

August 30, 2010

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555

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, 2009 through June 30, 2010.

Respectfully Submitted,

Donald Wall

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, 2009 to June 30, 2010**

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

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**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, 2009 to June 30, 2010

1. Narrative Summary of the Year's Operation

A. Operating Experience

Core 35A has accumulated 859.5 MWH from beginning of life (BOL) through June 30, 2010. A cumulative total of 242 samples were irradiated, for a total of 8406 user-hours. In addition, 39 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 61.4 MWD.

Table I
Fiscal Year 2010 Summary of Reactor Operation

| | J-A-S | O-N-D | J-F-M | A-M-J | TOTALS |
|--|--------|--------|--------|--------|--------|
| Hours of Operation | 189.50 | 278.35 | 275.55 | 253.12 | 996.52 |
| Megawatt Hours | 131.91 | 235.10 | 253.55 | 238.98 | 859.54 |
| No of Sample Irradiations ¹ | 26 | 8 | 25 | 28 | 87 |
| No. of Samples | 48 | 17 | 45 | 57 | 167 |
| No. of Iridium Cans Irradiated | 15 | 18 | 18 | 24 | 75 |
| User Hours | 1346 | 2236 | 2649 | 2175 | 8406 |
| No. of Pulses > \$1.00 | 17 | 11 | 7 | 4 | 39 |

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

3. Emergency Shutdowns and Inadvertent Scrams

There were no emergency shutdowns that occurred during the reporting period. The dates and causes of the 7 inadvertent scrams are listed in Table II. The scrams during 1/25/10 – 1/28/10 were due to recurring channel overheating that was diagnosed and fixed. No scrams were due to a violation of the Limiting Safety Systems Setting set point.

Table II
Inadvertent SCRAMS.

| Date | SCRAM |
|----------|---|
| 11/2/09 | Operator selected "auto range" on linear channel while on 1 kW scale, causing high power scram at 1 kW. Restart ok. |
| 11/16/09 | Linear channel 10 kW button was accidentally pressed, causing a high power scram signal. Restart ok. |
| 1/25/10 | Log-N high voltage failure scram caused by channel overheating. Restart ok. |
| 1/26/10 | Log-N high voltage failure scram caused by channel overheating. Restart ok. |
| 1/26/10 | Log-N high voltage failure scram caused by channel overheating. Restart ok. |
| 1/27/10 | Log-N high voltage failure scram caused by channel overheating. Restart ok. |
| 1/28/10 | Log-N high voltage failure scram caused by channel overheating. Restart ok. |

4. Major Maintenance

All routine planned maintenance items were completed within the reporting period.

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 4640 gallons of liquid waste was released; however, after analysis with gamma spectroscopy, no activity above the limit of detection was found. A total activity approximate of 0.31 pCi is reported for the release.

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 0.32 curies of argon-41 was released, with an average concentration of argon-41 of 4.80×10^{-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 ¹ | % DAC Limit Before Dilution ² | Quantity mCi ³ |
|--------------|--|--|--|---------------------------|
| July 2009 | 2.75E-09 | 0.11 | 0.00037 | 16 |
| August | 3.73E-09 | 0.15 | 0.00050 | 21 |
| September | 4.90E-09 | 0.20 | 0.00065 | 27 |
| October | 6.56E-09 | 0.26 | 0.00087 | 37 |
| November | 7.37E-09 | 0.29 | 0.00098 | 41 |
| December | 3.92E-09 | 0.16 | 0.00052 | 22 |
| January 2010 | 2.99E-09 | 0.12 | 0.00040 | 17 |
| February | 2.00E-09 | 0.08 | 0.00027 | 10 |
| March | 7.21E-09 | 0.29 | 0.00096 | 41 |
| April | 9.63E-09 | 0.39 | 0.00128 | 53 |
| May | 3.16E-09 | 0.13 | 0.00042 | 18 |
| June | 3.41E-09 | 0.14 | 0.00045 | 19 |

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

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

³ Based on 4500 CFM effluent of ventilation system in AUTO mode of operation.

C. Radioactive Solid Waste Disposal

During the reporting period, 0.32 mCi in 21 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 28 mrem, whole body. Other radiation workers were tracked that were participants in exercises during the reporting period, and while some exposures were higher than 28 mrem, the RSO dosimetry flagging limit was not reached.

A total of 1196 individual persons visited the Nuclear Radiation Center during the reporting period, of which 797 entered a Restricted Area. All exposures as determined by digital pocket dosimeter were less than or equal to 1 mrem. A total of 53 group tours, consisting of 333 individuals, visited the center during the reporting period. As determined by digital pocket dosimeter, all exposures were less than 1 mR.

Table IV
Quarterly Reactor and Experimenter Staff Exposure (in mrem)

| Badge No. | Jul-Aug-Sep 2009 | Oct-Nov-Dec 2009 | Jan-Feb-Mar 2010 | Apr-May-Jun 2010 |
|-----------|---------------------|---------------------|---------------------|---------------------|
| 08747 | M | -- | -- | -- |
| 08158 | M | M | -- | -- |
| 07528 | 3 | M | 11 | M |
| 08141 | 27 | 4 | 18 | 4 |
| 07588 | 19 | 9 | 28 | 6 |
| 07643 | M | -- | -- | -- |
| 08535 | M | M | -- | -- |
| 03504 | M | M | 13 | -- |
| 07805 | 9 | 5 | 14 | 1 |
| 08753 | M | M | 14 | -- |
| 08156 | -- | 34 | -- | -- |
| 08813 | -- | 1 | 14 | -- |
| 08152 | 5 | M | 17 | M |
| 07748 | 2 | M | 11 | M |
| 08532 | M | -- | -- | -- |
| 08777 | 16 | -- | -- | -- |
| 08778 | 71 | -- | -- | -- |
| 08775 | M | -- | -- | -- |
| 08539 | M | -- | -- | -- |
| 08780 | M | -- | -- | -- |
| 08779 | M | -- | -- | -- |
| 08773 | M | -- | -- | -- |
| 08776 | M | -- | -- | -- |
| 08774 | M | -- | -- | -- |
| 08781 | M | -- | -- | -- |
| 08772 | M | -- | -- | -- |

¹ The "--" denotes data not available due to departure from 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 6×10^{-8} $\mu\text{Ci}/\text{cm}^2$. Routine building surveys showed average removable contamination levels less than the MDL for most CAA and all non-CAA. The average removable contamination levels above the MDL was located on 201 Experimenter Platform (CAA, 1.07×10^{-7}); which falls well under contamination thresholds. Likewise,

surveys showed removable contamination levels less than $6 \times 10^{-8} \mu\text{Ci}/\text{cm}^2$ in locations that might be suspected to have a higher probability for contamination, including the sample drop tube in Room 201, Laboratory 120 (a gamma-spectroscopy laboratory) and the radiochemistry hoods.

The routine area radiation surveys of the building in controlled (CAAs) and non-controlled access areas¹ (non-CAAs) are given in Table V. The highest average dose rate level in a CAA was 8.69 mrem/h, which occurred in Room 2 East, behind a shielded storage area. The lowest average dose rate in a CAA was 0.04 mrem/h, which occurred in rooms 201A-C, 101 doorway, 116, 120, and B21. The average dose rate in the radiochemistry sample hoods (a non-CAA) was 1.01 mrem/h. The highest on site dose rate was 75 mrem/h, which occurred in Room 2 East. This area is accessible only through a locked room, and is not accessible to the public.

¹ 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 V
Average Radiation Dose Rates (in mrem/h) for
Weekly Monitoring in CAAs and Non-CAAs (bold)

| Location | Average dose rate (mrem/h) |
|---------------------------------|----------------------------|
| 201B | 0.04 |
| 201A | 0.04 |
| 201 Bridge | 1.11 |
| 201 Benches | 0.05 |
| 201 South | 0.36 |
| 201 East | 0.91 |
| 201C Heat Exchanger | 0.04 |
| 201 Floor North | 0.73 |
| 106 Ion Exchanger Pit | 0.38 |
| 101A Purification Pit | 2.32 |
| Sample Storage | 0.61 |
| 101 Door Way | 0.04 |
| 101 Shipment Bench | 0.43 |
| 101 Sample Drop Hood | 1.23 |
| Hood 1 | 0.79 |
| 116 | 0.04 |
| 120 | 0.04 |
| B21 Panoramic Irradiator | 0.04 |
| Rm 2 South | 0.04 |
| Rm 2 Thermal Column | 2.48 |
| Rm 2 North | 2.43 |
| Rm 2 West Cave | 6.63 |
| Rm 2 East Cave | 8.69 |

9. Environmental Monitoring Program

The environmental monitoring program uses thermo-luminescent 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) are 0.243 mrem/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.

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 of 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
 (Exposure in mrem/day)

| Location | Jul-Aug-Sep 2009 | Oct-Nov-Dec 2009 | Jan-Feb-Mar 2010 | Apr-May-Jun 2010 | Average |
|---------------------------|---------------------|---------------------|---------------------|---------------------|---------|
| > 25 meters ¹ | 0.257 | 0.305 | 0.354 | 0.336 | 0.313 |
| Granite Rock ² | 0.753 | 0.861 | 0.888 | -- ³ | 0.834 |

¹ For sampling stations located 25 meters or greater from the Nuclear Radiation Center.

² TLD attached to decorative granite display on Compton Union Building Mall approximately 1300 meters from the Nuclear Radiation Center.

³ 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 Center¹
(Exposure in mrem/day)

| Location | Jul-Aug-Sep 2009 | Oct-Nov-Dec 2009 | Jan-Feb-Mar 2010 | Apr-May-Jun 2010 | Average |
|--|---------------------|---------------------|---------------------|---------------------|---------|
| East Loading Dock² | 0.270 | 0.307 | 0.348 | 0.304 | 0.307 |
| Rad. Storage Shed | 0.315 | 0.327 | 0.483 | 0.380 | 0.376 |
| Reactor Room East Security Gate | 0.292 | 0.297 | 0.337 | 0.337 | 0.316 |
| Cooling Tower Fence | 0.281 | 0.307 | 0.371 | 0.359 | 0.329 |
| Liquid Waste Tank | 0.292 | 0.347 | 0.404 | 0.337 | 0.345 |
| Building Roof West | 0.258 | 0.287 | 0.326 | 0.315 | 0.297 |
| Building West Side | 0.270 | 0.277 | 0.348 | 0.315 | 0.303 |
| Reactor Room Exhaust Vent | 0.258 | 0.277 | 0.303 | 0.293 | 0.283 |
| Reactor Room West Vent ³ | 0.438 | 0.624 | 0.674 | 0.587 | 0.581 |
| Pool Room East Vent | 0.393 | 0.604 | 0.663 | 0.500 | 0.540 |
| Building Roof East | 0.258 | 0.287 | 0.337 | 0.315 | 0.299 |
| South Bldg. Entrance | 0.315 | 0.366 | 0.427 | 0.380 | 0.372 |

¹ For sampling stations located less than 25-meters from the Nuclear Radiation Center.

² Bold print locations indicate areas that are readily accessible by the public.

³ Pool Room West Vent. TLD on roof, directly above the reactor core.

⁴ The "--" denotes data not available due to missing TLD.

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 total background radiation dose rate level for sampling points 25 meters or greater from the facility was 0.313 mrem/day, while the average total radiation dose rate level at the closest extended occupied area 930 meters away was 0.292 mR/day, indicating no significant exposure level above natural background radiation.