

May 7, 1979

NUCLEAR ENGINEERING REACTOR LABORATORY
TRIGA MARK III Facility
University of California
Berkeley, California

BERKELEY RESEARCH REACTOR
ANNUAL REPORT OF OPERATIONS
January 1, 1978 through December 31, 1978

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BERKELEY RESEARCH REACTOR OPERATIONS, 1978

Reactor Use

The Berkeley Research Reactor (BRR) is a TRIGA Mark III facility capable of producing 1 MW steady state and of pulsing to 1200 MW peak power. The BRR is a research and educational tool of the University of California, is located on the Berkeley Campus and is operated by the Department of Nuclear Engineering.

Besides being used by the Department of Nuclear Engineering it is used by other departments and campuses of the University, by the Lawrence Berkeley Laboratory and is available to Universities and Colleges in the area. The Lawrence Berkeley Laboratory is operated by the University of California under contract from the Department of Energy.

In addition the BRR 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 I lists the experiments which were performed in the BRR during the year 1978. A total of 26 different experiments were performed. Two new experiments were approved between January 1 and December 31, 1978. The last column in Table I illustrates the number of times each experiment was performed.

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Table I. Experiments Performed at the BRR in 1978

Experiment #	Class	Title Objective	Facility	Principal Investigator, Experimenter	Dept. or Company*	No. of Runs
13	A	Staff operating of reactor, calibrations, demonstrations, etc.	any, all	Staff	NE	13
188	B	Determination of fission yield	Lazy Susan	Prussin	NE	2
196	A	A short term activation analysis study on arch. artifacts	Central Thimble	Asaro	LBL	140
221	A	Determination of nickel impurity in Fe ₂ O ₃	Central Thimble	Prussin, Cann	NE	4
242	A	Determination of soil trace elements and irradiation of iridium	Lazy Susan	Inman, Lim	SRI	3
272	A	Activation of inorganic iodide	Rabbit	Prussin	NE	84
273	A	Origin of pottery	Central Thimble	Asaro, McCracken	LBL	20
274	A	Irradiation of Ethylene Dibromide	Lazy Susan	Somorjai, Angeles	Chem.	9
275	B	Electronic components test	Exposure Room	Perry, et al	LMSC	85
280	A	Production of Co-60m	Lazy Susan	Prussin, Markowitz	NE	1

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Experiment #	Class	Title Objective	Facility	Principal Investigator, Experimenter	Dept. or Company*	No. of Runs
281	A	Production of Au-198	Lazy Susan	Prussin, Markowitz	NE	1
282	A	Production of P-32	Lazy Susan	Prussin, Markowitz	NE	1
283	A	Irradiation of household Al foil	Lazy Susan	Prussin, Cann	NE	10
293	A	Production of β^+ source	Lazy Susan and Central Thimble	Kaplan, Ruby, Lim	NE	8
303	A	Magnitude and Shape of Central Thimble Flux	Central Thimble	Ruby, Lim	NE	1
306	B	Graphite Prism and Thermal Column Experiment	Thermal Column	Ruby, Lim	NE	1
312	A	Production of Na-24	Lazy Susan	Ruby, Lim	NE	1
326	A	Boron autoradiography in Film	Thermal Column	Thomas, Lim	Material Science	4
327	A	Determination of Calcium Concentration in Biological materials	Flex-Rabbit	Prussin, Lim, Cann	NE/NASA	185
336	A	Irradiation of Soils and Rocks	Flex Rabbit	Prussin, Lim	NE	8
337	A	Irradiation of Oily Water	Lazy Susan	Asaro	LBL	3

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Experiment #	Class	Title Objective	Facility	Principal Investigator, Experimenter	Dept. or Company*	No. of Runs
338	B	n- γ fluence measurement of a pulse in the Exposure Room	Exposure Room	Ruby, Lim	NE	6
340	B	Cryogenic Irradiation in the Exposure Room	Exposure Room	Ruby, Lim	NE/LBL	8
342	A	Irradiation of UO ₂ in the Lazy Susan	Lazy Susan	Olander, Lim	NE	3
343	B	He-3 Neutron Spectrometry	Thermal Column	Prussin	NE	10
344	A	Irradiation of Freon Gas	Lazy Susan	Lim, Crawford	Physics	1

*Chem.: Department of Chemistry, University of California Berkeley

LBL: Lawrence Berkeley Laboratory

LMSC: Lockheed Missile & Space Co.

Physics: Department of Physics, University of California Berkeley

NASA: NASA/Ames Research Center, Moffett Field, California

NE: Department of Nuclear Engineering, University of California Berkeley

SRI: SRI International, Ken Park, California

Material Science: Department of Material Science, University of California Berkeley

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Reactor Maintenance

Other than routine maintenance, no other work was performed at the BRR facility during 1978.

10 CFR 50.59 Changes

The following 10 CFR 50.59 changes were performed in 1978:

Replace linear channel detector Reuter-Stokes RSN 234A-M3 with similar Reuter-Stokes RSN-C1-1210-135#6 (new factory number). The R.S. chamber is a compensated ion chamber (1-1/2" and 15" long) which is clamped in an aluminum tube fitted in core position G-13, 1/2" above the top grid plate. This tube extends to the surface of the water where it is bolted to the core support structure. The detector is securely positioned in the tube by a 1/4-20 machined aluminum screw. Position G-13 is symmetrical to position G-25 of the old linear chamber, about the long axis of the pool.

Routine Tests and Calibrations

The limit of transverse bend and longitudinal elongation of each reactor fuel element was measured during June, 1978 and was found to be within limits specified by the operating license. Thermal power calibrations were performed in July and December 1978.

The Constant Air Monitor was calibrated during the month of January 1978.

The Reactor Pool Water Radiation Monitor and the Area Radiation Monitors were calibrated in August, 1978 while the Stack Gas Argon-41 Monitor was calibrated in September 1978.

Gaseous Effluent

Gaseous effluent from the Reactor Laboratory is considered to be principally Argon-41 which is released via the facility's general and emergency exhaust ventilation system. The release

of gaseous effluent in curies of Argon-41 is calculated from the measured stack gas concentration in $\mu\text{Ci/cc}$ assuming the ventilation system continuously operates at its rated capacity of 60,000 CFM.

During 1978 the total amount of Argon-41 released was calculated to be approximately 2900 millicuries. This is approximately 0.10% of the allowable Ar-41 release for the BRR facility.

The maximum amount released during a one month period in 1978 was 400 millicuries in March and the minimum was 146 millicuries in June.

Operating Schedule

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

Fuel Addition

In August 1978, three used instrumented fuel elements were added to the reactor core G-ring. Also 9 standard fuel elements from the reactor core C-ring were interchanged with 9 from the G-ring. A total gain of excess reactivity of 64 cents was noted.

Energy Production and Fuel Burn-up

The BRR produced 206,625 kW-hours of energy during 1978. As there were 214 operating days in 1978 this corresponds to an average daily energy production of 966 kW-hours per operating day.

The BRR was critical approximately 317.0 hours and was operated at full power (1 MW) for approximately 159.0 hours. The total burnup in 1978 was 9.0 grams elemental and 10.0 grams of the isotope U-235.

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NRC Inspection

In February and March of 1978 inspections of the BRR operations and safety were performed by the NRC Walnut Creek Office. No items of non-compliance to the technical specifications and NRC regulations were found.

Operators Training

In February and May of 1978, two reactor operators passed the NRC 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 October 1978.

Exercise

Security and emergency evacuation exercises were performed during the month of June and December 1978. Both the reactor staff and campus police participated in the drills. Also, three groups of a total of twenty-seven firemen from the Berkeley Fire Department visited the reactor for a training tour. Each time the group was accompanied by the Campus Fire Marshal.

Formal University Courses Using the Reactor

The facilities of the Berkeley Research Reactor are used for five regular laboratory courses listed in the University General Catalog:

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| NE 102 | - Radiation Detection and Nuclear Instrumentation Laboratory
(Nuclear Engineering) (23 students) |
| NE 103 | - Experimental Neutronics Laboratory
(Nuclear Engineering) (6 students) |
| IDS 124 | - Chemical Methods in Nuclear Technology
(Interdepartmental Study/Chemistry and Nuclear Engineering) (13 students) |
| Chem. 111B | - Physical Chemistry Laboratory
(Chemistry) (Approx. 120 students) |
| Bio-Env. 153 | - Instrumentation and Tracer Analysis
(Public Health) (8 students) |

Graduate Students Using the Reactor for Thesis Work

Fourteen graduate students from the University of California at Berkeley were engaged in thesis research which required use of the BRR during 1978. Eleven students using the reactor were with the Department of Nuclear Engineering, and one student each with the Department of Material Science, Soil Nutrition and Nutritional Science of the University of California Berkeley.

The following theses were completed in 1978 and were based on research which was all or partly performed at the BRR.

Master of Science

GUENTHER, Charles: "Pulse Risetime Distribution
in a He-3 Neutron Spectrometer".
(Nuclear Engineering)

STERBENTZ, James: "Reaction Cross-Sections for the
Production of Beryllium-7 from
(^6Li , ^3He) and (^7Li , ^3He)".
(Nuclear Engineering)

Doctor of Philosophy

LUNG, Tai-Ping: "Reactor Noise Analysis: Subcritical
Reactivity from Two Detectors
Correlation Measurement".
(Nuclear Engineering)

YU, Kim Pao: "An Experimental Study of Carryover
and Liquid Entrainment during the
Reflooding Phase of the Loss of
Coolant-Accident".
(Nuclear Engineering)

Faculty Members, Post-Doctoral Appointees and Other Research Associates Using the Reactor

The Berkeley Research Reactor receives substantial usage from University faculty and post-doctoral appointees as well as other research associates throughout the Bay Area. As might

be expected the department affiliation of faculty members using the reactor closely compares with the department affiliation of graduate students. Of the faculty, post-doctoral and other research associates using the reactor, eighteen were with the Lawrence Berkeley Laboratory, seven were with the Department of Nuclear Engineering, three were with the Department of Material Science, two of each were with the Department of Public Health and the Department of Nutritional Science and one of each with the Department of Physics and the Department of Soil Nutrition, University of California Berkeley. The reactor was also used by three research associates of the University of California, San Francisco.

Service to Industry Irradiations

Irradiations are performed as a service to industry at the BRR facility if:

- (a) such work is for non-profit government supported research
- (b) suitable irradiation facilities are not available elsewhere
- (c) any cost savings are passed on to the non-profit or government sponsor.

On this basis, in 1978, service irradiations were performed for:

- (a) Lockheed Missile and Space Company
Sunnyvale, California
- (b) SRI International
Ken Park, California
- (c) NASA/Ames Research Center
Moffett Field, California

Tours

Tours of the reactor laboratory are held on the afternoon of alternate Fridays for students and the general public. In addition, tours are held as requested for classes from the University and nearby high schools and colleges.

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Partial Publications During 1978 Which Resulted
From Research Performed at the BRR

- Ruby, L., Froloff, W. B., and Lim, T. H., "Predicted Effect Using 12 w/o Fuel in the B Ring of the Berkeley Research Reactor", Sixth TRIGA Reactor Owner's Conference, Corvallis, Oregon, February 27-March 1, 1978, General Atomic Co., Publisher, p. 4-20.
- Ruby, L., and Lim, T. H., "Use of the TRIGA Mark III as a Simulator for the Tokamak Fusion Test Reactor", Sixth TRIGA Reactor Owner's Conference, Corvallis, Oregon, February 27-March 1, 1978, General Atomic Co., Publisher, p. 6-10.
- Graham, W. G., Lim, T. H., and Ruby, L., "Explosion Potential of Neutral-Beam-Source Cryopumps for TFTR", Transactions of the Third Topical Meeting on the Technology of Controlled Nuclear Fusion, Santa Fe, New Mexico, May 9-11, 1978, Electric Power Research Institute Publisher.
- Graham, W. G. and Ruby, L., "Radiation-Induced Degassing of Cryopumps", Trans. Am. Nucl. Soc. 30, 30 (1978).
- Pyle, R. V., Ruby, L., and Sterbentz, J. W., "Measurement of the ${}^6\text{Li}({}^3\text{He}, \text{d}){}^7\text{Be}$ and ${}^7\text{Li}({}^3\text{He}, \text{t}){}^7\text{Be}$ Cross Sections", Trans. Am. Nucl. Soc. 30, 623 (1978).
- Guenther, C., "Pulse Risetime Distribution in a He-3 Neutron Spectrometer". MS Thesis. Department of Nuclear Engineering, University of California Berkeley, 1978.
- Sterbentz, J., "Reaction Cross-Sections for the Production of Beryllium-7 from $({}^6\text{Li}, {}^3\text{He})$ and $({}^7\text{Li}, {}^3\text{He})$. MS Thesis. Department of Nuclear Engineering, University of California Berkeley, 1978.
- Yu, K. P., "An Experimental Study of Carryover and Liquid Entrainment during the Reflooding Phase of the Loss of Coolant-Accident". Ph.D. Thesis. Department of Nuclear Engineering, University of California Berkeley, 1978.

- Lung, T-P., "Reactor Noise Analysis: Subcritical Reactivity from Two Detectors Correlation Measurement". Ph.D. Thesis. Department of Nuclear Engineering, University of California Berkeley.
- Lim, T. H., "Kinetic Model Building Using Advanced Nuclear Medicine Techniques--The Kinetics of Chromium(III) in the Human Body". International Congress on Nuclear Medicine and Biology, Washington, D.C., September 17-21, 1978.
- Director, B., Kaplan, S., and Perez-Mendez, V., "A Pressurized Multiwire Proportional Chamber for Neutron Imaging". IEEE Transactions on Nuclear Science, Vol. NS-25, No.1, February 1978.
- Cann, C., Nagel, D., and Young, D. R., "Regulation of Calcium Metabolism in Hypodynamic Monkeys". NASA Contract Report NCA2-OR745-804, December 1978.
- King, J. C., Reynolds, W. R., Margen, S., "Absorbtion of Stable Isotope of Iron, Copper and Zinc During Oral Contraceptive Used". The American Journal of Clinical Nutrition, Volume 31, pp. 1198-1203, July, 1978.
- Michel, H. V., Asaro, F., and Norberg, A.L., "Chemical Characteristics of Medieval Brasses". LBL Annual Report 1978.
- Bard, J. C., Asaro, F., and Heizer, R. F., "Perspectives on the Dating of Prehistoric Great Basin Petroglyphs by Neutron Activation Analysis". Archaeometry 20, 85 (1978).
- Yellin, J., Perlman, I., Asaro, F., Michel, H., and Mosier, D.F., "Comparison of Neutron Activation Analysis from the Hebrew University and Lawrence Berkeley Laboratory". Archaeometry 20, 95 (1978).
- Stross, F.H., Bowman, H. R., Michel, H. V., Asaro, F., and Hammond, N., "Mayan Obsidian: source correlation for southern Belize artifacts". Archaeometry 20, 89 (1978).
- Asaro, F., Michel, H. V. and Meyers, C. W., "A Statistical Evaluation of some Columbia River Basalt Chemical Analysis." Rockwell International Report RHO-BWI-ST-3. May 1978.

Asaro, F., Michel, H. V., Sidrys, R. and Stross, F., "High Precision Chemical Characterization of Major Obsidian Sources in Guatemala". American Antiquity 43, 436-433 (1978).

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