WASHINGTON STATE UNIVERSITY
Nuclear Radiation Center

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

The Annual Report for the WSU facility, License R-76, Docket 50-27, prepared by C. Corey Hines, Reactor Supervisor of the WSU Facility, is hereby submitted. The report covers the operating period July 1, 2014 through June 30, 2015.

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, 2014 to June 30, 2015

Nuclear Radiation Center
Washington State University
Pullman, WA 99164-1300

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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, 2014 to June 30, 2015

1. Narrative Summary of the Year's Operation

A. Operating Experience

Core 35A has accumulated 7,423 MWH from beginning of life (BOL) through June 30, 2015. A total of 642 samples were irradiated, for a total of 11,953 user-hours. Additionally, 29 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.

The Standard Operating Procedures were revised and approved by the Reactor Safeguards Committee on 12/3/2014. The new SOP numbers are used in this report.

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 1,543 Megawatt Days (MWD). The mixed Standard Fuel and 30/20 LEU Fuel Core 35A installed in 2008 has accumulated a total of 313 MWD.

Table I
Fiscal Year 2015 Summary of Reactor Operation[1]

	Q3 2014	Q4 2014	Q1 2015	Q2 2015	TOTALS
Hours of Operation	407	494	358	236	1,495
Megawatt Hours	368	460	301	207	1,336
No of Sample Irradiations	34	30	21	27	112
No. of Samples	47	98	48	92	285
No. of Commercial Irradiations	73	151	105	28	357
User Hours	3,945	3,800	2,033	2,175	11,953
No. of Pulses > $1.00	3	3	14	9	29

[1] Number of samples and sample irradiations do not include commercial irradiations. User hours denotes the total user hours, including commercial irradiations

3. Emergency Shutdowns and Inadvertent Scrams

There were no emergency shutdowns or unplanned shutdown periods that occurred during the reporting period.

The dates and causes of the eight (8) inadvertent scrams are listed in Table II. No scrams were due to exceeding the Limiting Safety Systems Setting or Safety Limit.

Table II
Inadvertent Scrams

Date	Description of Scram
7/29/2014	Operator Trainee switched the reactor to test instead of rundown. Restart OK.
10/9/2014	Reactor scrammed due to loss of building power. Restart OK.
11/3/2014	Trainee switched to pulse mode during startup. Restart OK.
11/18/2014	Operator switched to test during rundown. Restart OK.
1/22/2015	Fuse IF9 blown. Restart OK.
5/11/2015	Manual scram due to operator dropping object in pool. Restart OK.
6/2/2015	Manual scram due to object falling in pool. Restart OK.
6/5/2015	Trainee inadvertently switched to test during rundown. Restart OK.

4. Major Maintenance

Although they are not part of routine preventative maintenance, the below listed items were performed.

7/1/2014: *Diffuser Pump*
The diffuser pump failed while the reactor was at power. The reactor was shut down when the operator noticed elevated radiation readings in the pool room and a pressure reading of zero on the pump pressure gauge. The impeller was replaced as well as the tubing for the pressure gauge.

7/9/2014: *Secondary Outlet Flow Rate Sensor Rotor/Gasket*
The secondary cooling system outlet flow rate sensor rotor accumulated a considerable amount of mineral buildup and was no longer reading properly. The rotor, shaft and gasket were replaced.

9/5/14: *BNCT Low Battery Bridge Retract*
The dry contacts on the backup battery supply to the console and the bridge motor were tested to ensure that the bridge will automatically retract and the reactor will rundown upon a battery self-test failure, low battery, or a battery fault. During the test a fault was simulated by overloading the battery which caused the bridge to retract. Since the bridge will retract on a low battery or a facility power failure, any conceivable loss of power situation would result in an automatic bridge retraction, this satisfies technical specification section 3.8.3.e. The test button on the BNCT control panel of the console used to simulate a battery trip for the BNCT checkout was tested and found to be operable. It was found that the reactor does not

rundown upon a low battery or fault. This means the BNCT bridge retract system needs to be rewired.

10/14/2014: *EGM Calibration and troubleshooting*
A calibration alignment was performed on 9/30/2014, per the SOP. The results of the calibration did not provide a straight line from which the appropriate base-line voltage setting in relation to the Ar-41 energy could be interpolated. The EGM detector was removed and connected to a scaler to perform bench-top testing. It was suspected that the detector was faulty. A series of counts were performed with a new detector in order to determine the proper gain and voltage setting to provide the best spectrum using all the sources. These bench-top tests proved to be ineffective when the detector was installed in its original position, possibly due to the length of cable between the detector and HV supply. The new detector was removed and the old detector was put in its original position. Another series of counts was performed with the detector installed in its intended position. A gain setting of 32 and a voltage setting of 8.69 V was found to provide an excellent spectrum from which a calibration could be performed. A new calibration was performed and the results were satisfactory.

11/21/2014: *Diffusor Pump*
The diffusor pump failed during a checkout. The cause was found to be a bad relay (17K3) in room 201C which was not allowing the pump motor to get power. The relay was removed, cleaned, and returned to service.

11/21/2014: *Key Bank Lights*
Key bank light 4 has not been functioning properly. Instead of turning red when the key is removed, it has been turning off. The cause was found to be a loose wire on pin N of connector 28P2. The wire was soldered back in place and the light is functioning normally.

12/9/2014: *Control Blade No.4 Troubleshooting*
After a SCRAM by building evacuation for an emergency drill on Saturday, December 6, 2014 it was found that the 'blade in' light for control element number four was not on. There was a faint smell of burnt electronics in the pool room. The gear motor for control element number four was hot to the touch. The blade appeared to be fully in, however, it did not activate the limit switch for the 'blade in' light. So the motor kept trying to run the rod in and forced the connecting rod through the electromagnet. The top cover of the magnet was punctured and deformed. The lead to the motor was disconnected and left over the weekend. On Monday 12/8/2014, upon further examination, it was found that blade four was about an inch out. The blade was jiggled slightly and fell in the rest of the way, leading us to suspect it somehow got caught on the shroud. We attempted to raise the drive for blade four and it would not move. The motor was taken off and disassembled. It was found that a spring pin in the gear motor had sheared off as a safety mechanism to protect the motor. The spring pin was replaced with an identical pin. The drive, limit switch, gear motor, and chain were tested and functioned normally. However, the electromagnet for blade four appeared to be damaged. The 'magnet engaged' light for number four was actuating when it should not have been. It appeared that the switch for the 'magnet engaged' button on the electromagnet was bent in such a way that the button was continuously actuated. This connection was bent back into place and shown to be operable. The connections for the blade four magnet were soldered back into place. The cover-plate for the blade four magnet was re-shaped and shown to fit properly over the magnet. The magnet was reconnected to the blade and a series of SCRAM tests were performed. Everything functioned normally. The gear motor, drive, limit-switch, and magnet for blade four are operable.

12/16/2014: *Vent System*
WSU Facilities was called to investigate an abnormally high reading on the D/P gauge in the control room during a ventilation system test. The cause was found to be low air pressure in the line that opens and closes damper 6. The air flow was restored and the dilute system is functioning normally.

12/18/2014: *Vent System Readjustment*
Damper 3 was indicating "Open" in the auto mode of the ventilation system. Upon visual inspection, it was found that the damper was actually closed, however, the lever arm which provides the "open/closed" signal was stuck. It was loosened and readjusted to allow the lever to move to the closed position.

1/16/2015: *EGM*
The exhaust gas monitor count-rate meter began malfunctioning on 1/7/2015. The argon totalizer was counting properly, and the detector hardware and electronics were working perfectly, however the 'rate/minute' meter was displaying only 0, and the 'gross counts' did not reset after the designated 10 minute counting period. The instrument was racked out and taken to WSU Technical Services for troubleshooting. In the interim, a scale/timer combination was connected in its place as a rate meter which was monitored by the operator at the controls. The rate/minute was calculated by dividing counts by the time elapsed and the counts automatically reset once per hour. This arrangement satisfied the requirements of the technical specifications for reactor operation.

The count-rate meter was returned on 1/16/2015 in perfect working order. Technical services reported that the problem was a series of loose connections on the wire-wrap logic board and some dirty IC contacts. The function was verified against the backup scaler and showed that the count-rate meter was operating normally.

1/22/2015: *Blown IF9 Fuse*
Console fuse IF9 blew while the reactor was at power, causing a SCRAM. Due to previous experience with this problem, it was determined that a bundle of wires from the relay boards to the back of the console were shorting. The wire bundle and relay drawers were readjusted and the fuse was replaced. The console key was replaced, and various systems were tested in an effort to replicate the problem. However, the fuse remained intact. The fuse is operable.

1/29/2015: *EGM*
The EGM failed in the same manner as it did on 1/7/2015. The issue was found to be a faulty IC in the clock circuit. WSU Technical Services performed the repairs.

1/30/2015: *Secondary Inlet Pressure Valve Leak*
The 3-way ball valve that allows for zeroing of the secondary inlet pressure transducer was found to be leaking at a steady rate. The valve was replaced with an equivalent part.

3/4/2015: *Ventilation System*
The reactor staff arrived at work at 8:00 a.m. on 3/4/15 to discover that the heating coil in the ventilation supply duct to the pool room had burst during the night. This also coincided with a power outage during the night that had forced the ventilation system into isolate mode. The steam leak had damaged a fire alarm in the vicinity,

so the Pullman Fire Department and WSU Facilities Operations were on site attempting to clear the alarm and initiate repairs. WSU FacOps determined that the heating coil was damaged beyond repair and was removed from the ventilation system pending replacement. The ventilation system remained inoperable during removal, and reactor operations ceased at 8:00 a.m. on 3/6/15 as per the requirements in the Technical Specifications.

3/24/2015: *EGM Calibration*
The monthly EGM channel test was performed on 3/20/2015 and the counts were low enough that a new calibration was required. Calibration of the EGM had previously been done on 2/24/2015 so a new one should not have been required. The single channel analyzer's window adjust potentiometers were exercised by turning them full scale to remove any oxide buildup. This had no effect. Since this problem had occurred for multiple months in a row resulting in almost monthly calibrations, the staff began systematic troubleshooting. Parts were replaced individually to identify where in the system the problem was.

The detector and photomultiplier base were replaced first with a model 2M 2/2 detector from Ortec and a model 266 photomultiplier base. A spectrum was taken of a Co-60 source with the following settings: window range of 0-10.0 volts, 30 second counts, and a window size of 0.5 volts. Different gain settings on the linear amplifier were tested to determine what gain setting was needed to see the Co-60 gamma peaks in the correct location. The Co-60 peaks were not able to be resolved correctly. The pre-amplifier was then replaced with a model 113 by Ortec as well as a new TC 202BLR Tennelec Linear amplifier and a model 550A Ortec single channel analyzer. The same procedure was used to determine Co-60 peaks. The correct peaks were still not seen, so an Ortec representative was contacted as well as Dave Leestma from WSU Tech Services to assist in troubleshooting the system and electronics.

The problem was found to be that the output signal from the preamplifier was too large for the linear amplifier, and the signal was being cut off before it could reach the single channel analyzer. The solution was to reduce the high voltage supply output to 800VDC, and increase the input capacitance on the preamplifier from 0 pf to 500 pf. This reduced signal was then able to be shaped correctly using the linear amplifier. A course gain setting of 20 and a fine gain setting of 0.5 were found to show the peaks in the correct locations.

A full calibration was performed and calculated a new window lower limit setting of 6.39, with a window size of 0.3 volts. The EGM was returned to service, and a calibration test was performed the next week to ensure that the calibration is holding its integrity.

3/31/2015: *Cooling System- Heat Exchange plate change*
The heat exchange plates were changed in accordance with the SOP and equipment manual.

5/8/2015: *Blown IF9 Fuse*
During a shutdown maintenance period, several unused wires were disconnected from the relay board and this appears to have solved the problem.

5/11/2015: *Damper 4 Indicator Arm*
The damper 4 indicator arm was removed 3/4/2015 by WSU Facilities Operations while repairs were being conducted on the heating coil. After repairs were complete

the damper 4 indicator arm could not be located. A new indicator arm was made from aluminum rod with a magnet attached, which replaced the original arm.

6/26/2015: *EGM*
The monthly EGM channel test was performed and resulted in counts low enough to require a new calibration. A calibration was performed with a new window voltage of 0.5, instead of 0.3, to try to resolve the low number of counts. A lower voltage setting was calculated during the calibration.

Since the Q-Coil was removed in February 2014 calibrations have been performed more frequently. The date of calibrations coincides with changes in outside temperatures. Literature shows that sodium iodide detectors become less efficient as temperature increases, in a nonlinear fashion. The results of the Q-Coil being removed causes more pool room air temperature fluctuations resulting in increased calibrations to compensate for these changes in detector efficiency. Steps are being taken to add temperature control to the ventilation system to cut down on temperature fluctuations.

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

A total of three (3) proposed changes to the facility were made during the 2014-2015 year. All of these proposals were screened with the 10 CFR 50.59 requirements and found to screen out, thus allowing the change to be made without further approval.

1) Two Ludlum model 272 radiation monitor readouts have been installed in Room 201B on the reactor console. They display the beta/gamma and neutron dose inside the treatment room during epithermal beam use. These monitors utilize a cable running directly from the Ludlum 375 and 375/2 displays on Room 2 South into Room 201B. The two displays installed on the reactor console are "slave" readouts of the Treatment Room Monitors on the BNCT Panel in Room 2 South and have no control functions. The entire treatment room monitoring system is separate and independent from the reactor console, high radiation alarm, building evacuation alarm, and security system. This change does not include any addition, removal, or change of a reactor component or procedure as described in the SAR and does not deviate from the technical specifications. The purpose of this addition is to provide the reactor operator with additional radiation monitoring capability during epithermal beam use. The monitors are positioned in such a way that they do not present a distraction to the operator at the controls and do not obstruct the operator's view of any existing readouts or controls.

   On July 30, 2014 the proposed modification was reviewed for the additional reporting requirements of 10 CFR 50.59, and it was determined that the change could be made without prior NRC approval.

2) The coolant temperature readout, a Newport Electronics 2003A-2, has been replaced with an Omega DP2000-A1. This new make and model coolant temperature readout has the same features and the same operational parameters as the old readout. Both are powered by 120 volt AC and respond at a rate of 1 millivolt per degree Celsius. The SAR does not specify a model number, and the new coolant temperature readout will report both primary inlet and outlet temperatures as required by the SAR. Since this does not constitute a change to the SAR a 10 CFR 50.59 review is not required.

On February 13, 2015 the proposed modification was reviewed for the additional reporting requirements of 10 CFR 50.59, and it was determined that the change could be made without prior NRC approval.

3) The following components were replaced in the Ar-41 monitoring system: NaI detector, photomultiplier base, pre-amplifier, linear amplifier, and single channel analyzer.

The detector, photomultiplier base, and pre-amplifier were replaced with the same make and model numbers as the original equipment. The linear amplifier and single channel analyzer were originally contained in a single Tennelec model TC 214. This was replaced with a Tennelec linear amplifier model TC 202BLR and an Ortec single channel analyzer model 550A.

The separated linear amplifier and single channel analyzer perform identically to the original TC 214, and have the same input and output ranges. The new system was tested and calibrated with the same calibration procedure and shown to have identical performance to the original system.

On March 24, 2015 the proposed modification was reviewed for the additional reporting requirements of 10 CFR 50.59, and it was determined that the change could be made without prior NRC approval

6. Radioactive Effluent Discharges

A. Radioactive Liquid Releases

The liquid effluent releases for the facility during the reporting period can be found in Table III.

Table III
Monthly Liquid Waste Releases

Month	Volume (gallons)
July 2014	0
August	0
September	0
October	0
November	0
December	0
January 2015	0
February	0
March	0
April	0
May	0
June	0

No liquid waste was released during this reporting period.

B. Radioactive Gaseous Release

During the reporting period, no measurable quantity of gaseous or particulate material with a half-life greater than eight (8) days was released. At no time did the argon-41 release exceed 20% of the effluent release limit. A total of 0.269 curies of argon-41 was released, with an average argon-41 concentration of 1.4×10^{-11} µCi/mL of air, after environmental dilution. The release of 0.269 curies of argon-41 is used in the 2015 Annual Report for Radioactive Air Emission License (RAEL-004), stack number 7. Per COMPLY v1.6, the reactor facility (stack 7) is in compliance at level 4 with an effective dose equivalent of 2.4×10^{-4} mrem/yr. The monthly releases are summarized in Table IV.

Table IV
Monthly Argon-41 Releases[2]

Month	Quantity (Ci)	Conc. After Dilution, (µCi/mL)	% of DAC Limit
July 2014	9.0×10^{-3}	5.4×10^{-12}	1.8×10^{-4}
August	3.7×10^{-2}	2.2×10^{-11}	7.3×10^{-4}
September	1.8×10^{-2}	1.1×10^{-11}	3.8×10^{-4}
October	2.2×10^{-2}	1.3×10^{-11}	4.3×10^{-4}
November	2.6×10^{-2}	1.6×10^{-11}	5.3×10^{-4}
December	3.7×10^{-2}	2.2×10^{-11}	7.3×10^{-4}
January 2015	1.6×10^{-2}	9.5×10^{-12}	3.2×10^{-4}
February	6.0×10^{-3}	4.0×10^{-12}	1.3×10^{-4}
March	4.1×10^{-2}	2.5×10^{-11}	8.2×10^{-4}
April	1.7×10^{-2}	1.0×10^{-11}	3.5×10^{-4}
May	2.5×10^{-2}	1.5×10^{-11}	5.0×10^{-4}
June	1.5×10^{-2}	9.5×10^{-12}	3.2×10^{-4}

C. Radioactive Solid Waste Disposal

During the reporting period, 2.5 mCi in 51 cubic feet of non-compacted solid waste was transferred to the WSU Radiation Safety Office for packaging and disposal.

7. Personnel and Visitor Radiation Doses

The quarterly doses of the WSU Nuclear Radiation Center reactor staff and experimenters who routinely utilize the WSU Reactor are given in Table V. The maximum quarterly dose of a reactor staff member was 112 mrem, whole body.

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[2] Quantity released based on 4500 CFM effluent of ventilation system in AUTO mode of operation. Concentration after dilution is based on 10 CFR 20 effluent release limit of 1.0×10^{-8} µCi/mL for Ar-41 (Table 2, Col.1), and a *dilution factor of 3.4×10^{3} (WSU Technical Specifications 3.5.2).* DAC limits are based on 10 CFR 20 derived air concentration limit of 3.0×10^{-6} µCi/mL for Ar-41 (Table 1, Col. 3) and a dilution factor of 3.4×10^{-3}.

A total of 1370 individual persons visited the Nuclear Radiation Center during the reporting period, of which 504 entered a controlled access area (CAA).[3] All doses as determined by digital pocket dosimeter were less than or equal to 0.5 mrem. A total of 31 group tours, consisting of 275 individuals, visited the center during the reporting period, also entering a CAA. As determined by digital pocket dosimeter, all doses were less than or equal to 0.2 mrem.

[3] A controlled access area is an area in the building where radioactive materials are used or stored and is a part of the licensed reactor facility.

Table V
Quarterly Reactor and Experimenter Staff Dose[4] (in mrem)

Badge No.	Q3 2014	Q4 2014	Q1 2015	Q2 2015
10452	12	18	48	112
10921	--	12	13	15
10915	--	7	10	--
10639	7	--	--	--
10462	8	5	6	--
10794	11	3	M	--
10012	M	--	--	--
10791	15	12	--	--
10912	--	8	8	--
10650	M	--	--	--
10460	9	7	7	4
08141	15	2	6	49
10914	--	M	M	--
07588	30	47	34	82
10910	--	6	11	12
10466	10	M	M	--
10465	10	6	5	5
10916	--	12	21	24
10913	--	M	M	--
10904	--	13	11	9
10911	--	11	6	--
10283	M	--	--	--
10451	52	65	71	26
10641	20	45	21	20
10649	16	3	--	--
10042	8	--	--	--
10231	17	6	M	--
10909	--	9	11	2
07748	8	5	3	4
10838	7	9	11	6
10643	14	7	31	3
10443	6	5	6	3
10897	--	5	6	M
11177	--	--	--	M

[4] 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 averaged over one year is 2.7 X 10^{-8} µCi/cm^2. Routine building surveys showed average counts less than the MDL for most CAAs and all non-CAAs. Areas that registered removable contamination levels above the MDL were the Room 201 Experimental Platform and Room 101 Sample Drop Hood 2. All measurable counts were still well below Standard Operating Procedure limits for those areas.

Table VI
Average Removable Contamination (in µCi/cm) for
Weekly Monitoring in CAAs and Non-CAAs[5]

Location	Measured Activity Above MDL (µCi/cm²)
201B	M
201A	M
201 RX BRIDGE STEPS	M
201 SAMPLE DROP TUBE	M
201 RX BRIDGE - SOUTH	M
201 RX BRIDGE - NORTH	M
201 EXPERIMENTER PLATFORM	4.5×10^{-8}
201 BENCHES	M
201 FLOOR SOUTH	M
201-C HEAT EXCHANGER FLOOR	M
201 FLOOR NORTH	M
106 ION EXCHANGER PIT	M
101-A PURIFICATION PUMP PIT	M
101 DOOR WAY	M
101 SHIPMENT BENCH	M
101 SAMPLE DROP HOOD #2	4.5×10^{-8}
101 SAMPLE DROP BENCH	M
101 HOOD #1	M
116 FLOOR	M
120 FLOOR	M
B21 PANORAMIC IRRADIATOR	M
B21 FLOOR	M
RM 2 SOUTH FLOOR	M
RM 2 THERMAL COLUMN	M
RM 2 THERMAL COLUMN FLOOR	M
RM 2 NORTH FLOOR	M
RM 2 WEST CAVE FLOOR	M
RM 2 EAST CAVE FLOOR	M

The routine area radiation surveys of the building in CAAs and non-CAAs are given in Table VII. The highest average dose rate for a single location in a CAA was 48 mrem/hr, which occurred in Room 2 East Cave. This value is less than the limit for CAAs. The lowest average dose rate in a CAA was 0.04 mrem/hr (a level

[5] Bolded text indicates a non-CAA. Regular text indicates a CAA. "M" indicates the value is below the MDL value of 2.7×10^{-6} µCi/cm². Room 116 and 120 were inspected and changed to non-radiation labs in week 6 of 2015, so no more swipes are needed in these rooms.

considered background), which occurred in Room 2 Thermal Column. The average dose rate in the radiochemistry sample hoods (a non-CAA) was 4 mrem/hr. The highest onsite dose rate was 48 mrem/hr, which occurred in the Room 2 East Cave.

The East and West cave are a storage area designed to house radioactive sources such that they are shielded and are locked away from daily activities. This space is posted as a high radiation area which permits radiation fields up to 500 rad/hr at 30 cm. Personnel do not typically work in this area and it is kept locked when not in use.

Table VII
Average Radiation Dose Rates (in mrem/hr) for
Weekly Monitoring in CAAs and Non-CAAs[6]

Location	Average Dose Rate (mrem/hr)
ROOM 201B	0.05
ROOM 201A	0.05
ROOM 201 BRIDGE	1.5
ROOM 201 BENCHES	0.23
ROOM 201 SOUTH	0.72
ROOM 201 EAST	8.3
ROOM 201C HEAT EXCHANGER	0.08
ROOM 201 FLOOR NORTH	1.1
ROOM 106 ION EXCHANGER PIT	11.0
ROOM 101A PURIFICATION PIT	4.7
SAMPLE STORAGE	0.58
ROOM 101 DOOR WAY	0.04
ROOM 101 SHIPMENT BENCH	0.07
ROOM 101 SAMPLE DROP HOOD	4.0
ROOM 101 HOOD 1	1.2
ROOM 116	0.03
ROOM 120	0.02
ROOM B21 PANORAMIC IRRADIATOR	0.05
ROOM 2 SOUTH	0.07
ROOM 2 THERMAL COLUMN	0.04
ROOM 2 NORTH	0.15
ROOM 2 WEST CAVE	3.2
ROOM 2 EAST CAVE	48

[6] Bolded text indicates a non-CAA. Regular text indicates a CAA. Rooms 116 and 120 were inspected and changed to non-radiation labs in week 6 of 2015, so no more surveys are needed in these rooms.

9. Environmental Monitoring Program

The environmental monitoring program uses thermoluminescent dosimeters (TLD's) placed at locations both onsite and offsite. The environmental monitoring program is used to determine the average background radiation levels through the use of offsite TLD locations. The offsite TLD locations are defined by Technical Specifications 1.0 and 5.1.1, and are TLDs 3, 7, 9, 15 through 35, and 39 through 44. The TLD's that are used to calculate the background do not have to meet the less than 20% above background requirement. The average background radiation level is then compared to the nearest occupied dwelling to ensure it does not, on an annual basis, exceed the average offsite background radiation by more than 20%.

Table VII shows the quarterly dose rates for those TLD's located at offsite locations. From table VIII, the background radiation levels and the 20% above background radiation levels can be seen in table XI. This data will be used for comparison to the closest offsite area of extended occupancy.

Table IX shows the quarterly exposures for those TLD's located at onsite locations. These locations are not required to be compared to background radiation levels.

The dose rate for the closest offsite points of extended occupancy can be found in Table X. In Chart I the closest offsite points of extended occupancy are compared to both the background radiation levels and the 20% above background radiation levels from Table XI. Technical Specifications describing ALARA effluent releases in 3.5.2(3) specify annual radiation exposure due to reactor operation, at the closest offsite extended occupancy, shall not, on an annual basis, exceed the average offsite background radiation by more than 20%. For the reporting period, the average background radiation dose rate for off-site locations was 0.33 mrem/day, while the average radiation dose rate at the closest extended occupancy area 600 meters away was 0.29 mrem/day. This result indicates that no exposure level above normal background radiation was found. While Chart I indicates TLD 36 was higher than background radiation levels for Q3 2014 and Q1 2015, TLD 36 was still well below the 20% above background radiation levels required by the Technical Specifications. This result shows that no dose levels exceeded Technical Specifications requirements for an offsite area of extended occupancy.

Table VIII
Environmental Radiation Levels at Offsite Locations to the Nuclear Radiation Center[7]
(dose rate in mrem/day)

Location	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Average
Fence E of NRC	0.29	0.28	0.31	0.28	0.29
Fence, N of Rad Waste Shed	0.36	0.35	0.38	0.33	0.35
Fence directly N Rad Waste Shed	0.44	0.78	0.72	0.56	0.63
S NRC, on parking lot fence	0.31	0.29	0.33	0.30	0.31
Fence S Roundtop Dr, 10th pole W of pole C14	0.34	0.32	0.35	0.31	0.33
Telephone pole C12	0.33	0.32	0.34	0.31	0.32
Telephone pole near golf course gate	0.32	0.30	0.36	0.31	0.32
E across fairway on pine tree	0.33	0.29	0.33	0.31	0.32
Maple tree #54 along driving range	--	0.30	0.31	0.31	0.31
NW to fence uphill from driving range	0.00	0.30	0.43	0.34	0.27
Follow fence E to fence corner	0.33	0.36	0.38	0.32	0.35
S to lone spruce tree near water hazard	0.32	0.29	0.30	0.27	0.30
Roundtop hill park, NW fence corner	--	0.29	0.34	--	0.32
Deciduous tree edge of 18th green	0.33	0.33	0.34	0.33	0.33
6ft pine tree, 3rd W down cart path from clubhouse	0.33	0.34	0.41	0.34	0.36
3rd to last tree after gap in same line of trees	0.32	0.30	0.31	0.28	0.30
SW to fence along path near 2nd to last tee box at bottom hill	0.33	0.29	0.55	0.32	0.37
Follow fence partway up hill after fence turns S	0.33	0.33	0.34	0.32	0.33
Follow fence, 15th pole E after fence turns W	0.34	0.30	0.36	0.34	0.34
Follow fence about halfway between last TLD and corner	0.36	0.34	0.35	0.30	0.34
Largest bush S of NRC	0.37	0.35	0.37	0.30	0.35
2nd fence S NRC, W end at gate	0.00	0.29	0.30	0.31	0.23
S Fairway Rd, 1st light post on right	0.29	0.32	0.34	0.28	0.30
S Fairway Rd, 2nd light post on right	0.31	0.32	0.30	0.28	0.30
Ellis Way and Hog Lane sign	0.29	0.29	0.36	0.29	0.31
Bottom of radio antenna hill, fence next to shrub left of gate	0.33	0.29	0.35	0.30	0.32
3rd fence S of NRC, SE corner, cow pasture	0.32	0.34	0.35	0.30	0.33
Airport fence W end runway at gate	0.30	0.30	0.34	0.29	0.31
Fence/entry bar E of Jewett Observatory	0.31	0.33	0.34	0.28	0.31
Granite rock Terrell Mall, hole in back	0.28	0.27	--	0.25	0.26

[7] Offsite defined by the Technical Specification 1.0 and 5.1.1 as any location which is outside the site boundary. The "--" indicates a TLD which was missing.

Table IX
Environmental Radiation Levels at Onsite Locations to the Nuclear Radiation Center[8]
(dose rate in mrem/day)

Location	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Average
E lower loading dock	0.31	0.30	0.35	0.29	0.31
Pool room truck door fence S end	0.44	0.48	0.49	0.39	0.45
Pool room truck door fence N end	0.50	0.83	0.84	0.40	0.64
E wall rad waste shed	0.41	0.45	0.44	0.36	0.41
N wall rad waste shed	0.36	0.35	0.38	0.33	0.35
Cooling tower fence, NE corner	0.78	1.29	1.14	0.81	1.00
Room 101 window	0.30	0.32	0.35	0.34	0.33
Railing next to upper liquid waste tank	0.37	0.33	0.37	0.31	0.34
Room 2 truck door fence	0.34	0.33	0.36	0.30	0.33
Transformer vault vent louvers	0.34	0.33	0.38	0.30	0.34
NRC main entrance, light fixture	0.34	0.39	0.40	0.34	0.37
NRC roof, pool room vent stack	0.31	0.32	0.31	0.28	0.31
NRC roof, guide wire E end of building	0.30	0.32	0.37	0.28	0.32
NRC roof, E pool room vent support leg	0.93	0.91	0.97	0.60	0.85
NRC roof, air conditioning support leg	0.89	0.32	0.38	0.28	0.47
NRC roof, W pool room vent support leg	0.91	0.89	0.78	0.61	0.80

Table X
Environmental Radiation Levels for the Closet Offsite Point of Extended Occupancy
(dose rate in mrem/day)

Location	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Average
Apt complex C, gas meter	0.31	0.30	0.36	0.28	0.31
Apt complex B, gas meter	0.25	0.28	0.33	0.26	0.28
1st fence S apt complex A	0.30	0.27	0.31	0.28	0.29

Table XI
Background Environmental Radiation Levels
(dose rate in mrem/day)

	Q3 2014	Q4 2014	Q1 2015	Q2 2015	Average
Background radiation levels	0.30	0.33	0.36	0.31	0.33
20% Above background radiation levels	0.37	0.39	0.44	0.38	0.39

[8] Onsite defined by the Technical Specification 1.0 and 5.1.1 as any location which is within the site boundary.

Chart I
Environmental Radiation Levels for the Closest Off-site Point of Extended Occupancy as Compared to Background Radiation Levels and 20% Above Background Radiation Levels