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U.S. 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 2001 through June 30th 2002. We apologize for the late delivery of this report.

Sincerely,

George E. Miller

George E. Miller
Reactor Supervisor

cc: American Nuclear Insurance, Town Center, Suite 300S, 29 South Main Street, West Hartford, CT 06107-2445, Policy NF-176
Reactor Operations Committee Members, UCI
Dean of Physical Sciences, Ron Stern

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U. C. IRVINE

Nuclear Reactor Facility

Annual Report

for

July 1st 2001 to June 30th 2002

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 in the use and application of radiochemical techniques and radioisotopes 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 Winter Quarter 2002 was 48 students.

Some use is made of the facility by other educational institutions. This program has involved tours, class demonstrations, and analyses of samples submitted by faculty. Modest support was obtained from the Reactor Sharing program for 2001-2002. Support was also granted for instrumentation upgrade from the URI program of the US Department of Energy. The two mechanical control rod drives were replaced with new units and a new portal exit monitor was installed. Equipment has been acquired for upgrade to security system computer hardware, but has not yet been installed.

Operations have been at a low to modest level, very similar to last year. Criticality was achieved for 101 hours, and the total energy generated was equivalent to 61 hours at full steady state power. 83 experiments were performed, and over 1000 samples were irradiated (sometimes multiple samples are included in a single capsule and are not separately logged). Only 9 low level isotope shipments were made (one of Yellow III, and the remainder Yellow II category or less). No pulse operations have been performed, even for test purposes.

The replacement rod drives have been performing satisfactorily, and the opportunity was realized to replace the fuel temperature monitoring circuitry at the same time, which has also performed well.

No NRC inspection was carried out during this reporting period. Monthly inspections are now routine from the EH&S Office at UCI. No significant safety or maintenance problems were encountered during this reporting period.

Section 2. Data Tabulations for the Period July 1st, 2001 to June 30th, 2002

TABLE I.

Experiment Approvals on file	8
Experiments performed (including repeats)	83
Samples irradiated	981+
Energy generated this period (Megawatt hours)	15.2
Total, 69 element core = 127.0	
>74 element core = 1346.9	
Total energy generated since initial criticality	1359.6 Mwh
Pulse operation this period	0
Total pulses to 6/30/02	978
Hours critical this period	101.0
Total hours critical to date	7803.0
Inadvertent scrams or unplanned shutdowns	3
Visitors to reactor - as individuals or in tour groups (curtailed after 9/11)	196
Maximum dosimeter recorded for visitors all less than	1 mrem
Visiting researchers (dosimeter issues)	6
Maximum dose recorded at one visit	2.4 mrem
Visiting researchers (badged)	4

TABLE II

Reactor Status 6/30/02 (no change since 6/30/01).

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			33
Graphite reflector elements in reactor tank storage			1
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			$2.75
Control rod worths (4/14/02)	REG	$2.75	
	SHIM	$3.72	
	ATR	$1.80	
	FTR	$0.70	
	Total:	$8.97	
Maximum possible pulse insertion			$2.50
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
2001			
7/21	~16:00		Building evacuated because of chemical fire in adjacent building. Reactor not in operation or affected by fire. Building closed until ~06:00 following morning.
8/10	13:58	250 kw	Linear scram at 105% power – operator failed to observe drift of power level as LS rotated with unbalanced sample load (only 8 samples). WRM and %P were both below 100%.
9/11	07:00		Facility placed on security alert status. No operation permitted pending clarification of status.
9/15	09:00		Operations resumed.
11/28	14:45	2.5 kw	Linear scram at 100% of 2.5 kw. Display on WRLM blanks out due to apparent failure of auto range change circuit. However circuit recovered at lower power range and operated correctly through all subsequent tests and operations. No repeat of this malfunction through 6/30/02, so assume a pure "glitch".
2002			
3/14	21:53	0w	FTR dropped slowly on shutdown. Operations suspended while investigated. (See maintenance below for resolution). Resumed operations3/23/02.
4/1			Operations suspended to replace rod drives and fuel temperature measurement channel with new units. Operations resumed after rod calibrations repeated on 4/15/02.
4/27			FTR unable to be fired due to SHIM DOWN switch misadjustment. No run done.

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.

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10/18 Rotating specimen rack stopped rotating during a run. Operation was extremely sluggish and needed hand assistance during unloading of samples. Oiling bearings and dismantling and re-greasing motor failed to cure problem. Tests and observations indicated motor start capacitor failed. New capacitor ordered and installed on 11/10/01. Operation now good.

11/12	EH&S personnel performed neutron and gamma surveys of facility with reactor at full power and cooling circulation on.
12/7	Right double door (to loading dock) lock needed repair as it failed to allow relocking of door (internal screws had lossened).
12/11	New portal monitor (Ludlum Model 53) installed and tested. Operating in walk through mode detects 100 nCi of ^{137}Cs as specified. No further checks needed.

2002

1/18	Security alarm system trip reported to UCIPD. No sign of entry, but security computer "frozen". Restart of computer restored operations fully.
1/31	Commence rod calibrations (completed 2/2/02). Results in excellent agreement with former values.
2/1	Reset maximum minimum alarm level of portal monitor to better accommodate operation with reactor at full power (instrument automatically adjusts background up to this limit).
2/2	Power calibration completed. Adjustment made of approximately 2% in %P meter, other channels within 1%, so unchanged.
2/3	FTR rod calibrated. All rod values in excellent agreement with former values. FTR and ATR solenoid valves dismantled, cleaned, and lightly oiled/greased. Function checks good.
3/17	FTR drive cylinder removed and inspected to check on drop time problem. Appears in good order and runs smoothly. Abnormal occurrence reported to NRC. Assumption is that lower plastic piston has broken due to ageing. GA contacted regarding replacement. Drawings obtained and new piston ordered from UCI machine shop.
3/17	FTR rod removed from core to floor of room (max contact rad level = 50 mr/hr). Piston exposed and found to be cracked through set screw section (piston otherwise in good condition (color, integrity).
3/22	FTR piston installed and rod drive reinserted to core. Drop times checked. Function now meets specs.
3/23	FTR worth remeasured to verify after repair. Worth measurement is OK.
4/1 – 4/14	SHIM and REG rod drives replaced with new units. Minor problems experienced with microswitch adjustments on new rod drives preventing rods raising. Needed to replace potentiometer in ATR drive to match other drives in order to align rod drive position indicators which are in parallel circuit. All functions confirmed and rod drops times tested to be within specs. A separate fuel temperature was installed to replace existing circuit. This operates at a lower scram level – more conservative – as T scale is lower. Scram circuit tested to function as before. Will tests T comparisons of core when runs at power are done. (All above done within 50.59 change permission as functions are identical to prior units.)
4/15	All rods recalibrated find total worth change by only \$0.03 (out of \$8.94) so excellent agreement in spite of changes in exact travel distances and unit potentiometers.
5/16	SHIM rod down switch adjusted to fix interlock FTR problem. Recommence normal operations.
5/24	SHIM rod failed to raise during start-up. Found rod drive down switch lock nut was loose allowing slow change in this setting. Probably cause of other problems with FTR interlock above. Adjusted and reset locknut. Operations resumed as normal.

During much of this period, one station of the six station Radiation Monitoring System was out of service because of a failure in the detector unit. No actual radiation releases were ever experienced. Sufficient units have been in service at all times to satisfy Tech. Spec. and general safety requirements. This unit may have a failed transformer which is difficult to replace.

Section 5
Facility Changes and Special Experiments Approved

Facility changes made include those referenced under maintenance. Formal approval was granted (under 10CFR 50.59) in December 2000 for replacement of control rod drives, revised specifications in February 2002 when approval was granted also for temperature monitor circuit replacement. A new portal monitor for personnel exit surveys was placed in service on 12/11/2001.

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 (7/1/01-6/30/02):

a. Minutes of operation:	296 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) =	2.1×10^{3} microcuries

(2) Release from pool surface (7/1/98-6/30/99):

a. Total hours of operation at power (Mwh x 4) =	60.9 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)	$= 4.4 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 6.5 \times 10^{3}$ microcuries**

e. Total effluent released in 1 year (525960 minutes/yr. x c) = 6.31×10^{13} mL

Concentration averaged over 12 months (d/e) $= < 1.0 \times 10^{-10}$ 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.

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). Direct disposals from this facility are given below. It is important to note that activity values are estimated at the time of transfer to EH&S control. Since no shipments are currently 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 and purchased materials.

DRY WASTES:
11/2/01 2 ft^3 dry waste containing approximately 1 microcurie of mixed activation products (including ^{60}Co and shorter-lived products) from irradiation experiments.
2/14/02 2 ft^3 dry waste containing approximately 40 microcuries of mixed activation products (including ^{60}Co, ^{54}Mn and shorter-lived products) from irradiation experiments.
LIQUIDS:
12/13/01 1.5 gallon liquid aqueous waste including approx 65 microcuries ^{3}H reactor generated by $^{6}LiOH$ irradiation and ^{3}H and less than 10 microcuries of ^{14}C from purchases.
2/14/02 2.0 gallon liquid aqueous waste including approx 93 microcuries ^{3}H reactor generated by $^{6}LiOH$ irradiation and less than 10 microcuries of ^{14}C from purchases.

Section 7.
Environmental Surveillance.

Calcium sulfate/Dysprosium thermoluminescent dosimeters in packs supplied by the Radiation Detection Company, Sunnyvale, California are placed at nine locations around the UCI Campus. One pack is kept on the edge of campus in a wood frame house in University Hills.

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. All waste material especially old flooring was surveyed by EH&S before disposal and 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.
3. Loading dock, adjacent to west wall of 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).

Table IV, on the following page, shows the data as received from RDC for the period.

TABLE IV.
Environmental Dosimetry Data.
2000-2001

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

Location.	Quarter 2/01	3/01	4/01	1/02	Annual Total 2001/2	Prior year Total 2000/1	Ratio 2002/2001
1. S. Facility perimeter	36	38	25	26	125*	77*	1.6
2. W. Facility perimeter	8	11	9	11	39	32	1.2
3. N Facility perimeter	10	14	10	12	46	28	1.6
4. Lab Room over facility	7	9	7	9	32	20	1.6
5. Facility main air exhaust	4	6	5	8	23	15	1.5
6. Bio. Sci II top floor	6	8	7	8	29	17	1.7
7. Library top floor	17	19	16	18	70	34	2.1
8. Computer Sci. top floor	3	5	6	7	22	11	2.0
9. Facility fume hood exh.	5	7	8	9	29	17	1.7
10. Faculty housing	2	2	3	5	12	3	4.0

* increased exposure since 1999 due to relocation of stored Cf-252 source closer to this sensor.

Discussion

It has been decided that raw data should be presented here, with no attempt to compute an average "background" since the data vary significantly. Location 7 has always indicated a consistent higher level because of roof level, unshielded cement building + bright window exposure in a place remote from the facility.

Data for this year reflects two issues:

- all raw results are higher than previous years, including "controls" far removed from the facility, by approximately a factor of 2. A presumption is that data processing has increased sensitivity or some recalibration has occurred, or that additional exposure is happening during storage and/or mailings.
- experimental work has been conducted using a modest sized Cf-252 source. This is stored within the facility when not in use, and the new location is relatively close to Location 1, raising its level slightly.

Exposure estimate probability to a single individual in an uncontrolled area at this facility is still very minimal. The perimeter of the facility is hallways or outside loading dock so occupancy rate of the areas monitored by these dosimeters is extremely low. The laboratory overhead (location 4) is occupied by very few individuals (one or two at the most). 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 above a warm, outside, cement wall. Over many years, the data at each specific location had shown remarkable consistency. These global increases are interesting and it will be seen if they continue. The net conclusion is that compared to 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 all personnel who might be handling isotopes on a regular basis. Neutron exposure badges are used by personnel (up to 4) who might work with the Cf-252 source. TLD and badge dosimetry are read quarterly by Radiation Detection Company, and results are presented in Table V.

Twelve (13) persons were issued monitors dosimeters on a continual basis most were also issued with finger dosimeters (TLD). 48 students and 3 teaching assistants in a radiochemistry class were also issued TLD monitors. Reports from those badges were not available for this report. Several of these individuals did no work in the facility (identified in the table by #4), so their badge readings indicate background variation and accumulated background exposure at the location inside the facility where the badges are kept.

Visiting individuals and tour groups are issued with direct-reading Canary II digital monitor instruments that record in units of 0.01 mR so low exposure information is available. Background levels during a tour visit typically accumulates 0.04-0.06 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 of 0.10 or above will be tabulated. In the past only readings in excess of 1 mR would have been noted. Personnel included in this group were individuals working on facility general maintenance. All work was done with the reactor shut down, and no readings >0.10 were found.

TABLE V.
Personnel Exposure Report Summary for 6/30/01 to 6/30/02 (in mrem)

Individuals	Whole Body		Finger Ring
	TEDE	TODE	(Shallow)
1[1]	125	125	0
1[4]	75	75	0
1[2]	60	60	0
1[4]	55	55	0
1	40	40	0
2[4]	40	40	0
1[4]	35	35	0
5	0	0	0
Totals 13	430	430	0
	(5590 person-mrem)		

1. This individual does extensive activation analysis and radiochemical work at the facility. Most of the exposure is a result of Cl-38 radioactivity production.
2. This individual does occasional activation analysis work on meteorites at the facility.
3. Some extremity exposure from handling high activity (1 curie level) samples for delivery to reactor customers.
4. These exposures were from a combination of handling low level isotopes during calibrations and source movements adjacent to the badge storage area and/or general background exposure within the facility. This is concluded since one of the badged individuals with recorded exposures did not visit the facility during the monitoring period.

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

	Person-days	accumulation
	1	2.33
	2	0.08
	3	0.05
	4	0.74
Summation	4	3.20

As noted earlier, 196 visitors were monitored using self-reading digital dosimeters (individuals or 3 per group when in a group). No readings >0.10 mrem were recorded for these tour events.

It is of note that both this data and that for the environmental dosimeters are higher than in prior years by a similar factor and that no changes in work load or facility management or design have occurred. Since the 'control" data are higher by similar factors, we are trying to investigate whether changes in procedures have occurred at RDC in reporting. For example if they are no longer subtracting 'background" before reporting, or are using lower values to subtract, this could by itself explain the change. This issue is under review.

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Facility changes made include those referenced under maintenance. Formal approval was granted (under 10CFR 50.59) in December 2000 for replacement of control rod drives, revised specifications in February 2002 when approval was granted also for temperature monitor circuit replacement. A new portal monitor for personnel exit surveys was placed in service on 12/11/2001.

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(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 (7/1/01-6/30/02):

a. Minutes of operation:	296 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) =	2.1×10^{3} microcuries

(2) Release from pool surface (7/1/98-6/30/99):

a. Total hours of operation at power (Mwh x 4) =	60.9 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)	$= 4.4 \times 10^{3}$ microcuries
d. Total of (1) and (2) emission in 1 year	**$= 6.5 \times 10^{3}$ microcuries**

e. Total effluent released in 1 year (525960 minutes/yr. x c) = 6.31×10^{13} mL

Concentration averaged over 12 months (d/e) $= < 1.0 \times 10^{-10}$ 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.

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(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). Direct disposals from this facility are given below. It is important to note that activity values are estimated at the time of transfer to EH&S control. Since no shipments are currently 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 and purchased materials.

DRY WASTES:
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2/14/02 2 ft^3 dry waste containing approximately 40 microcuries of mixed activation products (including ^{60}Co, ^{54}Mn and shorter-lived products) from irradiation experiments.
LIQUIDS:
12/13/01 1.5 gallon liquid aqueous waste including approx 65 microcuries ^{3}H reactor generated by $^{6}LiOH$ irradiation and ^{3}H and less than 10 microcuries of ^{14}C from purchases.
2/14/02 2.0 gallon liquid aqueous waste including approx 93 microcuries ^{3}H reactor generated by $^{6}LiOH$ irradiation and less than 10 microcuries of ^{14}C from purchases.

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Calcium sulfate/Dysprosium thermoluminescent dosimeters in packs supplied by the Radiation Detection Company, Sunnyvale, California are placed at nine locations around the UCI Campus. One pack is kept on the edge of campus in a wood frame house in University Hills.

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. All waste material especially old flooring was surveyed by EH&S before disposal and found to be free of removable and fixed contamination.

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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).

Table IV, on the following page, shows the data as received from RDC for the period.

TABLE IV.
Environmental Dosimetry Data.
2000-2001

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

Location.	Quarter 2/01	3/01	4/01	1/02	Annual Total 2001/2	Prior year Total 2000/1	Ratio 2002/2001
1. S. Facility perimeter	36	38	25	26	125*	77*	1.6
2. W. Facility perimeter	8	11	9	11	39	32	1.2
3. N Facility perimeter	10	14	10	12	46	28	1.6
4. Lab Room over facility	7	9	7	9	32	20	1.6
5. Facility main air exhaust	4	6	5	8	23	15	1.5
6. Bio. Sci II top floor	6	8	7	8	29	17	1.7
7. Library top floor	17	19	16	18	70	34	2.1
8. Computer Sci. top floor	3	5	6	7	22	11	2.0
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10. Faculty housing	2	2	3	5	12	3	4.0

* increased exposure since 1999 due to relocation of stored Cf-252 source closer to this sensor.

Discussion

It has been decided that raw data should be presented here, with no attempt to compute an average "background" since the data vary significantly. Location 7 has always indicated a consistent higher level because of roof level, unshielded cement building + bright window exposure in a place remote from the facility.

Data for this year reflects two issues:

- all raw results are higher than previous years, including "controls" far removed from the facility, by approximately a factor of 2. A presumption is that data processing has increased sensitivity or some recalibration has occurred, or that additional exposure is happening during storage and/or mailings.
- experimental work has been conducted using a modest sized Cf-252 source. This is stored within the facility when not in use, and the new location is relatively close to Location 1, raising its level slightly.

Exposure estimate probability to a single individual in an uncontrolled area at this facility is still very minimal. The perimeter of the facility is hallways or outside loading dock so occupancy rate of the areas monitored by these dosimeters is extremely low. The laboratory overhead (location 4) is occupied by very few individuals (one or two at the most). 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 above a warm, outside, cement wall. Over many years, the data at each specific location had shown remarkable consistency. These global increases are interesting and it will be seen if they continue. The net conclusion is that compared to control areas (numbers 7 and 10) we are operating fully ALARA as far as public exposure potential is concerned.

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UCI issues TLD badges to most students or researchers utilizing radiation. Finger dosimetry (TLD) rings are also issued to all personnel who might be handling isotopes on a regular basis. Neutron exposure badges are used by personnel (up to 4) who might work with the Cf-252 source. TLD and badge dosimetry are read quarterly by Radiation Detection Company, and results are presented in Table V.

Twelve (13) persons were issued monitors dosimeters on a continual basis most were also issued with finger dosimeters (TLD). 48 students and 3 teaching assistants in a radiochemistry class were also issued TLD monitors. Reports from those badges were not available for this report. Several of these individuals did no work in the facility (identified in the table by #4), so their badge readings indicate background variation and accumulated background exposure at the location inside the facility where the badges are kept.

Visiting individuals and tour groups are issued with direct-reading Canary II digital monitor instruments that record in units of 0.01 mR so low exposure information is available. Background levels during a tour visit typically accumulates 0.04-0.06 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 of 0.10 or above will be tabulated. In the past only readings in excess of 1 mR would have been noted. Personnel included in this group were individuals working on facility general maintenance. All work was done with the reactor shut down, and no readings >0.10 were found.

TABLE V.

Personnel Exposure Report Summary for 6/30/01 to 6/30/02 (in mrem)

Individuals	Whole Body		Finger Ring
	TEDE	TODE	(Shallow)
1[1]	125	125	0
1[4]	75	75	0
1[2]	60	60	0
1[4]	55	55	0
1	40	40	0
2[4]	40	40	0
1[4]	35	35	0
5	0	0	0
Totals 13	430	430	0
	(5590 person-mrem)		

1. This individual does extensive activation analysis and radiochemical work at the facility. Most of the exposure is a result of Cl-38 radioactivity production.
2. This individual does occasional activation analysis work on meteorites at the facility.
3. Some extremity exposure from handling high activity (1 curie level) samples for delivery to reactor customers.
4. These exposures were from a combination of handling low level isotopes during calibrations and source movements adjacent to the badge storage area and/or general background exposure within the facility. This is concluded since one of the badged individuals with recorded exposures did not visit the facility during the monitoring period.

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

	Person-days	accumulation
	1	2.33
	2	0.08
	3	0.05
	4	0.74
Summation	4	3.20

As noted earlier, 196 visitors were monitored using self-reading digital dosimeters (individuals or 3 per group when in a group). No readings >0.10 mrem were recorded for these tour events.

It is of note that both this data and that for the environmental dosimeters are higher than in prior years by a similar factor and that no changes in work load or facility management or design have occurred. Since the 'control" data are higher by similar factors, we are trying to investigate whether changes in procedures have occurred at RDC in reporting. For example if they are no longer subtracting 'background" before reporting, or are using lower values to subtract, this could by itself explain the change. This issue is under review.

U. C. IRVINE

Nuclear Reactor Facility

Annual Report

for

July 1st 2001 to June 30th 2002

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 in the use and application of radiochemical techniques and radioisotopes 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 Winter Quarter 2002 was 48 students.

Some use is made of the facility by other educational institutions. This program has involved tours, class demonstrations, and analyses of samples submitted by faculty. Modest support was obtained from the Reactor Sharing program for 2001-2002. Support was also granted for instrumentation upgrade from the URI program of the US Department of Energy. The two mechanical control rod drives were replaced with new units and a new portal exit monitor was installed. Equipment has been acquired for upgrade to security system computer hardware, but has not yet been installed.

Operations have been at a low to modest level, very similar to last year. Criticality was achieved for 101 hours, and the total energy generated was equivalent to 61 hours at full steady state power. 83 experiments were performed, and over 1000 samples were irradiated (sometimes multiple samples are included in a single capsule and are not separately logged). Only 9 low level isotope shipments were made (one of Yellow III, and the remainder Yellow II category or less). No pulse operations have been performed, even for test purposes.

The replacement rod drives have been performing satisfactorily, and the opportunity was realized to replace the fuel temperature monitoring circuitry at the same time, which has also performed well.

No NRC inspection was carried out during this reporting period. Monthly inspections are now routine from the EH&S Office at UCI. No significant safety or maintenance problems were encountered during this reporting period.

Section 2. Data Tabulations for the Period July 1st, 2001 to June 30th, 2002

TABLE I.

Experiment Approvals on file	8
Experiments performed (including repeats)	83
Samples irradiated	981+
Energy generated this period (Megawatt hours)	15.2
Total, 69 element core = 127.0	
>74 element core = 1346.9	
Total energy generated since initial criticality	1359.6 Mwh
Pulse operation this period	0
Total pulses to 6/30/02	978
Hours critical this period	101.0
Total hours critical to date	7803.0
Inadvertent scrams or unplanned shutdowns	3
Visitors to reactor - as individuals or in tour groups (curtailed after 9/11)	196
Maximum dosimeter recorded for visitors all less than	1 mrem
Visiting researchers (dosimeter issues)	6
Maximum dose recorded at one visit	2.4 mrem
Visiting researchers (badged)	4

TABLE II

Reactor Status 6/30/02 (no change since 6/30/01).

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		33
Graphite reflector elements in reactor tank storage		1
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		$2.75
Control rod worths (4/14/02)	REG	$2.75
	SHIM	$3.72
	ATR	$1.80
	FTR	$0.70
	Total:	$8.97
Maximum possible pulse insertion		$2.50
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
2001			
7/21	~16:00		Building evacuated because of chemical fire in adjacent building. Reactor not in operation or affected by fire. Building closed until ~06:00 following morning.
8/10	13:58	250 kw	Linear scram at 105% power – operator failed to observe drift of power level as LS rotated with unbalanced sample load (only 8 samples). WRM and %P were both below 100%.
9/11	07:00		Facility placed on security alert status. No operation permitted pending clarification of status.
9/15	09:00		Operations resumed.
11/28	14:45	2.5 kw	Linear scram at 100% of 2.5 kw. Display on WRLM blanks out due to apparent failure of auto range change circuit. However circuit recovered at lower power range and operated correctly through all subsequent tests and operations. No repeat of this malfunction through 6/30/02, so assume a pure "glitch".
2002			
3/14	21:53	0w	FTR dropped slowly on shutdown. Operations suspended while investigated. (See maintenance below for resolution). Resumed operations3/23/02.
4/1			Operations suspended to replace rod drives and fuel temperature measurement channel with new units. Operations resumed after rod calibrations repeated on 4/15/02.
4/27			FTR unable to be fired due to SHIM DOWN switch misadjustment. No run done.

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.

2001

10/18 Rotating specimen rack stopped rotating during a run. Operation was extremely sluggish and needed hand assistance during unloading of samples. Oiling bearings and dismantling and re-greasing motor failed to cure problem. Tests and observations indicated motor start capacitor failed. New capacitor ordered and installed on 11/10/01. Operation now good.

11/12	EH&S personnel performed neutron and gamma surveys of facility with reactor at full power and cooling circulation on.
12/7	Right double door (to loading dock) lock needed repair as it failed to allow relocking of door (internal screws had lossened).
12/11	New portal monitor (Ludlum Model 53) installed and tested. Operating in walk through mode detects 100 nCi of ^{137}Cs as specified. No further checks needed.

2002

1/18	Security alarm system trip reported to UCIPD. No sign of entry, but security computer "frozen". Restart of computer restored operations fully.
1/31	Commence rod calibrations (completed 2/2/02). Results in excellent agreement with former values.
2/1	Reset maximum minimum alarm level of portal monitor to better accommodate operation with reactor at full power (instrument automatically adjusts background up to this limit).
2/2	Power calibration completed. Adjustment made of approximately 2% in %P meter, other channels within 1%, so unchanged.
2/3	FTR rod calibrated. All rod values in excellent agreement with former values. FTR and ATR solenoid valves dismantled, cleaned, and lightly oiled/greased. Function checks good.
3/17	FTR drive cylinder removed and inspected to check on drop time problem. Appears in good order and runs smoothly. Abnormal occurrence reported to NRC. Assumption is that lower plastic piston has broken due to ageing. GA contacted regarding replacement. Drawings obtained and new piston ordered from UCI machine shop.
3/17	FTR rod removed from core to floor of room (max contact rad level = 50 mr/hr). Piston exposed and found to be cracked through set screw section (piston otherwise in good condition (color, integrity).
3/22	FTR piston installed and rod drive reinserted to core. Drop times checked. Function now meets specs.
3/23	FTR worth remeasured to verify after repair. Worth measurement is OK.
4/1 – 4/14	SHIM and REG rod drives replaced with new units. Minor problems experienced with microswitch adjustments on new rod drives preventing rods raising. Needed to replace potentiometer in ATR drive to match other drives in order to align rod drive position indicators which are in parallel circuit. All functions confirmed and rod drops times tested to be within specs. A separate fuel temperature was installed to replace existing circuit. This operates at a lower scram level – more conservative – as T scale is lower. Scram circuit tested to function as before. Will tests T comparisons of core when runs at power are done. (All above done within 50.59 change permission as functions are identical to prior units.)
4/15	All rods recalibrated find total worth change by only \$0.03 (out of \$8.94) so excellent agreement in spite of changes in exact travel distances and unit potentiometers.
5/16	SHIM rod down switch adjusted to fix interlock FTR problem. Recommence normal operations.
5/24	SHIM rod failed to raise during start-up. Found rod drive down switch lock nut was loose allowing slow change in this setting. Probably cause of other problems with FTR interlock above. Adjusted and reset locknut. Operations resumed as normal.

During much of this period, one station of the six station Radiation Monitoring System was out of service because of a failure in the detector unit. No actual radiation releases were ever experienced. Sufficient units have been in service at all times to satisfy Tech. Spec. and general safety requirements. This unit may have a failed transformer which is difficult to replace.

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5	0	0	0
Totals 13	430	430	0

(5590 person-mrem)

1. This individual does extensive activation analysis and radiochemical work at the facility. Most of the exposure is a result of Cl-38 radioactivity production.
2. This individual does occasional activation analysis work on meteorites at the facility.
3. Some extremity exposure from handling high activity (1 curie level) samples for delivery to reactor customers.
4. These exposures were from a combination of handling low level isotopes during calibrations and source movements adjacent to the badge storage area and/or general background exposure within the facility. This is concluded since one of the badged individuals with recorded exposures did not visit the facility during the monitoring period.

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

	Person-days	accumulation
	1	2.33
	2	0.08
	3	0.05
	4	0.74
Summation	4	3.20

As noted earlier, 196 visitors were monitored using self-reading digital dosimeters (individuals or 3 per group when in a group). No readings >0.10 mrem were recorded for these tour events.

It is of note that both this data and that for the environmental dosimeters are higher than in prior years by a similar factor and that no changes in work load or facility management or design have occurred. Since the 'control" data are higher by similar factors, we are trying to investigate whether changes in procedures have occurred at RDC in reporting. For example if they are no longer subtracting 'background" before reporting, or are using lower values to subtract, this could by itself explain the change. This issue is under review.