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US Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555-0001

Re: Docket 50-326; License R-116
Annual Report Submittal, Tech Spec 6.7f

Gentlemen:

Please find enclosed three (3) copies of a revised annual report for the UCI Nuclear Reactor Facility, covering the period July 1st 2010 through June 30th 2011. We regret that this report included some minor errors when first submitted. Please discard all former copies and replace with these new ones. Thank you.

Sincerely,

G. E. Miller

George E. Miller
Reactor Supervisor

Cc.,w/enc (*electronic copies)
American Nuclear Insurance, 95 Glastonbury Blvd, Glastonbury CT 06033,
Policy NF-176
Dean of Physical Sciences, Ken Janda
*Greg Schoenebeck, US Nuclear Regulatory Commission
*Spiros Traiforos, Project Manager,
US Nuclear Regulatory Commission
*Reactor Operations Committee Members, UCI

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Nuclear Reactor Facility

Annual Report

for

July 1st, 2010 to June 30th, 2011

Facility License R-116

Docket 50-326

Prepared in Accordance with Part 6.7f

of the Facility Technical Specifications

revised January 2012

by

Dr. G. E. Miller
Reactor Supervisor

Section 1. Operations Summary

Operation of this facility supports 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 and separation techniques including applications to nuclear waste separations (ChEMS).

Reactor utilization, apart from operator training and maintenance, is for analytical sample irradiation and production of isotopic tracers. Analysis samples come from diverse origins related to forensic science, fossil fuels, geochemistry, art, and archaeological studies, chemical separations in nuclear fuel cycle experiments, 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 2010 laboratory course in Radioisotope Techniques using the facility was 32 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 (NSOP) 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, NSOP received no direct financial support.

A grant from the Department of Energy was awarded to enable refurbishment of some auxiliary equipment (continuous air monitor samplers, automatic sample changer) and construction of a sample irradiation loop for flowing liquids, and a burn-up fuel element monitor instrument.

Operations have continued at the increased level experienced last year. Criticality was achieved for 128.5 hours, and the total energy generated was equivalent to 71 hours at full steady state power. 103 separate experiments were performed, and over 2000 samples were irradiated (sometimes multiple samples are included in a single capsule and are not always separately logged). 8 moderate level mixed isotope shipments were made, all Yellow II category. No pulse operations have been performed. Three 50.59 changes were approved this year: (i) revision of the facility ventilation system, (ii) installation of a new pool level meter and alarm, (iii) installation of new seismic switch/scram unit. In addition, a new pumping system for ground water adjacent to the reactor tank was installed. No unusual surveillance results/activities were conducted during this period.

An NRC general inspection was carried out from December 12th - 15th 2010. One Notice of Violation was received regarding the requirement to conduct emergency drills at the facility itself. In 2010-11, Reactor Operations Committee meetings were held on July 8th 2010 and February 8th 2011 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, 2011 for the UCI EH&S radiological personnel and reactor operators with debriefing and evaluation as related to response to a laboratory radiation spill event also involving personnel injury.

Inspections/audits continue to be conducted quarterly by the Radiation Protection staff of EH&S at UCI. These have identified that frequency schedules have been properly maintained, and results continue to show absence of significant levels of contamination or personnel exposure.

Operator examinations during the year (October 2010 and March 2011) resulted in the licensing of 3 new individuals as SRO's, and 1 RO. As of June 30th 2011, 3 SRO's were active. 1 SRO needed requalification, and the RO was inactive and had moved away.

Section 2. Data Tabulations for the Period July 1st, 2010 to June 30th, 2011

TABLE I.

Experiment Approvals on file	3
Experiments performed (including repeats)	103
Samples irradiated	2198+
Energy generated this period (Megawatt hours)	17.7
Total, 69 element core = 127.0	
>74 element core = 1369.6	
Total energy generated since initial criticality	1496.6 Mwh
Pulse operation this period	0
Total reactor pulses to 6/30/11	978
Hours critical this period	128.5
Total hours critical to date	8694.0
Inadvertent scrams or unplanned shutdowns or events at power	4
Visitors to reactor - as individuals or in tour groups –	425
Maximum dosimeter recorded for visitors - all less than	0.2 mrem
Visiting researchers (dosimeter issues)	5
Maximum exposure recorded at one visit	26.2 mrem
Visiting researchers (badged)	10
Students and teaching assistants in class, badged	34
Exposures reported for quarter (range: 0-30 mrem) average	21 mrem
Isotope Shipments this period (mixed act'n products = 12 millicuries total)	8

TABLE II

Reactor Core Status 6/30/11 (core configuration unchanged from 6/30/10)

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 6/22/2011)			$2.43
Control rod worths (calibrated 8/25/2010)	REG	$2.70	
	SHIM	$3.42	
	ATR	$1.62	
	FTR	$0.66	
	Total:	$8.40	
Maximum possible pulse insertion (calculated)			$2.28
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
2010			
09/30	09:20	~80 w	Linear scram. Auto ranging didn't switch up at 75 watt range at fast period about 5 sec. Trainee operator. Restart authorized by SRO
09/30	10:45	~25 w	Linear scram, repeat of above at 25 w range. Operators warned to use lower periods. Trainee operator. Restart authorized by SRO.
2011			
1/12	13:50	~75w	Period scram trainee operator error during raising power to 25 kw. Restart authorized by SRO.
3/16	15:50	< 2.5 w	Period scram. Operator error in start-to critical.. Relatively high Xe in core, operator misled as to appropriate rod positions. Restart authorized.

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.

2010

August 19th Power calibration run at 200 kilowatts indicated power (WRLM). Found 80.8% of 250 kilowatts. Only very slight adjustments made to WRM and PRM) to match WRLM.

August 25th

October 4th – 26th. Operation was suspended while new routing valves and roof ducting were installed for the revised exhaust/ventilation system. (see section 5 for further details)./

2011

February 22- March 9th Installation of new pit pump (Grundfos SQE) for ground water removal at west end of reactor room. New controller system allows start time/delay. Pump shuts off when dry. Pump base level is at 34 feet below floor level (reactor tank is 25 feet deep).

March 10th Rowland Hall emergency power circuits disabled to install new auto transfer switch wiring. On restart, the back-up battery in the diesel generator room exploded. Reactor UPS on security/rad safety equipment only lasted 2 hours. Manual observation maintained with no reactor operations. Systems all restored and functional after about 4 hours down time, from 3 am to 7:30 am. Reactor personnel were in attendance during that time.

March 22nd Two old security sensors (radar type) in control room that were failing were replaced with new PIR sensors – functionally equivalent. Performance verified as meeting and exceeding former coverage.

April 7th Fuel rack used for complete core unload was removed from the pool, and dismantled for storage until needed further. (Rack has not been used for many years)

April 5th -15th New stainless steel Flexmaster connectors installed in both water cooling and purification pump systems to replace former galvanized ones that were beginning to show corrosion. All functionally equivalent.

May 30th. New seismic switch/scram ('Mitigator") was installed, tested and placed in service. Trip Setting was 3%g in each of 3 dimensions.

Section 5
Facility Changes and Special Experiments Approved

The ROC approved the following changes according to 50.59 procedures, during this period.
(i) revision of the facility ventilation system, now tied in to main building exhausts with large exhaust fans creating high plume level and large dilution factor.
(ii) installation of a new pool level meter and alarm, level now set at 12 inches below tank top.
(iii) installation of new seismic switch/scram unit.

In addition, a new pumping system for ground water adjacent to the reactor tank was installed to maintain lower levels of ground water around the reactor tank. Radioactivity measurements of this water indicate natural decay products with no activities relating to reactor operations.

No special or unusual experiments were approved or carried out.
A new experiment number was authorized, but only in order to better track work by Prof. Nilsson's group. The experiments were the same as those previously authorized using other experiment numbers and involved sample activation. New procedures (approved by the UCI RSO) were implemented to track sample materials transferred from the reactor facility to Prof. Nilsson's laboratories in Engineering Tower.

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 measurements 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 locations 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 (7/1/10-6/30/11):

a. Minutes of operation:	223 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) =	1.6×10^{3} microcuries

(2) Release from pool surface (7/1/10-6/30/11):

a. Total hours of operation at full power (Mwh x 4) =	71.0 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)	$= 7.1 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 5.1 \times 10^{3}$ 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) = $\prec 0.8 \times 10^{-10}$ microcuries/mL
Since 20×10^{-10} microcuries/mL provides an annual exposure for constant immersion of 10 mrem, this corresponds to < 0.4 mrem potential additional radiation exposure to an individual standing breathing in the effluent stack for the entire year.

This computation assumes the prior ventilation system was in place for the entire annual period and no dilution of the plume at or beyond the release point. It also conservatively assumes all reactor operations were at 250 kw power, whereas significant operation time was at lower power levels.

** From October 28th 2010, new ventilation exhaust provisions were made at this facility. The exhaust is now diluted by a factor of 100 before release and the mixed plume is released at ~100 feet above the roof level (200 feet above surrounding ground. So the estimates could be reduced by a factor of 100 for the half-year period. Since the levels were already well below allowed levels, this was not done.

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 2 cubic foot container of dry waste were disposed during this period (7/1/10 through 6/30/11) estimated at a total quantity in 2 cu ft of 0.10 millicuries of mixed activation products (measured as ^{60}Co equivalent at time of transfer).

LIQUIDS:

No transfers mad in this period. 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 since 2007. As of January 2011, 3 locations for monitoring exhaust flows on the 3 building exhaust fans were established. These replaced locations #5 and #9 above and added one new location. (#11) An additional dosimeter has been located in the control room (#12), for a total of 12.

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.
2010-2011
Average Total Exposures in mrem (including "control background")

Location.	Quarter				Annual	Prior year	Excess(10-11) over control
	2/10	3/10	4/10	1/11	Total 20010/11	Totals 2009/10	mr ANNUAL
1. S. Facility perimeter	28	29	24	29	110	128	-7
2. W. Facility perimeter	28	26	26	29	109	105	-8
3. N Facility perimeter	29	30	26	30	115	123	-2
4. Hallway over facility	25	26	22	28	101	103	-16
5[1]. Facility main air exhaust	25	24	22	26	97	98	-20
6. McGaugh Hall top floor	26	28	25	28	107	101	-10
7. Langson Library top floor	31	31	26	34	122	130	5
8. Reines Hall top floor	29	29	25	30	113	113	-4
9[2]. Facility fume hood exh.	26	26	22	26	100	101	-17
10. On-campus housing	23	29	22	26	100	99	-17
11 Building exhaust 3	-	-	-				Added 4/2011
12 Control Room	-	-	-				Added 4-2011
Background control (GDS)	29	31	26	31	117	119	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 location 7 are less than GDS control background level.
- Location 7 is on the 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 remain statistically within range of previous year.
- Note 1. Location as of Nov 2010, now building exhaust 1
- Note 2. Location as of Nov 2010, now building exhaust 2

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/building (measured by locations #5 and #9) continues to give no detectable exposure above background. 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 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, 2010. 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. 5 persons were issued TLD badges on a continual basis; 3 were also issued with finger TLDs. 32 students and 2 teaching assistants in a Radioisotope Techniques class were TLC badged. Reported exposures fell in a narrow range averaging 21 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: 4/1/10 to 3/30/11 (in millirem)

Individuals	Whole Body			Finger Ring
	DEEP	EYE	SHALLOW	(Shallow)
1[1]	10	10	10	430
2[2]	35	35	35	188
2[3]	0	0	0	-
Totals	45	45	45	618
34[4]	Range 13-29 (mean 21)	Range 13-29 (mean 21)	Range 13-29 (mean 21)	not issued
class total	726	726	726	-
Totals	771 (39 individuals)	771 (39 individuals)	771 (39 individuals)	618 (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	33.9
223 other visitors logged	(1 each)	1.9
207 in tour groups[5]	1 each	0.0 to 0.1 each monitor
Summation (430 persons)	346	35.8 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. Individuals 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 Jan-Mar 2011. 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.

Personnel exposures continue to be very low at this facility in keeping with ALARA efforts. Fewer isotope shipments have been made this year, so exposure from that activity is lower.