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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 and Gentlemen:

Please find enclosed three (3) copies of the annual report for the UCI Nuclear Reactor Facility, covering the period July 1st 2009 through June 30th 2010.

Sincerely,

George E. Miller

George E. Miller
Reactor Supervisor

cc: American Nuclear Insurance, 95 Glastonbury Blvd, Glastonbury CT 06033, Policy NF-176
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Additional copies sent to PM

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Nuclear Reactor Facility

Annual Report

for

July 1st, 2009 to June 30th, 2010

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 UCI research and education programs in the Department of Chemistry (CHEM) and the Department of Chemical Engineering and Material Science (ChEMS). Research is being conducted in application of radioisotopes as tracers and radiochemical analytical techniques. A new addition is a research program in nuclear waste separations (ChEMS).

Reactor utilization, apart from operator training and maintenance, is mostly for analytical sample irradiation, but also for production of isotopic tracers. Analysis samples come from diverse origins related to forensic science, fossil fuels, geochemistry, art, and archaeological studies, chemical separations, 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 Fall Quarter 2009 laboratory course in Radioisotope Techniques using the facility was 30 students with 2 graduate teaching assistants, who also learned these techniques.

Use is also made of the facility by other educational institutions, both for research and for visits/tours A modest Nuclear Science Outreach program using UCI students to present talks and a laboratory to middle and high school classes has been continued. This program has also involved tours, class demonstrations, and analyses of samples submitted by faculty. In this period it received no direct financial support.

A grant from the Department of Energy was awarded to enable refurbishment of some auxiliary equipment (Compton suppression counting and delayed neutron assay system).

Operations have continued at an increased level significantly 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. No unusual maintenance or surveillance activities were conducted during this period.

An NRC general inspection was carried out during October 2009 (26th - 28th). No violations were noted. In 2009-10, Reactor Operations Committee meetings were held on August 10th 2009 and January 21st 2010 in accordance with Technical Specification schedule requirements.

No follow-ups or incidents have been forthcoming regarding security or emergency response. An exercise/training was held March 16th, 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 low level of operations, increased instrument reliability, and the continued finding of absence of significant levels of contamination or personnel exposure.

Operator training was commenced for four individuals, this is expected to culminate in a license examination in late 2010.

Section 2. Data Tabulations for the Period July 1st, 2009 to June 30th, 2010

TABLE I.

Experiment Approvals on file	2
Experiments performed (including repeats)	78
Samples irradiated	1538+
Energy generated this period (Megawatt hours)	24.6
Total, 69 element core = 127.0	
>74 element core = 1351.9	
Total energy generated since initial criticality	1478.9 Mwh
Pulse operation this period	0
Total reactor pulses to 6/30/10	978
Hours critical this period	136.5
Total hours critical to date	8565.0
Inadvertent scrams or unplanned shutdowns or events at power	4
Visitors to reactor - as individuals or in tour groups –	336
Maximum dosimeter recorded for visitors - all less than	0.2 mrem
Visiting researchers (dosimeter issues)	10
Maximum exposure recorded at one visit	645 mrem
Visiting researchers (badged)	2
Students and teaching assistants in class, badged	32
Exposures reported for quarter (range: 0-17 mrem) average	14 mrem
Isotope Shipments this period (5 mixed act'n products = 7.8 millicuries total; 5 x ^{24}Na = 1.72 curies total)	10

TABLE II
Reactor Core Status 6/30/10 (unchanged from 6/30/09)

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 6/16/2010)			$2.62
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 (calculated)			$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			
11/04	15:01	250 kw	Period scram caused by a file being opened on the console to check rod value hitting a test button on the Wide Range Monitor channel. System restarted, power restored.
2010			
2/05	08:14	0 kw	Linear power scram while attempting start-up. Auto ranging didn't switch up at 2.5 milliwatts. Restarted, same event. However further attempts to repeat did not result in any failures. Continued with normal operations, but seems abnormally noisy at very low powers.
3/02	10:38	milliwatts	Excessive noise noted in linear channel during start-up. Noticed that compensation voltage (CV) readings on CIC detector were not steady. Contacted manufacturer who indicated problem with CV power supply. New one obtained and installed – cures problem. Probably this explains behavior on 2/05. (Note not a safety issue, CV not required for safety!)
5/14	21:11	250 kw	Linear Power scram @ 105%, no obvious cause – sudden apparent electronic "spike" other channels did not show. Control rods in unusual positions during very long run (about 12 hours after start) may have influenced on movement in water swirl? Restarted, no further problems.

Section 4

Maintenance and Surveillance and Other Incidents

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.

2009

August 10th 09:00	1 sample vial came open inside a rabbit tube and spilled some irradiated rock powder on the bench when opened. Reactor not shut down. Spill cleaned up and checked with survey meter. Wipe materials to rad. waste. Operation continued.
August 19th 10:31	Building power failure, reactor not operating. Emergency generator operated within 5-10 seconds to power radiation systems, etc. Power restored at 10:48 but failed again at 10:53 restored by about 11:02.
September 8th	New pool temperature meter installed in console replacing old one. Same probe used. Readings same but to 1 more decimal.
December 4th	New pool level sensor (float) and meter installed for testing purposes. Function and level response measured – no safety function initiated as yet.

2010

January 6th	Power Range Monitor serviced to repair power adjust potentiometer mounting (level not changed). Lowered trip level to approximately 106% give more clearance below 110% on high power scram.
February 19th 8:15	Fire alarm for building as a result of contractor work. Reactor not operating. Evacuation complete. Building reoccupied within 20 minutes
March 9th	Installed new right hand control console panel to accommodate existing fuel temperature unit (NFT 1000), new pool temperature meter, new pool level meter and new magnet power supply with voltage and current meters (authorized in 1995!). No reactor functions affected, now all indicators active.

Section 5

Facility Changes and Special Experiments Approved

(1) A new magnet power supply and associated voltage and current displays on each magnet (REG and SHIM rods) approved in 1995 were installed this year. It was a direct replacement for prior power supply unit (1968), but added meters to indicate magnet currents (2) and voltage (1). Power supply was adjusted to provide same output (-48 volts) and currents (170 milliamps) as previously.

(2) Approved and implemented were changes to the right hand control console panel arrangement to accommodate above meters and the fuel temperature channel (NFT1000), a replacement pool temperature meter, and a new pool level monitoring device.

No special or unusual experiments were approved or carried out.

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 (7/1/09-6/30/10):

a. Minutes of operation:	283 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 (7/1/09-6/30/10):

a. Total hours of operation at full power (Mwh x 4) =	98.5 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)	$= 7.1 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 9.1 \times 10^{3}$ 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) $= \sim< 1.4 \times 10^{-10}$ microcuries/mL
Since 20×10^{-10} microcuries/mL provides an annual exposure for constant immersion of 10 mrem, this corresponds to < 0.7 mrem potential additional radiation exposure to an individual standing breathing in the effluent stack for the entire year.

This is a higher than 08/09 owing to increased operations but still 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:

Two transfer of 2 cubic foot container of dry waste were disposed during this period (7/1/09 through 6/30/10) estimated at a total quantity in 4 cu ft of 0.20 millicuries of mixed activation products (measured as ^{60}Co equivalent at time of transfer).

LIQUIDS:

1.5 gallon of ^{3}H - containing liquid waste was transferred during this period measured (by LSC) as 0.03 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. All dosimeters are housed in small metal lock-boxes (except for location 10). The table below lists the locations as of 2007.

Routine 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(09-10) over control
	2/09	3/09	4/09	1/10	Total 2009/10	Totals 2008/9	mr ANNUAL
1. S. Facility perimeter	27	37	30	34	128	101	9
2. W. Facility perimeter	24	30	27	24	105	106	-14
3. N Facility perimeter	30	36	31	26	123	115	4
4. Hallway over facility	24	31	26	22	103	95	-16
5. Facility main air exhaust	22	29	26	21	98	89	-21
6. McGaugh Hall top floor	24	29	27	21	101	99	-18
7. Langson Library top floor	31	38	33	28	130	115	11
8. Reines Hall top floor	24	35	29	25	113	102	-6
9. Facility fume hood exh.	23	31	25	22	101	89	-18
10. On-campus housing	24	30	24	21	99	89	-20
Background control (GDS)	28	34	30	27	119	108	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 1, 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 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 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 radioactive sources. TLD's are read quarterly by Global Dosimetry Solutions, and results are presented in Table Va. Data are for 4 quarters of operations since April 1, 2009. Reporting categories are DEEP, EYE, and SHALLOW. Other individuals visiting or casually working in the facility were issued DOSIMAN/R for which results are shown in Table Vb. 3 persons were issued TLD badges on a continual basis; 2 were also issued with finger TLDs. 30 students and 2 teaching assistants in a Radioisotope Techniques class were TLC badged. Reported exposures fell in a narrow range averaging 9 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. In the course of a few hours, a worker can accumulate 0.2 mr. A tour visitor accumulates 0.0 or 0.1 mR during a 45 minute visit to the facility. Any reading above 0.2 is thus 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]	20	35	45	131
2[2]	115	172	240	305
1[3]	0	0	0	-
Totals	135	207	285	436
32[4]	Range 0-17 (mean 9)	Range 0-17 (mean 9)	Range 0-17 (mean 9)	not issued
class total	280	280	280	-
Totals	415	487	565	436 (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)
1[1]	5	47.3
1[1]	4	[6]645.2
2[1]	1	1.5
104 other visitors logged	(1 each)	2.2
232 in tour groups[5]	1 each	0.0 to 0.1 each monitor
Summation (340 persons)	346	696.2 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 shipping isotopes, and/or calibration activities in the facility.
3. Individual who did enter but not carry out radiation related activities during this period, so any 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 Sept-Dec 2009. Note badges kept 24/7 in laboratory room. All also ran samples by NAA as well as working with sealed sources.
5. Issuing 1 dosimeter each for groups up to 10 and 10 randomly for larger groups. No readings > 0.1 mrem were recorded.
6. One individual accidently placed samples next to dosimeter by chest as transferring to shipping container.

Personnel exposures continue to be very low at this facility in keeping with ALARA efforts but for one incident (note 6 above) – researcher was reprimanded and was reminded of proper procedures.