). No pulse operations have been performed, even for test purposes.

The last NRC general inspection was carried out during November 2005 (15^{th} -18^{th}).
A follow up item concerned the lack of an Operator Requalification program now that only one operator is at the facility. However, Dr George Miller's SRO license was renewed for six years in September 2006. The part-time HP/operator trainee support person left UCI employment June 30^{th} 2006 and has not been replaced.
In August, 2006, the Reactor Operations Committee recognized it had not met according to required schedule and self-reported to NRC. In 2006, meetings were held on August 22^{nd} and December 20^{th} in accordance with Tech. Spec schedule requirements.
No follow-ups or incidents have been forthcoming regarding security or emergency response. A drill was held March 12^{th} 2007 in which UCI EH&S and UCIPD personnel practiced tracking and community control in a simulated incident involving a partly intercepted stolen isotope source.

Inspections continue to be routinely conducted by the EH&S Office at UCI. These have identified that former regular schedules have not been maintained during low facility use periods.
No trainee operators are currently in place.

Section 2. Data Tabulations for the Period July 1st, 2006 to June 30th, 2007

TABLE I.

Experiment Approvals on file	2
Experiments performed (including repeats)	67
Samples irradiated	1469+
Energy generated this period (Megawatt hours)	14.3
Total, 69 element core = 127.0	
>74 element core = 1306.8	
Total energy generated since initial criticality	1433.7 Mwh
Pulse operation this period	0
Total reactor pulses to 6/30/06	978
Hours critical this period	93.3
Total hours critical to date	8282.3
Inadvertent scrams or unplanned shutdowns	3
Visitors to reactor - as individuals or in tour groups –	109
Maximum dosimeter recorded for visitors - all less than	1 mrem
Visiting researchers (dosimeter issues)	58
Maximum exposure recorded at one visit	3.8 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 6/28/2007)		$2.69
Control rod worths (calibrated 7/9/06)	REG	$2.86
	SHIM	$3.66
	ATR	$1.79
	FTR	$0.67
	Total:	$8.98
Maximum possible pulse insertion		$2.46
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
2006			
7/08	13:41	~2.5w	SHIM rod dropped during rod calibration. ON lamp failure. Lamp replaced and operation continued.
7/21	13:34	250 ± 5% kw	Linear Power scram at 105% during power increase to 250 kw. UP REG rod button stuck on for seconds – other indicators at 95-101% power only. Button plastic filed to assure smoother release. No repeat on restart.
2007			
1/23	17:19	250 kw	Meter indication only 230°C. Electronic origin –possibly reset switch problem. Not reproduced. No recurrence.
2/07	14:38	250 kw	Fuel temperature scram initiated as surveillance measurements with millivoltmeter being made and disturbing terminal connections in rear of console.
2/20	15:21	~2.5 kw	Linear power scram while raising power level. No apparent cause. No repeat effect noted.

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.

2006

August 14: Water incursion following irrigation pipe/valve break into ground below facility and into two storage pits, one containing new fuel. Construction had removed dock allowing greater access. Sump pump had been disconnected. It was reconnected the next day. Water and soil sample collected as water pumped out. Fuel moved to alternate storage. A report sent to NRC.

September 12th. High radiation alarm reported – probably actuated by power glitch from work on building system. Alarm reset.

October 19th. Difficulty securing facility after doors had been opened to permit contract work on loading dock (pour concrete). Once doors fully closed, then security system OK.

October 30th. CAM alarm on low air flow. New filter installed.

November 17th. Area monitor on ceiling tripped. Found no signal output. After trading with another station, found connector at ceiling had not been properly locked closed. This cured problem.

November 20th . During entry found exhaust fan turned OFF. Contractors on roof had disabled power without notification. Power restored within hours, but personnel excluded while exhaust fan off. System operation verified after restart.

2007

During this period work on building seismic upgrade caused fairly frequent inadvertent tripping of alarms, smoke detection systems, etc. often resulting in building evacuation, etc. No "real" hazardous events were encountered.

Feb 13th Campus power failure. Building evacuated. Generator pick-up still tripped CAM alarm. Electric door lock failed to provide entry. Reactor runs suspended until systems restored.

March 12th Alarm systemns deliberately tripped to create an "incident for drill purposes.

Mar 26th Plumbing crew entered to stub off ceiling feeds to floor above no longer needed with reconstruction.

Apr 9th CAM alarm, system suffered low flow and electronic failure. Was restarted and reset.

Apr 12th RAD alarm sounding – no cause apparent. System reset.

Apr 14th Intrusion alarm ("zone motion") for no apparent cause. Possible power momentary interruption, Reset.

Apr 20th – 22nd Facility closure (no operations) on owing to water incursion through back lab ceiling and into ground under floor. Temporary pumping and clean-up initiated.

May 7th Intrusion alarm tripped owing to Campus power failure. No observed problem. System reset.

May 14th – June 11th with no operation until June 20th .Facility closure initiated as ventilation shut down by contractors during roof modifications. One short run was performed under provision of TS 3.6 during this period. Most general surveillance tests not carried out during this period.

Section 5
Facility Changes and Special Experiments Approved

No changes or special or unusual experiments were approved during this period. Note that building seismic upgrade does not directly change anything at the facility. Some access or monitoring locations outside the facility will be impacted.

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 (7/1/06-6/30/07):

a. Minutes of operation:	396 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) =	2.8×10^{3} microcuries

(2) Release from pool surface (7/1/06-6/30/07):

a. Total hours of operation at full power (Mwh x 4) =	57.0 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)	$= 4.1 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 7.0 \times 10^{3}$ 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 conservatively assumes all reactor 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). Those are disposed through the teaching stockroom and not the facility.

DRY WASTES:
No dry waste was disposed during this period (7/1/06 through 6/30/07).

LIQUIDS:
No liquid waste was disposed during this period.

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.

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. *On gas filter of pneumatic sample transfer system in 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 here as of January 2006.

TABLE IV.

Environmental Dosimetry Data.
2006-2007

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

Location.	Quarter				Annual	Prior year	Excess(06-7) over control
	2/06	3/06	4/06	1/07	Total 2006/7	Totals 2005/6	mr
1. S. Facility perimeter	36	35	36	35	142	156	43
2. W. Facility perimeter	25	26	24	26	101	99	2
3. N Facility perimeter	57	37	59	42	195	73	96
4. Lab Room over facility	26	26	24	23	99	96	0
5. Facility main air exhaust	24	23	22	24	93	90	-6
6. Bio. Sci II top floor	26	25	23	19	93	98	-6
7. Library top floor	33	32	32	35	132	126	33
8. Computer Sci. top floor	24	23	22	24	93	80	-6
9. Facility fume hood exh.	26	27	24	24	101	92	2
10. Faculty housing	23	23	21	22	89	80	-10
Background control	26	24	23	26	99	103	0

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, 3 and 7 are within control background level.
- Location 3 was moved inside the facility at the beginning of this time period, near the pneumatic transfer system and the detector used for all sample measurements. Thus it picks up exposure from movement of all experimental samples on their way to be counted.
- 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). 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 except when location changes have been made. 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 radioactivity. Dosimeters are read quarterly by Global Dosimetry Solutions, and results are presented in Table V. Reporting categories are DEEP, EYE, and SHALLOW.

4 persons were issued TLD on a continual basis; 3 were also issued with finger TLDs. 47 students and 3 teaching assistants in a radiochemistry class were issued TLD dosimeters and also used DOSIMAN/R direct reporting dosimeters. The latter typically showed only 0.1 mR for background during a 3 hour period in lab exercises. One TLD issued to a non-participating student was used as a control.

Visiting individuals and tour groups 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. In the past this was recorded as "0", so it will continue to be referred to in that way. Any reading above 0.1 will be tabulated. In the past only readings in excess of 1 mR would have been noted. Individuals working on facility general maintenance were issued DOSIMAN/R. All work was done with the reactor shut down, and no readings >0.1 were found. Data for the second quarter 2007 were not available as of this report, so these reflect 12 months of operations since April 1, 2006.

TABLE V.

Personnel Exposure Report Summary for 12 months: 4/1/06 to 3/30/07 (in mrem)

Individuals	Whole Body			Finger Ring
	DEEP	EYE	SHALLOW	(Shallow)
1[1]	40	146	239	492
1[2]	0	0	0	33
1[2]	0	0	0	0
1[3]	0	0	0	not issued
1[4]	33	33	33	
50[4]	-4 to +7	-4 to +7	-4 to +7	not issued
	(assumed 200 total)	(assumed 200 total)	(assumed 200 total)	
Totals	273	379	472	525

1. This individual does 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 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 2007. **One individual used as control who did not participate in class.**

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

Persons	Admissions	Accumulation (mrem)
1	8	8.38
4	2	0.58
1	2	0.96
50[4]	150 (3 each)	<0.10
Summation	162	10.02

As noted earlier, 109 additional 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.