U.C. IRVINE TRIGA REACTOR

Annual Report for Period

July 1st, 1978 to June 30, 1979

Facility License: R-116

Docket 50-326

Prepared in accordance with Part 6.7f of

the facility technical specifications.

by

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I. 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 realted to forensic science, fossil fuels, geochemistry, art and archeology studies, chemical synthesis, industrial quality control, enzyme study, etc.

The reactor was utilized by some undergraduate students performing irradiation experiments using small quantities of short-lived activation products.

Twenty graduate students and four postdoctoral associates have used the facility under the guidance of three faculty in Chemistry. These include individuals supported under IAEA training fellowships from Nigeria, Iran, Malaysia, Israel and Chile.

One senior operator and one operator have allowed licenses to lapse during this period so that the facility currently has active 4 licensed senior operators and 1 licensed operator.

The facility was closed for normal operations from September 28th, 1978 to allow for a strip-down to permit removal of dropped items (a pen and a finger dosimeter ring) from the core area. A reload to critical was made on November 4th and normal operations were resumed on November 14th following recalibrations.

Apart from this period, operation has been routine. Operation this year is substantially lower in terms of hours owing to completion

of one major project involving large numbers of samples to be analyzed.

A list of recent publications is given in Appendix I.

II. Date Tabulations for the Period (July 1, 1978-June 30, 1979).

Table I.

Experiment Approvals on File	14
Experiments Performed (including repeats)	441
Samples irradiated	5234
Energy generated, Mw hours	69.42
Total, 69 element core: 127.0	
(74-79 element core: 573.0)	
Total since initial criticality:	700.0 MwH
Pulse operation (annual)	41
of which	17> $2.00
Total pulses to 6-30-79	625
Hours critical (annual)	358 hours
Total to 6-30-79	3609 hours
Operator training and requalification	39 hours
Inadvertent scrams:	30
Visitors to reactor (admitted)	493
Max dose recorded (all within instrument errors)	1 mr
Visiting researchers (dosimeters issues)	(1274)
Maximum dose recorded	30 mr
Visiting researchers (badged)	7

Table II.

Reactor Status 6-30-79

Fuel elements in core (incl. 2 fuel followers):		77
Fuel elements in storage (reactor tank)-used		30
Fuel elements unused-(instrumented)		1
Graphite reflector elements in core		34
Experimental facilities in fuel element holes		3
Water filled positions		11
Core excess (cold, no Xenon)	$2.87	
Control rod worths (6-18-79)		

REG	$4.30
SHIM	$3.30
ATR	$2.06
FTR	$0.59
TOTAL	$10.25

Maximum possible pulse insertion (ATR + FTR):	$2.65	
Maximum peak power attained:		1100 Mw.
Maximum peak temperature observed (B-ring)		296°C

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III. Inadvertent Scrams and Unplanned Shutdowns.

Table III.

Date	Time	Power Level	Type and Explanation
1978			
7/6	09:46	<3w	Linear power scram. Operator switched range switch wrong direction.
7/6	14:15	<3w	Period scram. Trainee operator allowing too fast start up period.
7/7	12:54	250kw	SHIM rod dropped - lamp in magnet circuit failed.
7/12	07:42	1.5w	Seismic trip. No apparent seismic activity. Probably reset too sensitively following start up testing.
7/27	15:36	250kw	SHIM rod dropped into core and lamp burned out.
7/28	10:58	250kw	Pneumatic system carrier (rabbit) failed. Terminus removed from core to remove broken portions of carrier.
8/25	09:42	<3kw	Linear power scram. Operator switched range switch incorrect direction during control rod calibration operations.
8/25	15:35	1.5w	Period scram during rod calibration operations.
8/30	08:09	250kw	SHIM rod dropped. Magnet circuit indicator lamp failed.
8/30	14:11	<3w	Period scram, trainee operator error in approach to critical.
8/30	21:10	250kw	Pneumatic sample carrier failure. Pieces and sample retrieved by vacuum tube.
8/31	09:49	<1.5w	Seismic scram. No seismic activity. Imbalanced reset following start up check?
9/6	14:07	<1.5w	Period scram, operator error during start to critical.
9/8	09:44	<1w	Period scram, operator error during start to critical.

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Date	Time	Power Level	Type and Explanation
9/19	14:19	2.5kw	Seismic scram. No seismic activity. Imbalanced reset during prior training exercise?
9/25	15:30	<3w	Period scram, operator trainee error during start to critical.
9/25	15:36	<3w	SHIM rod magnet circuit lamp failure. Previous replacement found to have been incorrect wattage lamp!
9/26	13:53	<3w	Seismic scram, no seismic activity. Imbalanced reset during start-up check?
12/13	15:02	250kw	Seismic scram, no seismic activity. Imbalanced reset during start-up check?
12/14	18:21	250kw	Pneumatic transfer capsule failed to return. Successive operations finally achieved intact return.
1979			
1/4	14:47	<200w	REG rod dropped, magnet circuit lamp failure
1/12	13:40	< 1w	Period scram, operator error during start to critical.
2/2	9:08	< 1.5w	Linear power scram. Operator switching range switch incorrectly during start to critical.
2/2	13:22	< 3w	Period scram. operator error during start to critical.
2/6	10:	1.5w	Seismic scram, no seismic activity. Imbalanced reset following start-up check?
2/6	11:58	<10w	Period scram. operator error during start to critical.
2/9	12:26	30w	Linear power scram, operator range switch error during approach to power.
2/21	10:42	<3w	Period scram, operator error during start to critical.
3/7	9:41	<3w	Period scram, trainee error during start to critical.
3/7	10:16	250kw	% power scram, trainee error in adjustment of automatic mode failing to allow for unevenly loaded specimen rack.

Date	Time	Power Level	Type and Explanation
3/14	20:13	< 3w	Period scram, operator error during start to critical.
4/4	14:02	250kw	% power scram, error in adjustment of automatic control to allow for uneven sample load in specimen rack.
4/10	11:44	< 1w	Period scram, operator error during start to critical.
4/11	9:35	1.5w	Period scram, unexplained electrical surge during core excess measurement.
4/18	13:20	250kw	Seismic scram, no seismic activity. Imbalanced reset following start-up check?
5/10	11:36	250kw	Pneumatic sample carrier broke and sample failed to return. Sample eventually removed by vacuum system.
5/12	17:00	250kw	Pneumatic sample carrier broke. Sample and pieces retrieved.
6/6	10:52	1.5w	Seismic scram, no seismic activity. Imbalanced reset after start-up ckeck.
6/18	10:19	< 10w	Period scram, operator error during rod calibration operations.

IV. 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 items which continue from previous reports.

(a) SHIM rod drive magnet circuit. A new magnet has finally been delivered. It has not yet been installed since recent experience (since 9/25/78) has been good! The use of varying wattage lamps in the series circuit may have been a contributing factor.

(b) The fixed area monitor designed to monitor samples removed from the rotating specimen rack is still out of operation. Attempts to make it work adequately with a new geiger tube failed apparently because a direct replacement tube could not be obtained. The correct tube has been on order since February, 1979 but there is a supply problem. Local measurements of each sample are performed.

(c) The pneumatic transfer capsules (rabbits) continue to fracture on a more frequent basis then the early models. A log is being established to document the current "lifetime".

Other items requiring special maintenance were:

(a) Adjustable transient rod drive cylinder. On 11/13/78 this was overhauled as it seemed to be leaking excessive air. The unit was not fully screwed home, and when it was and the locking screw tightened, full travel could not be achieved. This restriction was finally traced to binding of the rod position potentiometer worm drive. When this was cleaned and correctly readjusted correct operation was restored.

(b) The linear channel recorder amplifier developed poor gain around 7/21/78. Electronic component replacement was needed and the recorder returned to service on 7/25/78.

V. Facility Changes and Special Experiments Approved.

(1). Installation of additional fuel element storage racks in the reactor tank was approved under provisions of Title 10CFR 50.59.,

to permit unloading the complete core so that objects dropped into the core structure could be removed. The rack is now empty but remains in the pool. Reactor Operations Committee instructions preclude any further utilization without specific approval. Copies of documentation involved were submitted with the 77/78 annual report for this facility.

(2). A portal radiation monitor has been acquired to monitor all persons on exit from the facility. The instrument is currently in use on a test basis pending establishment of calibration and routine testing procedures.

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

VI. Radioactive Effluent Release

(a) Gases. The major direct release to the environs is ^{41}Ar 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 measurements at point of origin within the facility and taking only dilution in the exhaust stream into account. An integrated dose estimate is provided by an environmental ($CaSO_4$:Dy) dosimeter hanging directly in the exhaust at the point of stack discharge and changed quarterly. This substantiates projections that the submersion dose to an individual standing at the exhaust stack continuously would be less than the reliability limit of such dosimeters (conservatively estimated at 4 quarters x5 mr or <20 mr above background).

The exact quarterly dose readings obtained are given in Section VII below - location 5.

(1) Operation of pneumatic transfer system (8/1/78-7/15/79):

Total (250 kw assumed)	3,303 minutes
Release rate	6×10^{-8} μc/ml
Flow rate (exhaust)	2×10^{6} ml/sec
Total release:	2.4×10^{4} μC_i

(2) Release from pool surface:

Total operation (Mwh x 4)	278 hours
Release rate (assumed)	$<1 \times 10^{-8}$ μc_i/ml
Flow rate (exhaust)	2×10^{6} ml/sec
Total release:	$<2 \times 10^{4}$ μC_i

Total of (1) and (2): $<4.4 \times 10^{4}$ μC_i

Concentration averaged over 12 months = $<7 \times 10^{-10}$ μC_i/ml

This is substantially lower than the 77/78 figure due to the lower run schedule.

(b) Liquids and Solids. Liquid and solid wastes from utilization of by-product materials are disposed through a University contract, after mixing with other isotopes used on Campus under State of California auspices. The disposal contract is administered through the Environmental Health and Safety office. No wastes were disposed this year as a direct result of reactor operation (as opposed to irradiated sample materials).

Included below are also some isotopes purchased under State of California license.

Much of the sample materials produced within the reactor facility is transferred to other users operative under State license and disposed as waste directly by those users.

Disposals by the facility were as follows:

a) Solid wastes

(i) Trace activation product - 19 cubic feet equivalent to 145 μC_i* of ^{24}Na activity.

(ii) Tritium as sealed accelerator target assemblies - 1 cubic foot approximately 40 curies of ^{3}H.

(iii) Chromium - 51 (purchased wastes totalling 2 cubic feet - 8 mC_i* activity.

b) Liquid wastes - 10 gallons of aqueous wastes containing trace activation products equivalent of about 40* μC_i of ^{24}Na

* activities determined at time of transfer to E, H and S control, not at time of final shipment off campus!

VII. Environmental Surveillance

$CaSO_4$:Dy 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 as a control. The average of the remotely located packs on campus is 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 received from RDC reports for the period. All levels are as expected - those above background reflecting the neutron generator operating schedule (^{16}N activity in 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 likely annual dose to a truly off-site individual would have been estimated at 60 m rem from this data.

As noted above, the main and fume hood exhaust duct data (locations 5 and 9 respectively) show no dose above background (within error limits) delivered to continuous occupancy of those locations.

Table IV

ENVIRONMENTAL THERMOLUMINSCENT DOSIMETER REPORT

1978-79

Average Exposures in mr

Location	Quarter 1 4/78-6/78	Quarter 2 7/78-9/78	Quarter 3 10/78-12/78	Quarter 4 1/79-3/79	Total	Total less "BACKGROUND" (130 mr) ±11
1	46	63	54	52	215	78
2	43	59	83	78	263	126
3	47	47	52	50	196	59
4	24	28	41	35	128	0
5	26	26	38	36	126	0
6	28	37	42	36	143†	(0)
7	30	29	41	43	143†	(0)
8	20	24	42	38	124†	(0)
9	26	42	34	45	147	10
10	22	32	54	35	143	6

† Average used for background.

VIII. Radiation Exposures 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.

50 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. Some contamination by ^{51}Cr was observed in laboratory floor areas following a spill of about 8 mC_i of this isotope during handling. This was removed following extensive cleaning of the area and the cleaning materials disposed tc waste.

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Table V.

Personnel Exposure Summary - 1/1/78 - 12/31/79 (in mrem)

Whole Body

Individuals	Pen	Non-Pen	Finger Ring
1	100	190	1190
1	80	0	1520
1	50	0	0
1	15	0	1540
1	15	0	100
1	15	0	0
1	0	0	240
1	0	0	220
1	0	0	180
1	0	0	90
1	0	0	80
2	0	0	70
2	0	0	60
1	0	0	50
2	0	0	40
2	0	0	30
54	0	0	-*

* not monitored.

Appendix I.

Reactor Facility Publications (1977-1979)

1. V. P. Guinn and M. A. Purcell, "A Very Rapid Instrumental Neutron Activation Analysis Method for the Forensic Comparison of Bullet-Lead Specimens", Journal of Radioanalytical Chemistry, 37 (1977), 85-91.

2. V. P. Guinn and D. A. Miller, "Recent Instrumental Neutron Activation Analysis Studies Utilizing Very Short-Lived Activities", Journal of Radioanalytical Chemistry, 37 (1977) 313-324.

3. V. P. Guinn, E. Garzanov, and E. Cortes T., "Further Studies in the Advance Prediction of Gamma-Ray Spectra and Detection Limits in Instrumental Neutron Activation Analysis", Journal of Radioanalytical Chemistry, 43 (1978) 599-609.

4. V. P. Guinn, Jeanne C. Leslie, and L. E. Murray, "Advance Prediction of Neutron Activation Analysis Spectra and Detection Limits", Trans. Amer. Nucl. Soc., 27 (1977) 218-219.

5. V. P. Guinn and J. Nichols, "Neutron Activation Analysis of Bullet-Lead Specimens: The President Kennedy Assassination". Trans. Amer. Nucl. Soc., 28 (1978) 92-93.

6. N. R. Wallis, V. P. Guinn, and M. A. Purcell, "Neutron Activation Analysis of Shotgun Pellets". Trans. Amer. Nucl. Soc., 28 (1978) 93-94.

7. T. Izak-Biran and V. P. Guinn" Analysis of Metal Fragments for Lead via the ^{204}Pb (n.n') ^{204m}Pb Reaction". Trans. Amer. Nucl. Soc., 28 (1978) 94.

8. V. P. Guinn, E. R. Christensen, K. De Lancey, W. W. Wadman III, J. H. Reed, N. Hansen, A. Abu Samra, and V. J. Orphan, "Neutron Activation Analysis Trace-Element Studies in Connection with the Offshore Drilling for Oil". Nuclear Methods in Environmental and Energy Research (CONF-771072, Univ. of Missouri, Columbia, 1977), pages 303-311.

9. E. R. Christensen, V. P. Guinn, and J. Scherfig, "Determination of Selected Metals in Urban Runoff and Related Estuarine Sediments by Neutron Activation and Atomic Absorption". Nuclear Methods in Environmental and Energy Research (CONF-771072, Univ. of Missouri, Columbia, 1977), pages 542-559.

10. E. R. Christensen and V. P. Guinn, "Zinc from Automobile Tires in Urban Runoff". Journal of the Environmental Engineering Divison (Amer. Soc. of Civil Engineers), 105 (1979) 149-168.

11. V. P. Guinn, "The New Mercury Tolerance Level in Fish in the U.S." Trans. Amer. Nucl. Soc., 32 (1979) 171-172.

12. V. P. Guinn, T. Izak-Biran, M. A. Purcell, V. Cassorla, and J. Nichols, "Instrumental Neutron Activation Analysis of WCC Mannlicher-Carcano 6.5 mm Bullet Lead". Trans. Amer. Nucl. Soc., 32 (1979) 188-189.

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13. V. P. Guinn and J. Hoste, "Elemental Analysis of Biological Materials by Neutron Activation Analysis". Nuclear Activation Techniques in the Life Sciences, 1978 (Intl. Atomic Energy Agency, Vienna, 1979), pages 71-74.

14. V. P. Guinn, O. I. Asubiojo, J. C. Leslie, and C. C. Perkins, "Recent Additions to the Basic INAA Advance Prediction Program". Trans. Amer. Nucl. Soc., 32 (1979) 191-192.

15. Oxygen Stoichiometry in the Geochemical Standards of the U.S. Geological Survey: A Blind Study.
A. Volborth, G. E. Miller and Claudia K. Garner
Chemical Geology, 20, 85 (1977)

16. Oxygen Stoichiometry of Common Reagents by Fast Neutron Activation.
A. Volborth, G. E. Miller and Claudia K. Garner
Chemical Geology, 19, 327 (1977).

17. Operational Health Physics Safeguards During Transfer of 38 Used TRIGA Fuel Elements.
G. E. Miller and W. W. Wadman III
Proceedings of Ninth Midyear Topical Symposium on Operational Health Physics, Health Physics Society, Denver, Colorado, February, 1976, p. 520.

18. Recently-Developed Neutron Activation Analysis Techniques Utilizing the U.C. Irvine TRIGA Mark I Reactor
V. P. Guinn, D. Chambless, E. Cortes, K. de Lancey, E. Garzanov, D. A. Miller, G. E. Miller and M. A. Purcell.
Proceedings of the Fourth European TRIGA Uses Conference, Vienna, 1976
G. A. Report TOC-8, pp. 4-11 to 4-21.

19. Activation Analysis Course Experiments with a 14 Mev Neutron Generator.
D. A. Miller and G. E. Miller
Scientific and Industrial Applications of Small Accelerators, Fourth Conference, 1976, IEEE, p. 270.

20. Use of a 14 Mev Neutron Generator in Analysis of Coal and Coal Derivatives.
G. E. Miller and A. Volborth.
Scientific and Industrial Applications of Small Accelerators, Fourth Conference, 1976, IEEE, p. 288.

21. Oxygen in Coal Ash: A Simplified Approach to the Analysis of Ash and Mineral Matter in Coal.
Alexis Volborth, George E. Miller, Claudia K. Garner and Paul A. Jerabek.
Fuel, 56, 204 (1977).

22. Material Balance in Coal 1: Material Balance and Oxygen Stoichiometry of Six Coals from Wyoming.
Alexis Volborth, George E. Miller, Claudia K. Garner and Paul A. Jerabek.
Fuel, 56, 209 (1977).

23. Fast Neutron Activation Analysis in Coal Research.
A. Volborth and G. E. Miller.
Trans. Amer. Nucl. Soc., 27, 160 (1977).

24. Chemical Analysis of Marble Sculptures: Crouching Aphrodite and the Westmacott Jupiter in the J. Paul Getty Museum.
G. E. Miller, L. Sangermano and D. L. Bunker
Getty Museum Journal, 5, 149 (1977)

25. Material Balance in Coal. 2: Oxygen Determination and Stoichiometry of 33 Coals.
Alexis Volborth, George E. Miller, Claudia K. Garner and Paul A. Jerabek
Fuel, 57, 49 (1978).

26. A Study of Oxidation of Dental Amalgams with Age.
Claudia K. Garner, G. E. Miller and A. Volborth.
Journal of Dental Research, 56 (12), 1489 (1977)

27. Maintenance of Fuel Rods and Pneumatic Transfer System
George E. Miller
Proceedings of TRIGA Owner's Conference VI, 3-1,
Corvallis, Oregon, February, 1978.
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28. Analysis of Materials for Oxygen, Nitrogen and Silicon by Fast Neutron Activation. Preliminary Study of Oxygen Stoichiometry of Coal.
G. E. Miller and A. Volborth
Fifth Annual DOE/Fossil Energy Conference on Univeristy Coal Research
Auguust, 1978, p. 316.

29. Competitive Radiotracer Evaluations of Rate Constants and Activation Energies for Reactions of ^{38}Cl with CH_4 and C_2H_6 versus $CH_2=CHBr$
Journal of Physical Chemistry, 81, 286-290 (1977)
Frank S. C. Lee and F. S. Rowland.

30. The Temperature Dependences of the Ultraviolet Absorption Cross-Sections of CCl_2F_2 and CCl_3F, and Their Stratospheric Significance
Journal of Physical Chemistry, 81, 286-290 (1977)
C. C. Chou, W. S. Smith, H. Vera Ruiz, K. Moe, G. Crescentini, M. Molina, and F. S. Rowland.

31. The Reactions of Chlorine Atoms with Acetylene and Their Possible Stratospheric Significance
Journal of Physical Chemistry, 81, 684-685 (1977)
F. S. C. Lee and F. S. Rowland.

32. Thermal ^{38}Cl Reactions with Propene
Journal of Physical Chemistry, 81, 1222-1229 (1977)
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33. Thermal ^{38}Cl Atom Sources: Neutron Irradiation of $CClF_3$ and CCl_2F_2
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34. Thermal ^{38}Cl Reactions with Ethylene
Journal of Physical Chemistry, 81, 1235-1239 (1977)
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35. The Chemical Form of Cosmogenic Radioactive ^{38}Cl and ^{39}Cl in the Lower Stratosphere
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F. S. Rowland.

36. Reactions of Radioactive ^{18}F with Alkenes, Alkynes, and Other Substrates "Fluorine-Containing Radicals", John W. Root, Editor, American Chemical Society Symposium Series, 1978, pages 26-58.
F. S. Rowland, Fleet Rust and Joan P. Frank.