U.C.IRVINE

Nuclear Reactor Facility

Annual Report

for

July 1st 1994 to June 30th 1995

Facility License R-116

Docket 50-326

Prepared in Accordance with Part 6.7f

of the Facility Technical Specifications

by

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## Section 1.

## Operations

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.

Some use is made of the facility by other educational institutions supported by the Reactor Sharing Program of DOE since September 1st 1987. This program has involved tours, class demonstrations, and analyses of samples submitted by faculty.

The reactor remained in shut-down condition from the beginning of this period until February 1995. At that time a new fission counter had been installed, new cabling acquired and installed for this channel, and all console check-outs made satisfactorily. A number of other items have needed maintenance during this period (see Section 4), but routine inspections have found the facility to be in good condition. Operations have been normal since February 1995.

From July - September 1994, Dr. Patricia Rogers was promoted to Reactor Supervisor on the move of the previous Supervisor, Dr. George Miller, to emeritus status. At the end of September, Dr. Miller was recalled to service as Reactor Supervisor (and Lecturer) by the Chemistry Department and Dr. Rogers returned to the position of Assistant Supervisor.

Section 2.

## Data Tabulations for the Period July 1st, 1994 to June 30th, 1995

### TABLE I.

| | |
|---|---|
| Experiment Approvals on file | 8 |
| Experiments performed (including repeats) | 128 |
| Samples irradiated | 935 |
| Energy generated this period (Megawatt hours) | 10.8 |
| Total, 69 element core = 127.0 | |
| >74 element core = 1112.5 | |
| Total energy generated since initial criticality | 1239 5 Mwh |
| Pulse operation this period | 0 |
| Total pulses to 6/30/94 | 978 |
| Hours critical this period | 85 |
| Total hours critical to date | 6944 |
| Inadvertent scrams or unplanned shutdowns | 0 |
| Visitors to reactor - admitted | 46 |
| Maximum dosimeter recorded for visitors | 0 mrem |
| Visiting researchers (dosimeter issues) | 2 |
| Maximum dose recorded | 3 mrem |
| Visiting researchers (badged) | 11 |

### TABLE II

Reactor Status 6/30/95

| | |
|---|---|
| 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 $2.69

Control rod worths (2/13/95)

| | |
|---|---|
| REG | $2.74 |
| SHIM | $3.32 |
| ATR | $1.88 |
| FTR | $0.70 |
| Total: | $8.64 |

| | |
|---|---|
| Maximum possible pulse insertion | $2.58 |
| Maximum peak power recorded (no pulse operation during this period) | - Mw |
| Maximum peak temperature recorded (B-ring) | -. °C |

## Section 3.

### Inadvertent Scrams and Unplanned Shutdowns

TABLE III.

| Date | Time | Power | Type and Cause |
|---|---|---|---|
| 1994 | | | |
| Reactor in shut-down condition. | | | |
| 1995 | | | |
| 02/08 | 23:00 | <1 w | During start-up testing the SHIM rod failed to rise. All circuit contacts checked, unused circuit by-passed, and rod tested to function correctly. |
| 02/09 | 17:00 | <1 w | SHIM rod again fails to raise from bottom position during attempt to calibrate REG rod. Exercise of UP switch and DOWN switch contacts seemed to cure problem. |
| 02/14 | 09:43 | 2.5 mw | Linear Power Scram (new Wide Range Channel) at 107% of 2.5 mwatts. Operator unfamiliarity with new system had unit in manual instead of auto-range mode during approach to critical. |
| 02/14 | 10:00 | 25 kw | No % Power reading during first start to take new console instrumentation above 1.5 watts power. Found to be poor connection of signal lead to %P channel. A new coax was assigned to this lead. |
| 03/31 | ?time | <2.5 mw | Operator reported difficulty with ATF and FTR not firing during start-up checklist operations. Reactor Supervisor traced problem to poorly made switch contacts on pulse rod AIR switch. Operation a few times cleared the problem. |

## Section 4

### Maintenance and Surveillance

The following non-routine maintenance activities were carried out during this period:

July 1994 - January 1995 -

During this period work continued on the fission counter channel problem. The counter had given erratic or no signals when connected to the new Wide Range Monitor (WRM) Channel, and had been removed for the core shroud at the end of June 1994. The welded housing was cut open to reveal that moisture (over 30 years) had corroded the HN connectors at the top of the counter. These were removed with considerable difficulty. Silver activation products (the HN connectors are silver plated), were noticeable, but no fission products were observed on wipe counts. Connection of the fission counter, while in air, to the WRM yielded a high noise signal that responded weakly to neutrons form a small external Cf-252 source. . Attempts to check for ground loops were unproductive. The supply company for the WRM (Gamma-Metrics) agreed to loan a new fission counter for further tests. With this attached, good, low noise, signals were obtained, using the neutron source. Since the counter was offered on long-term loan, a new water-tight housing was fabricated in the UCI machine shop to fit this counter of differing shape and size from the old counter. The guide lead portions of the old system were re-used. The first two versions of this system failed leak weld tests and had to be re-fabricated.

Section 4 Maintenance and Surveillance (continued)

Installation of this systems was completed, but when attempts were made to test all circuits operating simultaneously prior to start-up, (New WRM, and Wide Range Linear Monitor (WRLM), with former % Power channel) a high noise interaction between the new WRM and WRLM was encountered. After diligent testing for ground loops, emission frequencies, etc., the problem could not be cured. Gamma-metrics finally proposed that replacement low-noise mineral insulated coax cable might eliminate this problem. This proved to be the case. the entire system was dismantled and the former "regular" coax signal/HV cable was replaced with new mineral insulated cable. All systems finally operated satisfactorily in late January 1995.

Start-up was accomplished in stages, first by adjusting the WRM and WRLM channels to approximately agree at low powers (<2.5 watts), then by calibrating control rods using the WRLM data to measure differential insertion periods. Finally slow increases in power level were conducted, relying on the one former channel (%P) which had not been modified to provide appropriate power level indications. Each of the other channels was successively brought into line. Finally, full calorimetric power level tests were conducted at estimated 200 kilowatts, found 206 kilowatts, and channels adjusted accordingly. remarkable agreement was found between all former values (prior to February 1994) for control rod worths, curves, and power settings.

The reactor was returned to routine operations at 14:10 on February 14th, 1995.

Other items of maintenance noted during this period:
(See also Section 3 for problems with transient rod firing circuit.)

08/12/94 A main Campus power failure was experienced between 10:30 and 11:00 am. The emergency generator provided power to radiation monitors and the security system during this time.

02/02/95 and during prior shut-down period. Two of the Area Radiation Monitor detector units were serviced to repair failed circuit components. In one case, Geiger counter failure had also caused failure of a diode and high meg resistor. Four of the six units remained in service at all times.

## Section 5
## Facility Changes and Special Experiments Approved

No special experiments or additional facility changes were approved during this period.

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 kwatts) 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 (7/1/94-6/30/95):

| | |
|---|---|
| a. Minutes of operation: | 105 minutes |
| b. Release rate assumed: | $6. \times 10^{-8}$ microcuries/ml |
| c. Flow rate of exhaust air: | $1.2 \times 10^{8}$ ml/min |
| Total release computed: (a x b x c) = | $0.8 \times 10^{3}$ microcuries |

(2) Release from pool surface (7/1/94-6/30/95):

| | |
|---|---|
| a. Total hours of operation at power (Mwh x 4) = | 43 hours |
| b. Release rate assumed: | $<1. \times 10^{-8}$ microcuries/ml |
| c. Flow rate of exhaust air: | $1.2 \times 10^{8}$ ml/min |
| Total release computed: (a x 60 x b x c) | $= 3.1 \times 10^{3}$ microcuries |
| **Total of (1) and (2) emission in 1 year** | **$= 3.9 \times 10^{3}$ microcuries** |

| | |
|---|---|
| **Concentration averaged over 12 months** | **$= < 6.2 \times 10^{-11}$ microcuries/ml** |

This remains similar to values reported in previous years considering the reduction in operation hours, and remains lower than MPC even assuming no dilution of the plume at the stack.

(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. In all instances, considerable time elapses before final shipment from campus, if, any, so that substantial decay may occur for medium-lived radionuclides.

DRY WASTES: none disposed during this period.

LIQUIDS: none disposed during this period.

## 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. In fact, the average of the more remotely located "concrete environment" packs on campus is used as the background for comparison purposes, since a more similar microenvironment is experienced by such packs.

### Table of Locations.

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).

* The location of this dosimeter was moved on October 3 1991, following occupancy of the new BS2 building which is closer to the reactor than the older building.

Table IV shows the data as received from RDC for the period. All levels are as expected and are similar to those reported in recent years. As noted before, areas (1) and (2) are also partly controlled so that maximum possible exposure to an individual in an uncontrolled area is very minimal at this facility with current operations. 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 show remarkable consistency. An appreciable change would be easily noticeable.

TABLE IV.
Environmental Dosimetry Data.
1994-1995

Average Exposures in mr.

| Location. | Quarter 2/94 | 3/94 | 4/94 | 1/95 | Annual Total | Total less background (36± 25) |
|---|---|---|---|---|---|---|
| 1 | 8 | 5 | 6 | 7 | 26 | 0 |
| 2 | 13 | 9 | 12 | 11 | 45 | 9 |
| 3 | 10 | 9 | 12 | 11 | 42 | 6 |
| 4 | 5 | 4 | 5 | 5 | 14 | 0 |
| 5 | 6 | 6 | 12 | 7 | 31 | 0 |
| 6 | 7 | 6 | 6 | 7 | 26 | 0 |
| 7 | 16 | 14 | 20 | 14 | 64 | 28 |
| 8 | 4 | 4 | 4 | 5 | 17 | 0 |
| 9 | 6 | 7 | 7 | 7 | 27 | 0 |
| 10 | 3 | 2 | 1 | 2 | 8 | 0 |

Average of locations 6, 7, and 8 used for "background" ( = 36)

## Section 8.
## Radiation Exposure to Personnel.

The annual exposures reported as a result of finger dosimeter ring and film badge dosimetry are presented in Table V. All of this exposure was acquired in the course of isotope handling experiments, and in one instance was partly accumulated in an area outside the facility, in a location licensed by the State of California, but from by-product material produced at the facility. No exposures have been reported for individuals involved in facility operations.

Eleven (11) persons were monitored on a continual basis using film badges, and all of these were also issued with finger dosimeter rings. These were required to be worn while handling isotopes. Film badges were generally worn at waist level by all personnel.

Certain additional monitoring is done of visiting individuals who are issued with direct-reading pocket dosimeters in addition to film badges and finger dosimeter rings.

Contamination surveys consisting of wipe tests and G-M surveys have shown significant, removable contamination only in areas coming into direct contact with samples removed from the reactor, and on sample handling tools.

### TABLE V.

Personnel Exposure Summary for 5/1/94 to 4/30/95 (in mrem)

| | Individuals | Whole Body Deep | Whole Body Shallow | Finger Ring Shallow |
|---|---|---|---|---|
| | 1 | 0 | 5 | 630* |
| | 1 | 0 | 0 | 30* |
| | 9 | 0 | 0 | 0 |
| Totals | 11 | 0 | 5 | 660* |

*Results from two researchers working primarily with $^{38}Cl$ isotope (38 minute half-life) and performing rapid radiochemical operations. These individuals have been counseled to review handling procedures to reduce hand exposures.

Additional aggregated data from self-reading pocket dosimeters issued to researchers:

| | | |
|---|---|---|
| 1 | 1 | (2 visits) |