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Nuclear Radiation Center
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Stephen W. Holmes
Inspector
US Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Holmes:

Enclosed is the Annual Report for the reporting period of July 1, 1999, to June 30, 2000. This report details the operations of, changes in, and surveillance of the WSU TRIGA nuclear reactor facility.

I am pleased to report that WSU operation seems to be going rather well. This year heralded a total of 878 MWh, some significant improvements in the reactor cooling system, as well as work on the BNCT facility planned here at WSU.

Thank you very much for your support throughout this year. Should you have any questions or comments about this report or our operations, please feel free to contact the WSU Nuclear Radiation Center.

Sincerely,

Brian F. Bunce,
WSU Nuclear Radiation Center

Cc: USNRC 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, 1999 to June 30, 2000

A. Narrative Summary of the Year's Operation

I. Operating Experience

The Washington State University Reactor has accumulated 878 Megawatt hours on Core 33-X hours during the reporting period. A total of 330 irradiations for a total of 1272 samples were performed. In addition, 11 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.

There were no changes in design, performance characteristics, or procedures that related to reactor safety during the reporting period.

III. All surveillance tests and requirements were performed and completed within the prescribed time period. The results of all inspections revealed no abnormalities.

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	18.3	183.79	307.07	426.6	935.76
Megawatt Hours	16.28	158.13	289.55	410.39	874.35
No. of Irradiations	5	29	63	233	330
No. of Samples Irradiated	106	115	570	481	1272
No. Pulses > $1.00	0	8	0	3	11

The cumulative energy output since criticality of the TRIGA core since 1967 is 877 Megawatt Days. The mixed core of FLIP and Standard fuels installed in 1976 has accumulated 611 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

DATE	CAUSE
10/07/99	Short period at 1MW. No other indication.
10/29/99	Short period at 1MW. No other indication.
02/01/00	Loss of Console power. Operator inadvertently moved key with knee.
02/03/00	Blades and Pulse Rod disengaged when console cabinet door shut.
03/03/00	Short period at 1MW. No other indication.
04/05/00	High power SCRAM caused by jarring console. No safety setting exceeded.
04/05/00	High power SCRAM caused by jarring console. No safety setting exceeded.
04/25/00	SCRAM - High Power. Control Element raise button stuck in W/D position. Power never exceeded 130%. Temperature channels showed no temperature rise. Replaced control element raise button.
05/24/00	High power SCRAM caused by jarring console. No safety setting exceeded.
05/31/00	SCRAM at 80% power. Logic Element lit. No other indication.
06/14/00	Accidental activation of Air Scram button by dropping of telephone.
06/27/00	High power SCRAM caused by jarring console. No safety setting exceeded.
06/27/00	High power SCRAM caused by jarring console. No safety setting exceeded.

D. Major Maintenance

All other major maintenance performed was routine planned maintenance items.

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

Several modifications to the facility were made in this reporting period. An upgrade of the reactor cooling system was completed, replacing the cooling tower, heat exchanger, cooling pumps, and associated valves and piping. This was performed for the purpose of increasing the cooling capacity of the system; the new cooling tower has a larger capacity than the old, and the new heat exchanger replaces one that had become fouled with sediment.

The second major improvement to the facility was the re-lining of the reactor pool. The reactor pool was stripped of its old paint, and re-lined with an epoxy-based pool paint. This greatly reduces the potential for leaks of the reactor pool water. The reactor pool water cleanup loop was modified to allow greater cleanup capacity, allowing reactor pool water to be maintained at even higher purity levels.

Finally, work was begun on the building of a BNCT treatment test facility at the thermal column of the reactor. This work involves the design, building, and testing of a concrete treatment room, a facility control panel, radiation monitoring systems, and personnel safety systems. To do these things, the reactor beam ports have been permanently closed, with the exception of the thermal column; and the core cooling plenum was moved to allow the bridge to move to the thermal column. A motor was installed on the reactor bridge to allow the bridge to retract in the event of an emergency situation. This work should be completed late in the year 2000.

F. Radioactive Effluent Discharges

1. Radioactive Liquid Releases

A total of 54.27 microcuries was released in 2,073,495 liters of liquid during the reporting period. The releases are listed in Table III on Page 3.

TABLE III
Radioactive Liquid Releases

Date	Quantity μCi	Release Concen. μCi /ml	Release Volume Liters	WSU Sewer Volume Liters	Total Dilute Volume Liters	Sewer Concen. μCi/ml	% MPC
07/20/99	2.40	8.28×10^{-09}	290,045	480,000	770,045	3.12×10^{-09}	0.008 [2]
11/08/99	0.81	1.57×10^{-08}	51,741	480,000	531,741	1.53×10^{-09}	0.004 [2]
12/13/99	0.17	1.25×10^{-08}	13,342	480,000	493,342	3.38×10^{-10}	1.69 [1]
01/21/00	0.24	1.28×10^{-08}	18,600**	480,000	498,600	4.78×10^{-10}	2.39 [1]
06/01/00	0.35	1.60×10^{-08}	21,608	480,000	501,608	5.51×10^{-10}	2.76 [1]

[1] Based on a release limit of 2.0×10^{-08} μCi /ml for unknown mixture, 10 CFR 20, Table 3.
[2] Isotope found to be K^{40}. Release limit is 4.0×10^{-05} μCi /ml, 10 CFR 20, Table 3
**Based on an assumed volume of 656.8 ft^3. Tank was accidentally emptied during installation of cooling tower drain line when liquid waste system upper collection tank drain line was broken.

2. Radioactive Gaseous Release

During the reporting period, no significant quantity of any gaseous or particulate material with a half-life greater that 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 4.52 Curies of Argon-41 was released in 5.86×10^{13} cc of air, which yields an average monthly concentration of Argon-41 of 7.71×10^{-08} μCi /cc. The monthly releases are summarized in Table IV.

TABLE IV
Monthly Argon-41 Releases

Month	Conc. Before Dilution, μCi /ml	% Release Limit (1) Before Dilution	% DAC Limit (2) Before Dilution	Quantity mCi
Jul. (1999)	7.40×10^{-08}	2.96	0.00978	370
Aug.	-	-		0
Sep.	4.59×10^{-08}	1.84	0.00612	229
Oct.	8.62×10^{-08}	3.45	0.0115	431
Nov.	4.29×10^{-08}	1.72	0.00573	214
Dec.	4.46×10^{-08}	1.78	0.00594	223
Jan. (2000)	1.41×10^{-07}	5.62	0.0187	704
Feb.	8.81×10^{-08}	3.53	0.0118	440
Mar.	6.19×10^{-08}	2.48	0.00826	309
Apr.	3.08×10^{-08}	1.23	0.00411	154
May.	1.16×10^{-07}	4.62	0.0154	579
Jun.	9.59×10^{-08}	3.83	0.0128	479

(1) Based on 10 CFR 20 effluent release limit of 1.0×10^{-8} μCi /ml for ^{41}Ar (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} μCi/cc. (20% of limit is 5.0×10^{-7} μCi/ml).

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

3. Radioactive Solid Waste Disposal

During the reporting period, 165 cubic feet of non-compacted solid waste for a total of 3.08781 millicuries of activity was transferred to the Campus Radiation Safety Office for packaging and disposal.

G. Personnel and Visitor Radiation Exposures

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

A total of 2240 non-Nuclear Radiation Center staff or routine facility user individuals visited the Center during the reporting period, out of which 616 enter Restricted Areas. As determined by digital pocket dosimeter and an exposure recorded, the average individual exposure was <1.0 millirem.

A total of 20 group tours, consisting of 223 individuals, visited the Center during the reporting period. As determined by digital pocket dosimeter and an exposure recorded, the average group exposure was <1.0 millirem.

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

Badge No.	Jul-Aug-Sep	Oct-Nov-Dec	Jan-Feb-Mar	Apr-May-Jun
1	3	7	13	13
2	22	80	35	25
3	16	11	21	22
4	1	5	2	0
5	0	0	1	0

H. Reactor Facility Radiation and Contamination Levels

The routine area radiation surveys of the building in non-reactor vital areas (1) had an average dose level of 0.26 mR/Hr., while routinely accessible reactor vital areas had an average dose level of 0.48 mR/Hr. The highest average dose level in a routinely accessible reactor vital area was 1.38 mR/Hr., which occurred in Room 201, Reactor Pool Room, South side. The lowest average dose in a routinely accessible reactor vital area was 0.02 mR/Hr., which occurred in Room 201A, the Reactor Shop area. The average dose in the Reactor Control Room was 0.05 mR/Hr. The average dose in the radiochemistry sample hoods was 0.26 mR/Hr. The highest average on site dose level was 33.5 mR/Hr. which occurred in Room 2A, Cave Room, which is a locked storage area where radioactive material and radioactive sources are stored.

Routine building surveys for removable contamination in non-reactor vital areas (1) had an average level of 3.91×10^{-06} μCi/100cm^2, while the average level in the reactor vital areas was 5.08×10^{-06} μCi/100cm^2. The highest average value in the reactor vital areas was 5.49×10^{-05} μCi/100cm^2, which was found on the platform where experimenters stand to insert and withdraw their samples from the reactor. The lowest average value in the reactor vital areas was 1.26×10^{-06} μCi/100cm^2, which was in Room 201, the Reactor Room Floor.

The average level of removable contamination in the radiochemistry sample hoods was $1.37x10^{-06}$ $\mu Ci/100cm^2$.

(1) 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 thermoluminecent dosimeters (TLD's) at locations both near and at distances around the reactor building facility. 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 μRem/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 environment radiation levels due to reactor operation.

TABLE VI
Environmental Radiation Levels in the Vicinity of the Nuclear Radiation Center (1)
(Exposure in μRem /day)

Jul-Aug-Sep	Oct-Nov-Dec	Jan-Feb-Mar	Apr-May-Jun	Median
158	158	158	132	158
667 (2)	667	667	197	667

(1) For sampling stations located 25 meters or greater from the Nuclear Radiation Center. Located in Excel File: Environmental Dosimeter Evaluation for the specified quarter.
(2) TLD attached to "Decorative" granite display on Compton Union Building Mall approximately 1300 meters from the Nuclear Radiation Center.
* Apr-May-Jun TLD's exposures not available at the time report was prepared.

Quarterly exposures at locations at 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 (1)
(Exposure in μR/day)

Location	Jul-Aug-Sep	Oct-Nov-Dec	Jan-Feb-Mar	Apr-May-Jun	Median
E. Loading Dock (#2)	141	141	141	119	136
Rad. Storage Shed (#3)	275	275	275	165	248
Rx Rm W. Secr. Gate (#4)	212	212	212	339	244
Cooling Tower Fence (#5)	290	290	290	156	257
Liquid Waste Tank (#6)	227	227	227	156	209
Building Roof West (#7)	149	149	149	147	149
Building W. Side (#8)	180	180	180	147	172
Pool Rm Exh. Vent (#10)	129	129	129	101	122
Pool Room W. Vent (#11)	490 (2)	490	490	697	542
Pool Room E. Vent (#12)	337	337	337	431	361
Building Roof East (#37)	129	129	129	110	124
S. Bldg. Entrance (#40)	235	235	235	193	225

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

(2) Pool Room West Vent. TLD on roof, directly above reactor core.

* Apr-May-Jun TLD's exposures not available at the time report was prepared.

Underlined locations indicate areas that are readily accessible.

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 400 meters or greater from the facility was 142 μR /day, while the average total radiation level at the closest extended occupied area 930 meters away was 156 μR /day. This yields a ratio of 9.4%, indicating no significant exposure level above natural background.