

NUCLEAR ENGINEERING REACTOR LABORATORY
TRIGA MARK III FACILITY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA

BERKELEY RESEARCH REACTOR
ANNUAL REPORT OF OPERATIONS
January 1, 1985 through December 31, 1985
(BRR Technical Specifications 6.7.2.)

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Reactor Supervisor

BERKELEY RESEARCH REACTOR OPERATIONS, 1985

Reactor Use

The Berkeley Research Reactor (BRR) is a TRIGA Mark III facility capable of producing 1 MW steady state and of pulsing to 1300MW peak power. The Berkeley Research Reactor is a research and educational tool of the University of California. It is located on the Berkeley Campus and operated by the Department of Nuclear Engineering.

Besides being used by the Department of Nuclear Engineering, the reactor is also used by other departments and campuses within the University, the Lawrence Berkeley and Lawrence Livermore laboratories, and is available to other universities and colleges in the area.

In addition, the Berkeley Research Reactor is used as an irradiation source for service to industry contracts and provides a stimulant to touring and interested high school and college students.

Experiments Performed

Table 1 lists the experiments which were performed at the Berkeley Research Reactor during the year 1985. A total of 29 different experiments were performed. Four new experiments were approved between January 1 and December 31, 1985. The last column in Table 1 illustrates the number of times each experiment was performed.

Table 1. Experiments Performed at the Berkeley Research Reactor in 1985

Experiment #	Class	Title Objective	Facility	Principal Investigator/Experimenter	Dept/Company	No. of Runs
13	A	Staff operation of reactor, calibrations, demonstrations, etc.	Any, all	Lim	NE	69
196	A	A short term activation analysis study on archaeological artifacts	Central Thimble	Asaro, Michel	DOE	29
210	C	Neutron Radiography facility development	Lazy Susan	Lim	NE	20
221	A	Determination of nickel impurity in Fe_2O_3 by activation analysis	Central Thimble	Prussin, Cann	NE	5
273	A	Origin of pottery	Central Thimble	Asaro, Michel	DOE	6
274	A	Irradiation of ethylene dibromide	Lazy Susan	Somorjai, Abgeles	Chemistry	1
275	B	Electronic components test	Exposure Room	Young et al	LMSC	58
280	A	Production of $^{60\text{m}}\text{Co}$ and ^{60}Co	Fl Rabbit	Prussin	Chemistry	8
281	A	Production of ^{198}Au	Fl Rabbit	Prussin, Lim	Chemistry	2
282	A	Production of ^{32}P	Lazy Susan and Central Thimble	Prussin, Lim	Chemistry	1
283	A	Irradiation of household aluminum foil	Lazy Susan	Prussin, Cann	NE	8
303	A	Magnitude and shape of Central Thimble flux	Central Thimble	Lim	NE	4
304	A	Reactor checkout, approach to critical and pulsing	Pool	Ruby, Lim	NE	10
305	A	Reactivity worth of control rods	All	Lim	NE	10
306	B	Graphite prism and thermal column experiment	Thermal column	Ruby, Lim	NE	3

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Table 1. Experiments Performed at the Berkeley Research Reactor in 1985

Experiment #	Class	Title Objective	Facility	Principal Investigator	Dept./ Company	No. of Runs
315	A	Activation analysis of geological materials	Lazy Susan	Lim	Sonoma State University	1
351	B	Neutron Tracks Studies in LEXAN	Hohlraum	Wollenberg	DOE	2
352	A	Deuterium-tritium micro balloons irradiation	Central Thimble	Lane, Lim	DOE	10
353	A	Doping of Germanium	Central Thimble	Hansen	DOE	4
354	A	Irradiation of environmental samples	Central Thimble	Helft, Lim	DOE	3
361	B	Irradiation of natural or depleted uranium in ceramic form	Lazy Susan	Prussin	NE	16
362	A	Production of Lutecium	Central Thimble	Lim, Seaborg	Chemistry	1
369	A	Activation analysis of geological materials	Central Thimble	Denton, Lim	NE	17
370	A	Production of ^{24}Na	Central Thimble	Lim	Chevron	1
371	A	Production of activity tracers ^{169}Er , ^{170}Tm , $^{169,175}\text{Yb}$	Central Thimble	Lim, Seaborg	NE/DOE	3
372	B	Radiation Effect on electronic components	Exposure Room	Lim et al	TRW Hughes Motorola Ford	135
373	B	Radiation effect on electronic components	Exposure Room	Lim et al	NE	6
374	A	Production of ^{56}Mn and ^{198}Au sources	Lazy Susan	Lim, Norman	NE/DOE	12
375	B	Genetic hazard of n irradiation in mice	Exposure Room	Lim, Goldstein	UCSF	5

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Chemistry: Department of Chemistry, University of California, Berkeley.
Chevron: Chevron Research Company
DOE: Department of Energy (Lawrence Berkeley and Lawrence Livermore Laboratories).
LMSC: Lockheed Missiles & Space Company, Inc.
NE: Department of Nuclear Engineering, University of California, Berkeley.
TRW: TRW, Inc.
Hughes: Hughes Aircraft, Inc.
Motorola: Motorola, Inc.
Ford: Ford Aerospace & Communications, Inc.

Reactor Maintenance

Routine maintenance, minor repair and modification, testing and inspection as required by the Tech Specs were performed during 1985. Major maintenance included the replacement of the reactor ion-exchange resins, replacement of the reactor linear chamber, replacement of the ventilation system absolute filters, and refurbishing of the fission chamber.

10 CFR 50.59 Changes

There were no changes in 1985 that required review under paragraph 10 CFR 50.59.

Routine Tests and Calibrations

Thermal power calibrations were performed in April and September, and the constant Air Monitor was calibrated in November 1985.

The Reactor Pool Water Radiation Monitor was calibrated in April, and the Stack Gas Argon-41 Monitor was calibrated in September 1985.

Operating Schedule

The Berkeley Research Reactor normally operates on a single 8-hour shift, between 8AM and 5PM, Monday through Friday. One day every two weeks is set aside for routine checks and maintenance. Extended reactor runs and overtime operation are allowed if required by the experimental program.

Fuel Addition and Fuel Inventory

Three new fuel elements were loaded to the reactor core in October 1985 to replace three suspected leaking instrumented fuel elements. There were no fuel additions.

Energy Production and Fuel Burn-Up

The Berkeley Research Reactor produced 134,000 kW-hours or 5.58 MW-days of energy during 1985. As there were 202 operating days in 1985, this corresponds to an average daily energy production of 660 kW-hours per operating day. In 1985 the Berkeley Research Reactor was critical approximately 239 hours and was operated at full power (1 MW) for approximately 125 hours.

The total burn-up was 6.0 grams elemental and 7.0 grams of the isotope U-235.

The total cumulative energy production since initial criticality is approximately 277.68 MW-days.

Nuclear Regulatory Commission Inspection

An NRC inspection was conducted in May 1985. This inspection referred to a follow-up inspection to ensure that NRC recommendations made during a routine inspection in December 1984 had been carried out. This inspection concluded that all recommendations had been resolved. No items of non-compliance with NRC requirements were identified within the scope of this inspection.

Emergency Shutdowns and Inadvertent Scrams

<u>Date</u>	<u>Scram Circuit</u>	<u>Reasons</u>
5-30-85	Period Scram	Operator Error
8-9-85	Linear Power Scram	Operator Error
9-30-85	Linear Power Scram	Operator Error
10-18-85	External Scram	Operator Error
11-13-85	Linear Power Scram	Operator Error

Operator's Training

In December 1985, one reactor operator passed the Nuclear Regulatory Commission Reactor Operator's Examination.

Requalification Training Program

In accordance with regulations, a successful requalification written examination was given to licensed operators and senior operators in August and November 1985.

Exercise

An emergency and security evacuation exercise involving the Reactor staff, the officer of Environmental Health and Safety and the Campus Police Department was conducted on July 2, 1985 between 07:00 and 10:00 hours. The scenario included evacuation of the Etcheverry Hall Patio by the Campus police during a hypothetical loss of pool water accident. This exercise was part of a requirement specified in the Berkeley Research Reactor Emergency and Security Plans.

Radioactive Effluent Released or Shipped

Liquid Waste

No liquid radioactive waste generated by the reactor facility was picked up by Campus Environmental Health and Safety Personnel.

No liquid radioactive waste was discharged to the sewer, storm drain or other location in the environment from this facility in 1985.

Gaseous Waste

All gaseous radioactive waste discharged was calculated as Ar-41, since studies in the past have shown no other significant radionuclides occur from

normal operations.

The total released was 6.13 Ci as Ar-41 of a maximum permitted release of 2,785 Ci which corresponded to 0.22% of the allowable release. Maximum concentration at one particular period at stack discharge was 2.54×10^6 $\mu\text{Ci/ml}$. This concentration is 81% of the allowable maximum concentration for this facility of 3.12×10^6 $\mu\text{Ci/ml}$. No average concentration was calculated due to frequent periods of time when the reactor was idle more than 50% of normal operational time (8 hours per day, 5 days a week, excluding legal and university holidays).

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Filter paper air samples showed that no particulate radioactivity above naturally occurring levels could be detected in the exhaust stream.

Trace amounts of fission products from a leaking instrumented fuel element were detected during the months of September and October 1985. During this incident, the estimated average concentration of detectable fission gasses (Kr-85m, KR-87, KR-88) in the reactor room were found to be lower than the allowable maximum concentration in unrestricted areas averaged over a year, as stated in 10 CFR 20, Appendix B. Most of the fission products were confined to the reactor room and disappeared by decay. The leaking fuel element has been isolated and removed from the core. This incident was reported to the NRC Region V Office.

Solid (Dry) Waste

No solid (dry) waste was released for disposal during the year.

Personnel Radiation Exposure

Recorded radiation exposures for the year to personnel included:

a. Facility personnel (routine users of dosimeters):

- maximum total whole body exposure to an individual - 300 mrem
- maximum total extremity exposure to an individual - 980 mrem
- minimum total whole body exposure to an individual - 0 mrem
- minimum total extremity exposure to an individual - 0 mrem

Note: At year end, 35 individuals were assigned whole body dosimeters, and seven were assigned extremity dosimeters. Three individuals showed an exposure. Exposures were both whole body and extremity.

b. Visitors (non-routine dosimeter users):

Approximately six hundred and ninety entries were made by visitors. Less than 7% had any reading. None were significant. The highest was 10 mrem. No average exposure was calculated.

c. There were no exposures in excess of 10 CFR 20 limits.

Radiation and Contamination Levels

a) Routine monthly meter surveys generated 329 individual radiation readings.

- maximum reading observed - 100 mrem/hr. (gamma)
- minimum reading observed - 0 mrem/hr.

Average of readings was not meaningful due to abnormal influence of a few high dose rate areas out of 26 locations routinely surveyed.

b) Routine area quarterly film dosimeters at 23 locations generated 92 readings; routine monthly dosimeters at 5 locations generated 60 readings.

Maximum readings observed:

- monthly location - 460 mrem (gamma)
- quarterly location - 900 mrem (gamma)

Minimum readings observed - (0)

Maximum annual accumulated:

- monthly location - 1345 mrem (all gamma)
- quarterly location - 2370 mrem (all gamma)

Average dose is meaningless due to excessive influence of a few positions.

c) Routine quarterly area TLD dosimeter readings totalled 52 at 13 locations.

- maximum total dose at any location for the year - 299 mrem
- minimum total dose at any location for the year - 0 mrem

Average dose is meaningless due to excessive influence of a few positions.

Note that the period reported for quarterly film and TLD is 2/1/85 through to 1/31/86.

d) Routine weekly swipe program generated 2040 swipes of which 63 showed contamination above normally expected level.

- maximum swipe activities recorded was 8.4×10^2 $\mu\text{Ci}/100 \text{ cm}^2$ from normally contaminated surfaces. This was due to tritium not associated with reactor operations.
- minimum activities for both categories was zero.

Averages were not determined due to excessive influence of a few swipes.

Environmental Surveys

Environmental TLD measurements at 9 locations outside the facility generated 36 radiation readings.

- maximum total recorded exposure at any outside location for the year was 200 mrem.
- minimum total recorded exposure at any location for the year was 0 mrem.

Averages were not determined because the majority of locations had very low or no exposure, and only a few locations had significant readings.

Note that the period reported was 2/1/85 through to 1/31/86.

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COLLEGE OF ENGINEERING
DEPARTMENT OF NUCLEAR ENGINEERING

BERKELEY, CALIFORNIA 94720

March 14, 1986

Docket No. 50-224

License No. R-101

Director
U.S. Nuclear Engineering Commission, Region V
Office of Inspection & Enforcement
1450 Maria Lane, Suite 210
Walnut Creek, California 94596

Sir:

For your information, enclosed is a copy of the Berkeley Research Reactor's Annual Report for the year 1985.

The report is prepared for the Nuclear Regulatory Commission, as required by our Technical Specifications.

Sincerely,

Thomas H. Pigford
Chairman

THP/lp
Enclosure.

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11