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

In accordance with Technical Specifications for Facility License R-76 the attached Annual Report prepared by C. Corey Hines, Reactor Supervisor of the WSU Facility, is hereby submitted. The report covers the operating period July 1, 2010 through June 30, 2011.

Respectfully Submitted,



Donald Wall, Ph.D.  
Director

Enclosure

cc: C.C. Hines

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**ANNUAL REPORT**

**WASHINGTON STATE UNIVERSITY**

**NUCLEAR RADIATION CENTER**

**TRIGA REACTOR**

**Facility License R-76 for the Reporting Period of  
July 1, 2010 to June 30, 2011**

Nuclear Radiation Center  
Washington State University  
Pullman, WA 99163-1300

## TABLE OF CONTENTS

1.	Narrative Summary of the Year's Operation.....	2
2.	Energy and Cumulative Output .....	2
3.	Emergency Shutdowns and Inadvertent Scrams.....	3
4.	Major Maintenance .....	3
5.	Changes, Tests, and Experiments Performed Under 10 CFR 50.59 Criteria.....	4
6.	Radioactive Effluent Discharges.....	4
7.	Personnel and Visitor Radiation Exposures.....	5
8.	Reactor Facility Radiation and Contamination Levels .....	6
9.	Environmental Monitoring Program.....	7

**ANNUAL REPORT ON THE OPERATION OF THE  
WASHINGTON STATE UNIVERSITY NUCLEAR RADIATION CENTER  
TRIGA REACTOR**

Facility License R-76 for the Reporting Period of  
July 1, 2010 to June 30, 2011

**1. Narrative Summary of the Year's Operation**

**A. Operating Experience**

Core 35A has accumulated 2,480.2 MWH from beginning of life (BOL) through June 30, 2011. A total of 991 samples were irradiated, for a total of 41,790.3 user-hours. In addition, 21 pulses greater than \$1.00 of reactivity addition were performed during this reporting period. The quarterly operations summaries are shown in Table I located in Section 2.

**B. Changes In Facility Design, Performance Characteristics, and Operating Procedures Related to Reactor Safety.**

No changes were performed during the reporting period.

**C. Results of Surveillance Tests and Requirements**

All surveillance tests and requirements were performed and completed within the prescribed time period.

**2. Energy and Cumulative Output**

The quarterly operations summaries are given in Table I. The cumulative energy output since criticality of the TRIGA core (1967) is 1291.3 Megawatt Days (MWD). The mixed Standard Fuel and 30/20 LEU Fuel Core 35A installed in 2008 has accumulated a total of 103.3 MWD.

**Table I**  
Fiscal Year 2011 Summary of Reactor Operation

	<b>J-A-S</b>	<b>O-N-D</b>	<b>J-F-M</b>	<b>A-M-J</b>	<b>TOTALS</b>
Hours of Operation	287.4	296.4	295.4	261.7	1,140.9
Megawatt Hours	236.6	251.1	279.3	239.0	1,006.0
No of Sample Irradiations <sup>1</sup>	40	62	25	33	160
No. of Samples	115	432	61	278	886
No. of Iridium Cans Irradiated	39	22	20	24	105
User Hours	3,697.5	4,315.8	29,983.5	3,793.5	41,790.3
No. of Pulses > \$1.00	3	10	2	6	21

<sup>1</sup> Number of samples and sample irradiations do not include iridium data. User hours denotes the total user hours, including iridium.

### 3. Emergency Shutdowns and Inadvertent Scrams

There were no emergency shutdowns that occurred during the reporting period. The dates and causes of the 3 inadvertent scrams are listed in Table II. No scrams were due to exceeding the Limiting Safety Systems Setting set point.

**Table II**  
Inadvertent SCRAMS

Date	SCRAM
7/22/10	Operator inadvertently pressed auto range button causing the channel to SCRAM. Restart ok.
8/18/10	Operator bumped control rod #1 magnet with experiment support rotator hose weight causing the magnet to disengage while at power. Restart ok.
1/6/10	Operator inadvertently depressed 100 kW scale switch on the linear channel causing a high power SCRAM. Restart ok.

### 4. Major Maintenance

All routine planned maintenance items were completed within the reporting period. The below listed items were performed, although they are not part of routine preventative maintenance.

12/22/2010: Cooling system: Cooling tower

The cooling tower head was removed to identify the condition that was causing the cooling tower head (the water spray assembly) to bind. A set of ball bearings was replaced allowing the cooling tower head to rotate freely.

5/9/2011: Cooling System: Heat Exchanger Plate Change

The heat exchanger plates were removed and replaced.

**5. Changes, Tests, and Experiments Performed Under 10 CFR 50.59 Criteria**

No changes were performed during the reporting period.

**6. Radioactive Effluent Discharges**

**A. Radioactive Liquid Releases**

Approximately 9309 gallons of liquid waste was released; however, after analysis with gamma spectroscopy, no radioactivity above the limit of detection was found.

**B. Radioactive Gaseous Release**

During the reporting period, no significant quantity of gaseous or particulate material with a half-life greater than eight days was released. At no time did the argon-41 release exceed 20% of the effluent release limit. A total of 0.55 curies of argon-41 was released, with an average argon-41 concentration of  $8.22 \times 10^{-9}$   $\mu\text{Ci/mL}$  of air, before dilution. The monthly releases are summarized in Table III.



**Table III**  
Monthly Argon-41 Releases

Month	Conc. Before Dilution, $\mu\text{Ci/mL}$	% Release Limit Before Dilution <sup>1</sup>	% DAC Limit Before Dilution <sup>2</sup>	Quantity mCi <sup>3</sup>
July 2010	9.74E-09	0.39	0.00130	55
August	1.25E-08	0.50	0.00167	71
September	7.14E-09	0.29	0.00095	39
October	1.06E-08	0.42	0.00142	60
November	7.86E-09	0.31	0.00105	43
December	8.05E-09	0.32	0.00107	46
January 2011	4.65E-09	0.19	0.00062	26
February	8.87E-09	0.35	0.00118	46
March	7.74E-09	0.31	0.00103	44
April	1.14E-08	0.45	0.00151	63
May	6.56E-09	0.26	0.00087	37
June	3.57E-09	0.14	0.00048	20

<sup>1</sup> Based on 10 CFR 20 effluent release limit of  $1.0 \times 10^{-8}$   $\mu\text{Ci/mL}$  for Ar-41 (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  $2.5 \times 10^{-6}$   $\mu\text{Ci/mL}$ . (20% of limit is  $5.0 \times 10^{-7}$   $\mu\text{Ci/mL}$ ).

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

<sup>3</sup> Based on 4500 CFM effluent of ventilation system in AUTO mode of operation.

### C. Radioactive Solid Waste Disposal

During the reporting period, 2.67 mCi in 39.70 cubic feet of non-compacted solid waste was transferred to the WSU Radiation Safety Office for packaging and disposal.

## 7. Personnel and Visitor Radiation Exposures

The quarterly exposures of the WSU Nuclear Radiation Center reactor staff and experimenters who routinely utilize the WSU Reactor are given in Table IV. The maximum quarterly exposure of a reactor staff member was 22 mrem, whole body.

A total of 1488 individual persons visited the Nuclear Radiation Center during the reporting period, of which 935 entered a controlled access area (CAA).<sup>1</sup> All exposures as determined by digital pocket dosimeters were less than or equal to 1 mrem. A total of 61 group tours, consisting of 581 individuals, visited the center during the reporting period. As determined by digital pocket dosimeters, all exposures were less than 1 mrem.

<sup>1</sup> A non-controlled access 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.

**Table IV**  
**Quarterly Reactor and Experimenter Staff Exposure (in mrem)<sup>1</sup>**

Badge No.	Jul-Aug-Sep 2010	Oct-Nov-Dec 2010	Jan-Feb-Mar 2011	Apr-May-Jun 2011
10012	M	M	M	7
07528	M	1	M	9
08025	--	11	M	14
07463	--	17	7	22
08141	7	13	4	18
07588	20	9	6	22
07805	8	11	M	13
08152	M	2	M	16
07748	2	3	M	11
10079	--	--	4	--
10042	--	--	M	16
10224	--	--	--	M
10232	--	--	--	M
10225	--	--	--	M
10231	--	--	--	2

<sup>1</sup> The "--" denotes data not available either due to departure from the facility or new personnel starting at the facility. An 'M' denotes that the dosimeter reading was less than or equal to the background radiation level for that quarter.

## 8. Reactor Facility Radiation and Contamination Levels

The method detection limit (MDL) for building survey samples (collected for removable contamination determination) by liquid scintillation assay is  $6 \times 10^{-8} \mu\text{Ci}/\text{cm}^2$ . Routine building surveys showed average removable contamination levels less than the MDL for most CAAs and all non-CAAs. The only removable contamination level above the MDL was located on Room 201 Experimenter Platform (CAA,  $6.71 \times 10^{-8} \mu\text{Ci}/\text{cm}^2$ ); which falls under contamination thresholds for a CAA. Other areas in the facility where contamination is more likely, the sample drop tube in Room 201, Laboratory 120 and the radiochemistry hoods, showed averaged removable contamination levels below that of the MDL.

The routine area radiation surveys of the building in CAAs and non-CAAs are given in Table V. The highest average dose rate level in a CAA was 8.85 mrem/hr which occurred in Room 2 East behind a shielded storage area. The lowest average dose rate in a CAA was 0.04 mrem/hr, which occurred in Rooms 201 A and B, Room 101 doorway, and Room 120. The average dose rate in the radiochemistry sample hoods (a non-CAA) was 0.79 mrem/hr. The highest onsite dose rate was 40 mrem/hr, which occurred in 201 East, but is still below limits for a CAA. This area is accessible only through a locked room, and is not accessible to the public.



**Table V**  
Average Radiation Dose Rates (in mrem/h) for  
Weekly Monitoring in CAAs and Non-CAAs (bold)

Location	Average dose rate (mrem/hr)
Room 201B	0.04
Room 201A	0.04
Room 201 Bridge	0.71
Room 201 Benches	0.08
Room 201 South	0.20
Room 201 East	3.20
Room 201C Heat Exchanger	0.06
Room 201 Floor North	0.82
Room 106 Ion Exchanger Pit	0.96
Room 101A Purification Pit	0.47
<b>Sample Storage</b>	0.22
<b>Rom 101 Door Way</b>	0.04
<b>Room 101 Shipment Bench</b>	0.07
<b>Room 101 Sample Drop Hood</b>	0.79
<b>Room 101 Hood 1</b>	0.87
<b>Room 116</b>	0.15
<b>Room 120</b>	0.04
<b>Room B21 Panoramic Irradiation</b>	0.05
Room 2 South	0.05
Room 2 Thermal Column	2.19
Room 2 North	0.26
Room 2 West Cave	0.42
Room 2 East Cave	8.85

## 9. Environmental Monitoring Program

The environmental monitoring program uses thermoluminescent dosimeters (TLD's) at locations both near and farther away from 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 dose rates for this area (80 mile radius) are 0.243 mrem/day as reported in the 30<sup>th</sup> Annual Report of the Environmental Radiation Program, Washington State Department of Health, Environmental Health Program, Table A-12, page 131.

A large decorative granite structure, located in the center of the WSU campus, has been monitored for comparison to the dose rate values obtained in the environmental surveys for the areas that are in the vicinity of the Nuclear Radiation Center. The dose rate level values for the areas located greater than 25 meters from the WSUNRC, when compared to the central campus dose rate values, show no appreciable increase in ambient dose rate levels due to reactor operation.

**Table VI**  
Environmental Radiation Levels in the Vicinity of the Nuclear Radiation Center  
(Dose Rate in mrem/day)

Location	Jul-Aug-Sep 2010	Oct-Nov-Dec 2010	Jan-Feb-Mar 2011	Apr-May-Jun 2011	Average
> 25 meters <sup>1</sup>	0.355	0.367	0.364	0.355	0.390
Granite Rock <sup>2</sup>	0.811	0.841	0.901	-- <sup>3</sup>	0.851

<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.

<sup>3</sup> The "--" denotes data not available due to missing TLD.

#### B. Locations Adjacent to Reactor Facility

Quarterly measured dose rates at locations adjacent to the reactor facility are listed in Table VII. 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 mrem/day)**

Location	Jul-Aug-Sep 2010	Oct-Nov-Dec 2010	Jan-Feb-Mar 2011	Apr-May-Jun 2011	Average
<b>East Loading Dock<sup>2</sup></b>	0.337	0.398	0.352	0.357	0.361
Rad. Storage Shed	0.432	0.420	0.429	0.476	0.439
<b>Reactor Room East Security Gate</b>	0.358	0.364	0.407	0.405	0.384
<b>Cooling Tower Fence</b>	0.358	0.364	0.374	0.357	0.363
<b>Liquid Waste Tank</b>	0.337	0.352	0.396	0.405	0.373
Building Roof West	0.326	0.364	0.330	0.369	0.347
<b>Building West Side</b>	0.326	0.364	0.352	0.381	0.356
Reactor Room Exhaust Vent	0.305	0.330	0.319	0.345	0.325
Reactor Room West Vent <sup>3</sup>	0.716	0.739	0.747	0.714	0.729
Pool Room East Vent	0.526	0.693	0.703	0.619	0.635
Building Roof East	0.295	0.352	0.341	0.357	0.336
<b>South Bldg. Entrance</b>	0.379	0.455	0.429	0.464	0.432

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

<sup>2</sup> Bold print locations indicate areas that are readily accessible by the public.

<sup>3</sup> Pool Room West Vent. TLD on roof, directly above the reactor core.

### C. ALARA Release Limits

Technical Specifications describing ALARA effluent releases in 3.12(2) specify annual radiation exposure due to reactor operation, at the closest off-site extended occupancy, shall not, on an annual basis, exceed the average local off-site background radiation by more than 20%. For the reporting period, the average background radiation dose rate for sampling points 25 meters or greater from the facility was 0.360 mrem/day, while the average radiation dose rate at the closest extended occupied area 600 meters away was 0.325 mrem/day, indicating no measureable exposure level above natural background radiation.