U.C.IRVINE TRIGA REACTOR

Annual Report for Period

July 1st, 1980 to June 30, 1981

Facility License: R-116
Docket 50-326

Prepared in accordance with Part 6.7f of the facility specifications.

by

Dr G.E.Miller
Reactor Supervisor

CHAPTER 1

OPERATIONS

Operation of this facility is in support of the Department of Chemistry program in research and education in the use and application of radiochemical techniques and radioisotope utilization 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 archeology studies, chemical synthesis, industrial quality control, enzyme studies, trace element pollution,etc.

The reactor was also utilized in class work by undergraduates learning tracer and activation analysis techniques using small quantities of short-lived activated materials.

13 graduate students and 7 post-doctoral associates have used the facility under the guidance of three faculty in Chemistry. These include visitors from Israel, Norway, Nigeria, Thailand, Peoples Republic of China and I reland.

Currently the facility has 4 licensed senior operators and 1 licensed operator (including the reactor supervisor).

No major changes have been made in this period. The annual inspection of core components indicated that all core items are in good condition.

A maintenance problem was failure of a ballrace in the drive system for the rot ating specimen rack. A repair has not yet been accomplished and rotation is now limited to loading and unloading so as not to create undue wear on the chain drive.

Operations this year have been maintained at about the level of last year. A list of recent publications is given in Appendix I.

CHAPTER 2

DATA TABULATIONS FOR THE PERIOD (JULY 1,1980 -JUNE 30,1981).

TABLE I.

Experiment approvals on file	7	
Experiments performed (including repeats)	302	
Samples irradiated	4455	
Energy generated, Mw hours	56.8	
Total, 69 element core: 127.0		
>74 element core: 698.3		
Total since initial criticality:	825.3	Mwh
Pulse operation (this period)	13	
of which greater than $2.00 insertion:	8	
Total pulses to 6-30-81	649	
Hours critical (this period)	331	
Total to 6-30-81	4284	hours
Operator training and requalification,this period	10	hours
Inadvertent scrams	26	
Visitors to reactor (admitted)	690	
Max dose recorded (all within instrument errors)	1	mr
Visiting researchers(dosimeter issues)	79	
Maximum dose recorded	4	mr
Visiting researchers (badged)	6	

Table II.

Reactor Status 6-30-81

Fuel elements in core (incl 2 fuel followers):	79
Fuel elements in storage (reactor tank) - used	28
Fuel elements unused (instrumented)	1
Graphite reflector elements in core	29
Experimental facilities in fuel element positions	4
Water filled positions	13
Core excess (cold, no Xenon)	$2.93

Control Rod worths (6-8-81)

REG	$3.60
SHIM	$4.00
ATR	$1.99
FTR	$0.72
TOTAL	$10.31

Maximum possible pulse insertion (ATR + FTR)	$2.71
Maximum peak power attained(6-23-81)	960 Mw
Maximum peak temperature observed (B-ring)	328 °C

CHAPTER 3

INADVERTENT SCRAMS AND UNPLANNED SHUTDOWNS

TABLE III

DATE	TIME	POWER	TYPE AND CAUSE
1980			
7/9	10:12	250kw	Linear power scram on switching to auto mode.
7/16	10:42	<10w	Period scram. Operator error during criticality approach.
7/18	13:49	<3w	Period scram. Operator error during criticality approach.
8/30	14:27	<1.5w	Period scram. Operator error during criticality approach.
9/2	15:20	250kw	% Power scram. Operator error on gamma build-up from samples.
9/6	14:00	250kw	% Power scram. Same as 9/2.
10/24	15:58	250kw	Seismic scram. No seismic activity.
10/29	11:30	<3w	Linear power scram operator range switch error on increasing power.
10/31	08:25	<1w	Period scram. Operator error during criticality approach.
11/6	08:07	~100w	Period scram. Operator error during criticality approach.
11/15	14:05	<3w	Period scram. Trainee operator error during criticality approach.
11/20	14:29	~300w	Period scram. Surge in LOG circuit caused by connector at reactor bridge becoming immersed in pool water.
11/21	01:35	250kw	Period scram. Connector still not dry enough after service!
	01:43, 01:45		Same as above!
12/11	10:20	<1w	Period scram. Trainee operator error during criticality approach.
1981			
1/6	10:26	250kw	%Power scram. Same error as 9/8/80
2/17	17:03	250kw	Period scram on switching to auto mode.
3/12	14:37	250kw	Seismic scram. No seismic activity.
4/24	14:18	10kw	Linear scram on switch to auto mode.
5/12	14:52	250kw	Linear scram on switch to auto mode.
6/3	00:14	250kw	Linear scram on switch to auto mode.
6/3	00:19	250kw	Linear scram on switch to auto mode.
6/4	11:44	10kw	Linear scram on switch to auto mode.
6/19	08:15	10kw	Linear scram on switch to auto mode.
6/19	10:10	1kw	Linear scram on switch to auto mode.

CHAPTER 4

MAINTENANCE OPERATIONS

All major items (fuel elements,control rods,console systems) continue to be found in good condition during routine maintenance inspections. There are a few recurring and new items given special attention this year.

(a)Continuous Air Monitor (CAM) and Area Monitor (RAM). Both units experienced low DC voltage supply failure this period owing to resistor and capacitor failure.

(b)LOG and PERIOD channel circuit. Problems were encountered when the signal lead from the compensated ion chamber feeding these channels became submerged in the pool water at a connection point by the reactor bridge. Eventually both connection ends had to be taken apart and the cable ends trimmed, before the problem of sudden signal surges was completely eliminated. Each major surge caused a period scram.

(c)Physical Security Sensor System. With changes and augmentation of the physical security sensor system, quite a number of false alarms were turned in in this period. Some units were adjusted or relocated to circumvent these difficulties.

(d)Radiological safety staff personnel have been appointed to work at the facility aproximately 20 hours per week, starting in March, 1981. After an initial familiarization period, a complete review of the radiological safety program is being conducted and the Standard Operating Procedures are being rewritten, section by section, as a result.

(e)MODE switch. Several unexpected reactor scrams have occurred in recent months, apparently caused by poor switching contacts in the MODE switch when switched from MANUAL to AUTO mode. Elecronics personnel have not yet been available to attend to this problem by cleaning or replacing the switch.

(f) The pneumatic transfer capsules (rabbits) continue to fracture more frequently and easily than expected. Methods have been developed for easy sample retrieval when this occurs and no special problems have resulted.

(g) Rotating Specimen Rack. On 8/20/81 an operator saw that the rotating specimen rack was rotating in a very jerky manner. Rather than continue with the reactor run, he unloaded the samples and saw four small ball bearings in the top cap of one of the sample holders. The bearings were mildly radioactive (Co-60, Cr-51 etc). Using a magnet on a string, a further three balls and a strip of crumpled retainer metal were recovered from the rack.

Examination of the drawings available and consultation with the reactor manufacturer led to the conclusion being made that the bearing supporting the main drive shaft within the rack assembly had collapsed. This permits some lateral movement (though not much vertical) of the gear driving the drive chain for the rack. Since the rack is a permanently welded structure, with a high radiation level, replacement of the bearing is not feasible. Consideration is being given to fabricating a graphite sleeve, which could be slid down the lower section of the dri shaft into the rack assembly to provide lateral stabilization for the drive gear. This manipulation should be able to be done with the rack still under some shielding water.

Meanwhile, rotation of the rack is being restricted to unloading and loading operations, or very occasional 90 degree rotation during long runs, so as to reduce the possibility of damage to the drive chain. This problem is not con idered to constitute any form of safety related problem, except for radiological concerns during any attempted repair operation.

CHAPTER 5

FACILITY CHANGES AND SPECIAL EXPERIMENTS APPROVED

Changes to the physical security system were made during this year to improve the ability to detect unauthorized intrusion or activities within the facility. In all cases, improvement of security was attained. Complete details of the new system have been submitted to NRC in the form of a revised Security Plan. Final approval has not yet been given.

No other significant changes were made during this period and no special experiments were approved.

CHAPTER 6

RADIOACTIVE EFFLUENT RELEASES

(a)Gases. The major direct release to the environs is Argon-41 produced during normal operations. Very small amounts of other short-lived gases may be released from irradiated materials in experiments.

Releases are estimated based on original estimates at point of origin within the facility and taking only dilution into account. An integrated dose estimate is provided by an environmental dosimeter (calcium sulfate-dysprosium) hanging directly in the exhaust at the point of stack discharge. This is changed quarterly. The results substantiate the projection that the submersion dose to an individual standing in the stack discharge continuously would be less than the reliability limit of the dosimeter, estimated at about 20 mrem per year.

The exact quarterly dose readings obtained are given below at Location 5 in Section 7.

(1) Operation of the pneumatic transfer system (7/1/80-6/30/81):

Total (250 kw assumed)	4,170 minutes
Release rate	6 x 10(-3) microcuries/ml
Flow rate	2 x 10(6) ml/sec
Total release	3.0 x 10(4) microcuries

(2)Release from pool surface:

Total operation (Mwh x 4)	227 hours
Release rate (assumed)	<1 x 10(-8) microcuries/ml
Flow rate (exhaust)	2 x 10(+6) ml/sec
Total release	<2 x 10(+4) microcuries

Total of (1) and (2) <5 x 10(+4) microcuries
Concentration averaged over 12 months = <8 x 10(-10) microcuries/ml

This is almost the same as the level reported last year.

(b)Liquids and Solids. Liquid and solid wastes from utilization of by-product materials are disposed through a University contract. Waste is transferred to custody of E,H and S for final packaging and shipment. No wastes have been generated this year other than irradiated sample materials.

Some of the materials generated are transferred to other users operative under State of California license and transferred by those users beyond control of the reactor facility.

Disposals by the facility were as follows: (activities are determined as of time of transfer to Radiation Safety Office control).

Dry wastes:	6 cubic feet	- 7 microcuries (mixed activation products)
Liquid wastes:	2 cubic feet	-37 microcuries (irradiation vials with liquid mixed activation products)
	2 gallons	- 5 microcuries (mixed activation products)

CHAPTER 7

ENVIRONMENTAL SURVEILLANCE

Calcium-sulphate:Dysprosium thermoluminescent dosimeters in packs supplied by Radiation Detection Company, Sunnyvale, California are placed at nine locations around Campus. One pack is kept off-campus in a wood frame house (second story) as a control. The average of the remotely located packs on campus is in fact used as a "concrete environment" background for comparison purposes for evaluation of packs placed closer to the facility.

Locations:

1. Window of reactor room (inside facility).
2. Between reactor laboratories and radiochemical lab, in hall.
3. Loading dock, adjacent to west wall of reactor facility.
4. Classroom 152, over reactor facility.
5. In roof exhaust air flow from reactor room.
6. Steinhaus Hall (Bio.Sci) building: 4th floor.
7. Library building, 5th floor.
8. Computer Science Building, 4th floor.
9. Fume Hood Exhaust, Roof Level, from reactor lab.
10. 17941 Spicewood Way, Irvine (control).

Table IV shows the data as received from RDC reports for the period. All levels are as expected. Those above background reflect the neutron generator operating schedule (nitrogen-16 in the cooling water) and are essentially similar to those reported in prior years. As noted before, areas 1 and 2 are partly controlled so that the maximum possible annual dose to a true "off-site" individual would be estimated at less than 40 mrem from this data (above background).

The main and fume hood exhaust ducts continue to show no dose above background within error limits delivered to continuous occupancy of the exit stack locations.

TABLE IV
ENVIRONMENTAL DOSIMETRY REPORT DATA
1979-80

Location	Average Exposures in mr — Quarter 2 80	3 80	4 80	1 81	Total	Total less BACKGROUND (127 ± 14)
1	39	40	48	51	178	51
2	53	107	65	48	273	146
3	38	34	48	34	154	27
4	23	22	32	27	104	0
5	24	18	36	27	105	0
6	30	29	41	33	133	(0)
7	29	28	46	34	137	(0)
8	20	21	31	39	111	(0)
9	25	24	36	28	113	0
10	21	[illegible]	34	28	103	0

Average of locations 6,7,8 used for BACKGROUND.

CHAPTER 8

RADIATION EXPOSURE TO PERSONNEL

The annual exposures recorded are presented in Table V. Essentially all of these exposures are acquired in the course of isotope handling experiments and in some instances will have been received in State licensed areas. Most personnel working within the facility also carried neutron film. No non-zero exposures have ever been reported for these films.

29 of the personnel reported were undergraduate students in a class in Radioisotope Techniques meeting for one academic quarter (9 weeks of laboratory work) only. No non-zero readings were reported for this group.

Contamination surveys consisting of wipe tests and G-M surveys have shown significant, removable short-lived contamination in isotope handling areas. No other contamination areas have been found.

TABLE V.

Personnel Exposure Summary - 1/1/80 - 12/31/80 (in mrem)

Individuals	Whole Body Pen	Whole Body Non-Pen	Finger Ring
1	65	0	670
1	15	0	360
1	0	120	1520
1	0	50	70
1	0	0	550
1	0	0	150
1	0	0	140
1	0	0	90
1	0	0	40
1	0	0	30
55+	0	0	*

* Not monitored in all cases

\+ includes 29 students monitored for only 9 weeks.

APPENDIX I

Publications - (July 1 , 1980 - June 30, 1981)

T. Izak-Biran, V. P. Guinn, and M. A. Purcell, "Detailed Study of the Removal of Copper Jackets from Jacket Bullets", J. Forensic Sciences, 25 (1980) 374-379.

V. P. Guinn, "Cyclic Nuclear Activation Analysis", Radiochemical and Radioanalytical Letters, 44 (1980) 133-138.

V. P. Guinn, "Nuclear Activation Analysis 45 Years after George Hevesy's Discovery", Journal of Radioanalytical Chemistry, 5c (1980) 309-314.

Thermal ^{38}Cl Reactions with Propyne
Journal of Physical Chemistry, 84, 1876-1881 (1980)
F.S.C. Lee and F.S. Rowland

The Abstraction Reactions of Methylene with Deuterated Methyl Halides
Journal of Physical Chemistry, 85, 136 (1981)
Peter S.-T. Lee and F.S. Rowland

Direct Formation of RCl from the Gas Phase Reaction of Thermal Atomic Chlorine with PbR_4 ($R = CH_3$, C_2H_5)
Journal of Physical Chemistry, 85, 84 (1981)
Makoto Kikuchi, F.S.C. Lee, and F.S. Rowland

Gas Phase Reactions of Thermal ^{18}F with Propyne and 3,3,3-Trifluoropropyne
Journal of Physical Chemistry 85, 89 (1981)
Colman Concannon and F.S. Rowland

A Microprocessor Based Monitoring System for a Small Nuclear Reactor Facility
G.E.Miller and C.F.DeKeyser
Proceedings of TRIGA Owners' Conference VII,
San Diego, California, March 1980

Assessments of Accuracy and Precision of Multi-Element Determinations in Whole Coal by Non-destructive Neutron Activation Analysis.
George E. Miller, Don R. Burtner, and Paul A. Jerabek
Proceedings of 3rd annual Conference on Nuclear Methods in Environmental and Energy Research
Columbia, Missouri, April 1980

- -