



Washington State University

Nuclear Radiation Center

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August 27, 2004

Non-Power Reactors and Decommissioning Project Directorate  
Division of Reactor Program Management  
Office of Nuclear Reactor Regulation  
One White Flint North  
11555 Rockville Pike  
Rockville, MD 20852-2738

Re: Docket No. 50-27; Facility License R-76

Dear Sir:

In accordance with the Technical Specifications for Facility License R-76 and the provisions of 10 CFR 50.59, paragraph (6), the attached Annual Report prepared by Stephanie L. Sharp, Reactor Supervisor of the WSU facility, is hereby submitted. The report covers the period July 1, 2003 to June 30, 2004.

Sincerely,

A handwritten signature in cursive script, reading 'G. E. Tripard'.

Gerald E. Tripard  
Director

GET/pw

Enclosure

cc: S.L. Sharp  
American Nuclear Insurers  
U.S. NRC, Document Control Desk

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# ANNUAL REPORT ON THE OPERATION OF THE WASHINGTON STATE UNIVERSITY TRIGA REACTOR

Facility License R-76 for the Reporting Period of  
July 1, 2003 to June 30, 2004

## A. Narrative Summary of the Year's Operation

### I. Operating Experience

The Washington State University Reactor has accumulated 1405 Megawatt hours on cores 33-X and 34-A during the reporting period. A total of 470 samples were irradiated, for a total of 7937.6 user-hours. In addition, 8 pulses greater than \$1.00 of reactivity addition were performed during this reporting period. The quarterly operations summaries are shown in Table I Section B.

### II. Changes In Facility Design, Performance Characteristics, and Operating Procedures Related to Reactor Safety.

The reactor facility has made several upgrades during the reporting period including a core configuration change, the installation of new irradiation facilities, and the reinstallation of a beamport. None of the changes were 50.59 type modifications, and were all performed according to appropriate procedure.

### III. All surveillance tests and requirements were performed and completed within the prescribed time period. The NRC inspection of the week of June 7 found that some shipping papers had been incorrectly prepared. The program used to prepare these papers has since been corrected.

## B. Energy and Cumulative Output

The quarterly operations summaries are given in Table I.

TABLE I  
Fiscal Year Summary of Reactor Operations

	J-A-S	O-N-D	J-F-M	A-M-J	TOTALS
Hours of Operation	195.43	542.25	594.07	324.55	1656.3
Megawatt Hours	187.81	458.17	448.57	310.86	1405.41
No of Sample Irradiations <sup>1</sup>	15	31	17	33	96
No. of Samples	79	100	40	150	369
No. of Iridium Cans Irradiated	18	18	27	22	85
No. of Silicon Cans Irradiated	1	3	6	6	16
User Hours	980.4	1488.8	3102.5	2365.9	7937.6
No. Pulses > \$1.00	0	4	0	4	8

<sup>1</sup>This table has been modified for clarity. Numbers of Samples and Sample Irradiations do not include Iridium and Silicon data. Those data are listed in individual format. User hours denotes the total user hours, including Iridium and Silicon.

The cumulative energy output since criticality of the TRIGA core since 1967 is 1016 Megawatt Days, The mixed core of FLIP and Standard fuels installed in 1976 has accumulated 750 Megawatt Days.

### C. Emergency Shutdowns and Inadvertent Scrams

There were no emergency shutdowns that occurred during the reporting period. The dates and causes of the 14 inadvertent SCRAMS are listed in Table II.

TABLE II  
Inadvertent SCRAMS

7/17/03	Short period. Blade pulled too quickly by trainee.
8/5/03	Short period. Log-N channel pegged high.
12/23/03	Short period. Noise in Log-N channel.
1/30/04	Short period. Log-N channel pegged high.
2/2/04	High Radiation on bridge. Sample re-shielded.
2/26/04	Short period. Blade pulled too quickly.
3/8/04	Scram due to BNCT system being turned off.
3/16/04	Power failure.
3/16/04	Power failure.
3/16/04	Power failure.
3/17/04	Power failure.
3/18/04	Power failure.
4/16/04	Log-N channel pegged high.
5/18/04	Manual SCRAM due to fire alarm in building.

### D. Major Maintenance

All routine planned maintenance items were completed within the reporting period. Additionally, several modifications/improvements to the facility were made, including a core configuration change, the addition of several new irradiation facilities, and the re-installation of a beamport tube.

The core was re-configured to ensure that the maximum flux was available at the west face of the reactor, for use in BNCT experiments. A new iridium irradiation facility was made to hang from the reactor core support structure, providing a facility to expose iridium to the highest flux available. This facility is movable, so it can be easily removed from the reactor core face to facilitate BNCT operations. This facility was installed by divers in the reactor pool while the core was de-fueled.

## E. Changes, Tests and Experiments performed Under 10 CFR 50.59 Criteria

There have been no changes to the facility made under 10 CFR 50.59 criteria within the reporting period.

## F. Radioactive Effluent Discharges

### I. Radioactive Liquid Releases

A total of 13.7 microcuries was released in 670 gallons of liquid during the reporting period. The releases are listed in Table III.

TABLE III  
Radioactive Liquid Releases

Date	Nuclide	Activity ( $\mu\text{Ci/ml}$ )	Release Limit	Percent of Release Limit
11/12/2003	$^{46}\text{Sc}$	8.64e-8	1.00e-4	0.09
	$^{51}\text{Cr}$	1.81e-7	5.00e-3	0.00
	$^{54}\text{Mn}$	2.11e-10	3.00e-4	0.00
	$^{57}\text{Co}$	3.05e-9	6.00e-4	0.00
	$^{58}\text{Co}$	7.21e-7	2.00e-4	0.36
	$^{60}\text{Co}$	1.01e-8	3.00e-5	0.03
	$^{105}\text{Rh}$	1.36e-7	5.00e-4	0.03
	$^{192}\text{Ir}$	5.41e-8	1.00e-4	0.05
Total Activity Released in 670 ft <sup>3</sup> water: 13.7 $\mu\text{Ci}$				

### 2. Radioactive Gaseous Release

During the reporting period, no significant quantity of any gaseous or particulate material with a half-life greater than eight days was released.

During the reporting period, at no time did the Argon-41 release exceed 20% of the Effluent Release Limit.

A total of 9.97 Curies of Argon-41 was released, with an average concentration of Argon-41 of  $1.511 \times 10^{-07}$   $\mu\text{Ci/cc}$ . The monthly releases are summarized in Table IV on Page 4.

**TABLE IV**  
**Monthly Argon-41 Releases**

Month	Conc. Before Dilution, uCi/ml	% Release Limit Before Dilution <sup>1</sup>	% DAC Limit Before Dilution <sup>2</sup>	Quantity mCi
Jul. 03	$1.935 \times 10^{-7}$	7.74	0.0258	1064
Aug. 03	$7.494 \times 10^{-8}$	3.00	0.0100	412
Sep. 03	$8.791 \times 10^{-8}$	3.52	0.0116	483
Oct. 03	$2.078 \times 10^{-7}$	8.31	0.0277	1143
Nov. 03	$1.177 \times 10^{-7}$	4.71	0.0157	647
Dec. 03	$1.883 \times 10^{-7}$	7.53	0.0251	1036
Jan. 04	$1.218 \times 10^{-7}$	4.87	0.0163	670
Feb. 04	$1.273 \times 10^{-7}$	5.09	0.0170	700
Mar. 04	$3.137 \times 10^{-7}$	12.55	0.0418	1725
Apr. 04	$1.454 \times 10^{-7}$	5.81	0.0194	800
May. 04	$9.843 \times 10^{-8}$	3.94	0.0131	541
Jun. 04	$1.365 \times 10^{-7}$	5.46	0.0182	751

<sup>1</sup> Based on 10 CFR 20 effluent release limit of  $1.0 \times 10^{-8}$  uCi/ml for <sup>41</sup>Ar (Table 2, Col.1), and a dilution factor of  $4.0 \times 10^{-3}$  (S.A.R. 6.4.2) for a before dilution limit of  $2.5 \times 10^{-6}$  uCi/cc. (20% of limit is  $5.0 \times 10^{-7}$  uCi/ml).

<sup>2</sup> Based on 10 CFR 20 DAC limit of  $3.0 \times 10^{-6}$  uCi/ml for <sup>41</sup>Ar (Table 1, Col. 3) and a dilution factor of  $4.0 \times 10^{-3}$  for a before dilution DAC limit of  $7.5 \times 10^{-4}$  uCi/ml.

### 3. Radioactive Solid Waste Disposal

During the reporting period, the following solid waste was transferred to the Campus Radiation Safety Office for packaging and disposal.

0.02 millicuries in 14 cubic feet of non-compacted solid waste.

82.5 millicuries in 7.5 cubic feet, (1 - 7.5 cuft barrel), of non-compacted solid waste.

## G. Personnel and Visitor Radiation Exposures

The quarterly exposures of selected Nuclear Radiation Center reactor staff and experimenters who routinely utilize the W.S.U. reactor are given in Table V on Page 5. The maximum quarterly exposure of a reactor staff member was 34 millirem, whole body.

A total of 2372 individual persons visited the Nuclear Radiation Center during the reporting period, of which 564 entered a Restricted Area. All exposures as determined by digital pocket dosimeter were less than 1 millirem.

A total of 30 group tours, consisting of 354 individuals, visited the Center during the reporting period. As determined by digital pocket dosimeter, all exposures were less than 1 millirem.

TABLE V  
Quarterly Reactor and Experimenter Staff Exposure  
(in millirem)

Badge No.	Jul-Aug-Sep 03	Oct-Nov-Dec 03	Jan-Feb-Mar 04	Apr-May-Jun 04
6618	5			
6296	1	22	24	20
4045	3	4	-	-
3504	- <sup>1</sup>	-	-	-
5855	9	12	8	4
6834	31	31	34	29
5723	1	-	-	4

<sup>1</sup> The “-“ denotes a dosimeter reading that is less than or equal to the background radiation level for that quarter.

#### H. Reactor Facility Radiation and Contamination Levels

The routine area radiation surveys of the building in non-reactor vital areas<sup>1</sup> had an average dose level of 0.240mR/Hr., while routinely accessible reactor vital areas had an average dose level of 0.182 mR/Hr. The highest average dose level in a routinely accessible reactor vital area was 0.68 mR/Hr., which occurred in Room 201, Reactor Pool Room, on the reactor bridge. The lowest average dose in a routinely accessible reactor vital area was 0.03 mR/Hr., which occurred in Room 201B, the Reactor Console area. The average dose in the radiochemistry sample hoods was 0.09 mR/Hr. The highest average on site dose level was 12.0 mR/Hr. which occurred in Room 101-A, Purification Pump Room, which is accessible only through a floor hatch, and is adjacent to the reactor pool.

Routine building surveys for removable contamination in non-reactor vital areas<sup>1</sup> had an average level of  $8.98 \times 10^{-07} \mu\text{Ci}/100 \text{ cm}^2$ , while the average level in the reactor vital areas was  $6.03 \times 10^{-07} \mu\text{Ci}/100 \text{ cm}^2$ . The highest average value in the reactor vital areas was  $2.03 \times 10^{-06} \mu\text{Ci}/100 \text{ cm}^2$  which was found on the heat exchanger pit floor. The lowest average value in the reactor vital areas was  $3.13 \times 10^{-07} \mu\text{Ci}/100 \text{ cm}^2$  which was in Room 201, the Reactor Bridge, north side. The average level of removable contamination in the radiochemistry hoods was  $1.46 \times 10^{-06} \mu\text{Ci}/100 \text{ cm}^2$ .

<sup>1</sup> A non-reactor vital area is an area in the building where radioactive materials are used or stored but which is not a part of the Licensed reactor facility.

## I. Environmental Monitoring Program

The environmental monitoring program uses thermoluminescent dosimeters (TLD's) at locations both near and at distances around the reactor facility building. The quarterly exposures in the vicinity of the Nuclear Radiation Center are listed in Table VI. The average ambient gamma radiation levels for this area (80 mile radius) is 243  $\mu\text{Rem/day}$  as reported in the 30th Annual Report of the Environmental Radiation Program, Washington State Department of Health, Environmental Health Program, Table A-12, Page 131.

The values observed indicate there is no significant effect on the environmental radiation levels due to reactor operation.

**TABLE VI**  
Environmental Radiation Levels in the Vicinity of the Nuclear Radiation Center<sup>1</sup>  
(Exposure in  $\mu\text{Rem/day}$ )

Jul-Aug-Sep 02	Oct-Nov-Dec 02	Jan-Feb-Mar 03 <sup>3</sup>	Average
186.5	113.3	101.8	133.8
698.9 <sup>2</sup>	474.7 <sup>2</sup>	494.4 <sup>2</sup>	556.0 <sup>2</sup>

<sup>1</sup> For sampling stations located 25 meters or greater from the Nuclear Radiation Center.

<sup>2</sup> TLD attached to "Decorative" granite display on Compton Union Building Mall approximately 1300 meters from the Nuclear Radiation Center.

Quarterly exposures at locations adjacent to the reactor facility are listed in Table VII on Page 7. No significant effect on the environmental radiation levels by reactor operation was noted.

TABLE VII  
Environmental Radiation Levels Adjacent to the Nuclear Radiation Center <sup>1</sup>  
(Exposure in  $\mu\text{R/day}$ )

Location	Jul-Aug-Sep	Oct-Nov-Dec	Jan-Feb-Mar	Average <sup>3</sup>
<b>E. Loading Dock</b>	150.54	121.21	101.12	114.51
Rad. Storage Shed	247.31	151.52	123.60	174.14
<b>Rx Rm E. Secr. Gate</b>	258.06	222.22	202.25	227.51
<b>Cooling Tower Fence</b>	268.82	121.21	112.36	167.46
<b>Liquid Waste Tank</b>	182.80	121.21	112.36	138.79
Building Roof West	139.78	90.91	78.65	103.11
<b>Building W. Side</b>	204.30	121.21	123.60	149.70
Rx. Room Exh. Vent	118.28	70.71	78.65	89.21
Rx. Room W. Vent <sup>2</sup>	462.37	454.55	393.26	436.73
Pool Room E. Vent	451.61	464.65	449.44	455.23
Building Roof East	139.78	90.91	89.89	106.86
<b>S. Bldg. Entrance</b>	225.81	161.62	157.30	181.58

<sup>1</sup> For sampling stations located less than 25 meters from the Nuclear Radiation Center.

<sup>2</sup> Pool Room West Vent. TLD on roof, directly above reactor core.

<sup>3</sup> April-May-June results were not received by the time this report was written.

**BOLD** print locations indicate areas that are readily accessible by the public.

Technical Specifications ALARA effluent releases in 3.12(2) specify annual radiation exposures at the closest off-site extended occupancy shall not, on an annual basis, exceed the average local off-site background radiation level by more than 20%. For the reporting period, the average total background radiation level for sampling points 25 meters or greater from the facility was 133  $\mu\text{R/day}$ , while the average total radiation level at the closest extended occupied area 930 meters away was 132  $\mu\text{R/day}$ , indicating no significant exposure level above natural background.