Idaho State
UNIVERSITY

Office for Research and Economic Development
921 South 8th Avenue, Stop 8130 • Pocatello, Idaho 83209-8130

September 19, 2013

NRC Document Control Desk
U.S. Nuclear Regulatory Commission
One White Flint North, MS OWEN-1 E13
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: Transmittal of Annual Report and Minor Amendment (#8) to the Technical Specifications for NRC Reactor License R-110

The two copies of each enclosure are:

1. The Annual Report for calendar year 2012 for the AGN-201 Reactor, NRC License R-110. Docket #50-284.

2. Amendment #8 for the Technical Specifications for the same reactor. This amendment is a minor change to the organization chart for the university. The name of the college where the reactor is located and administered has been changed from "College of Engineering" to "College of Science and Engineering". Also, the reporting line for the Reactor Safety Committee is now shown specifically as being to the Reactor Administrator.

Please transmit one copy of each of these documents to the license program manager.

Mr. Duane A. Hardesty
Research and Test Reactors
Mail Stop: 0-12 D03
Phone: (301)415-3724

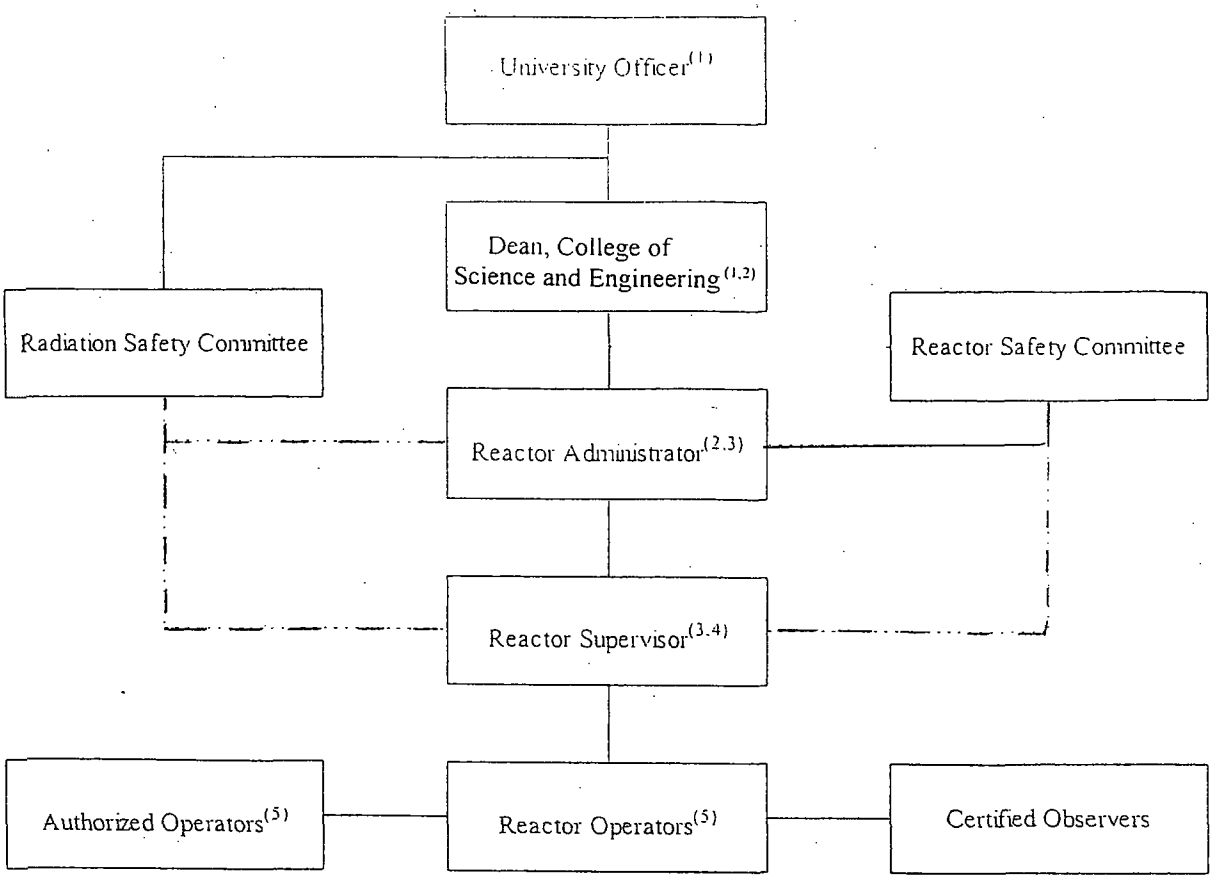
Sincerely,

Howard Grimes
Vice President for Research and Economic Development

Encl: (4)

ec: Dr. Jay Kunze, Reactor Administrator

A020
NRR



(1) University Officer and Dean of the College of Science and Engineering may be the same individual

(2) The Reactor Administrator could be the Dean of Science and Engineering, or the Chair or a faculty member of the Department of Nuclear Engineering and Health Physics. However, regarding NRC licenses, the Reactor Administrator reports to the Dean of the College of Science and Engineering and not necessarily through the Department of Nuclear Engineering and Health Physics, which is a department in the College of Science and Engineering.

(3) The Reactor Supervisor reports to the Reactor Administrator, and may not necessarily report through the Chair of the Nuclear Engineering and Health Phys8ics Department.

(4) Requires a NRC Senior Reactor Operators (SRO) License

(5) Requires a NRC Reactor Operators License (or an SRO license), except per 10 CFR 55.13

Figure 1. Administrative Organization of the ISU AGN-201 Reactor Facility, NRC License R-110, chain of command in regard to nuclear operation and safety. Dotted lines represent communication channels.

Persons holding positions on the Administrative organization shall meet or exceed the qualification requirements of ANSI/ANS-15.4-1988, "Selection and Training of Personnel for Research Reactors."

6.1.5 Reactor Operators

Reactor Operators shall be responsible for the manipulation of the reactor controls, monitoring of instrumentation, operation of the reactor-related equipment, and maintenance of the complete and current records during operation of the facility. Reactor Operators shall hold a valid Reactor Operator's license issued by the U.S. Nuclear Regulatory Commission.

Idaho State University
AGN-201M Reactor Facility
License R-110, Docket No. 50-284
Annual Operating Report for 2012 Calendar Year

1. Narrative Summary

A. Changes in Facility Design, Performance Characteristics, and Operating Procedures:

There were no changes in facility design, performance characteristics, and operating procedures relating to reactor safety or operations during the reporting period.

B. Results of Major Surveillance Tests and Inspections:

(1) Channel tests performed on all safety channels and scram interlocks were found to be satisfactory and within specifications. Channels 1, 2, & 3 were tested 8/10/2012, 5/2/2012, & 8/20/2012 respectively.

(2) Power level (4/2/2012) and period check (3/22/2012) experiments were performed with satisfactory results.

(3) The shield water tank was inspected (6/11/2012) and no leaks or excessive corrosion were observed. The water level interlock tested satisfactorily (6/11/2012).

(4) The seismic displacement & temperature interlocks were tested and found satisfactory (7/26/2012).

(5) (a) Control element capsules (cladding) were inspected (6/28/12) and found to be in good condition with no evidence of deterioration since the previous inspection.

(b) The control rod drive mechanisms were inspected (6/28/12) and tested with satisfactory results.

(c) Ejection times were measured for all SCRAM-able rods and found to be less than 1 seconds

(d) The reactivity worth of all safety and control rods were measured, as well as the time required to drive each rod to its fully inserted position. Reactivity insertion rates were determined to be less than $0.042\%\Delta k/k\ s^{-1}$ ($0.058 s^{-1}) for all rods.

(e) The shutdown margin was determined to be greater than $2.2\%\Delta k/k$ ($3.0) with both the most reactive SCRAM-able rod and the fine control rod fully inserted. 8/15/12.

(f) All surveillances were within the appropriate Technical Specification requirements.

2. Operating History and Energy Output.

The reactor was operated at power levels up to 4.9 watts for a total of 148 watt-hours of thermal energy during this reporting period. A summary of monthly operations for 2012 is given in Table I.

Table I. Summary of Monthly Reactor Operations
(1 January 2012 through 31 December 2012)

Month	Energy (W-hr)
January	0.0
February	9.9
March	11.9
April	17.9
May	8.6
June	8.3
June	6.2
August	14.6
September	31.3
October	15.8
November	17.1
December	6.5
Total	148.0

The 0.148 kWh consumed 7.5 micrograms of U-235. During the calendar year, a number of students went through reactor operator training. During the calendar year, four students took NRC licensing exams. Two were awarded Reactor-Operator (RO) licenses and one was awarded a Senior Reactor-Operator (SRO) license. Two operator-licenses were terminated during the year because students left the university.

3. A. Unscheduled Shutdowns and Corrective Actions Taken.

None.

B. Inadvertent Scrams and Action Taken.

There were 159 inadvertent scrams during this reporting period. Table II summarizes the inadvertent scrams, known or suspected cause, and action taken.

Table II. Summary of Inadvertent Scrams
(1 January 2012 through 31 December 2012)

Date	Time	Scram Type	Cause	Action
2/1/12	15:43	Channel 1 Low	Operator Error	Restart
	16:21	Channel 1 Low	Operator Error	Shutdown
2/2/12	14:13	Channel 1 High	Range Change Error	Restart
	14:43	Not Indicated	Suspected Electrical Transient*	Shutdown
2/8/12	16:09	Channel 3 High	Range Change Error	Restart
	16:19	Channel 1 High	Range Change Error	Restart
	16:22	Period	Operator Error	Restart
2/9/12	13:51	Channel 3 High	Signal Irregularity	Restart
	14:17	Period	Operator Error	Restart
	15:03	Period	Insertion of Source	Restart
	15:13	Channel 1 High	Range Change Error	Restart
2/13/12	23:36	Channel 1 Low	Low Power Operation	Restart
	0:02	Channel 1 High	Low Power Operation	Restart
2/16/12	13:35	Channel 1 Low	Loss of Signal	Restart
	14:07	Channel 1 Low	Loss of Signal	Restart
2/22/12	13:50	Magnet Over-Current	Magnet Current SCRAM Set Too Low	Restart
2/27/12	17:14	Channel 3 High	Range Change Error	Restart
	18:04	Not Indicated	Suspected Electrical Transient*	Shutdown
3/21/12	15:56	Channel 1 Low	Loss of Signal	Shutdown
4/2/12	16:52	Channel 1 Low	Loss of Signal	Restart
4/4/12	11:11	Channel 1 Low	Loss of Signal	Restart
4/9/12	16:38	Magnet Over-Current	Magnet Current SCRAM Set Too Low	Restart
5/9/12	16:48	Channel 3 High	Signal Irregularity	Restart
	17:06	Channel 3 High	Signal Irregularity	Restart
5/15/12	16:40	Channel 3 High	Signal Irregularity & Range Change Error	Restart
	19:43	Channel 3 High	Over Estimation of Oscillator Reactivity	Restart
5/18/12	11:37	Channel 3 High	Range Change Error	Restart
	14:36	Not Indicated	Range Change Error	Restart
5/23/12	16:47	Magnet Over-Current	Suspected Electrical Transient*	Restart
	17:18	Magnet Over-Current	Suspected Signal Interference & Detector is Insulated	Restart
5/24/12	11:14	Magnet Over-Current	Suspected Electrical Transient*	Shutdown
6/5/12	16:27	Period	Chanel #1 Raise Interference	Restart
6/6/12	16:37	Channel 1 High	Range Change Error	Restart

7/13/12	15:42	Channel 3 High	Operator Error (Training)	Restart
	15:50	Channel 3 High	Operator Error (Training)	Restart
	16:10	Channel 3 Low	Signal Irregularity	Restart
8/7/12	16:47	Channel 1 Low	Suspected Electrical Transient*	Restart
8/8/12	16:18	Channel 1 Low	Removing the Start Up Source	Restart
	16:30	Channel 1 Low	Signal Irregularity	Restart
8/10/12	13:10	Channel 1 Low	Suspected Signal Irregularity	Restart
	13:29	Channel 1 Low	Detector Stuck When Raise Pressed	Investigate & Restart
	14:28	Channel 1 Low	Suspected Signal Irregularity	Restart
8/30/12	13:34	Channel 1	Supervisor Re-Set Time Constant During Operation	Shutdown
8/31/12	10:39	Channel 1 Low	Signal Irregularity	Shutdown
	14:59	Channel 3 High	Range Change Error	Restart
	15:08	Channel 1 High	Suspected Signal Irregularity	Shutdown
9/5/12	20:24	Channel 3 High	Range Change Error	Restart
	21:33	Channel 3 High	Range Change Error	Restart
9/6/12	11:26	Channel 1 Low	Range Change Error	Restart
	11:35	Channel 1 Low	Range Change Error	Restart
9/6/12	17:35	Channel 3 High	Occurred During Range Change	Restart
	17:41	Raise Button	Raising Detector Caused Additional Signal Noise	Restart
9/7/12	12:38	Channel 1 Low	Suspected Signal Irregularity	Restart
	12:58	Channel 1 Low	Suspected Signal Irregularity	Restart
9/12/12	14:52	Channel 3 High	Operator Error (Training)	Restart
9/13/12	9:11	Channel 3 High	Operator Error	Restart
	9:33	Channel 3 High	Erratic Response Changing to 3x10^(-9) Range	Restart
	10:10	Channel 3 High	Erratic Signal	Restart
	10:23	Channel 3 High	Operator Error	Restart
	14:00	Not Indicated	Occurred During Raising Ch #1	Restart
	14:38	Channel 3 High	Signal Irregularity During Range Change	Restart
9/14/12	12:59	Not Indicated	Occurred During Raising Ch #1	Restart
	14:07	Channel 1 Low	Suspected Signal Irregularity	Shutdown
9/15/12	11:28	Channel 3 High	Range Change Error	Restart
	15:07	Channel 3 High	Signal Irregularity During Range Change	Restart
9/18/12	9:58	Channel 3 Low	Accidently Hitting the Console	Restart
9/19/12	19:40	Channel 3 High	Range Change Error	Restart
	19:55	Channel 1 High	Range Change Error	Restart
9/24/12	14:37	Period scram	Raising Detector Caused Additional Signal Noise	Adjust Cable & Restart
	20:01	Channel 1 Low	Operator Error	Restart
9/25/12	12:59	Channel 1 Low	Suspected Electrical Transient*	Investigate & Restart

	14:09	Channel 1 Low	Suspected Electrical Transient*	Restart
9/27/12	11:42	Channel 1 Low	Raising Detector Caused Additional Signal Noise	Restart
	14:39	Raise Button	Raising Detector Caused Additional Signal Noise	Restart
10/1/12	20:29	Channel 3 High	Signal Irregularity During Range Change	Restart
10/5/12	10:34	Channel 3 High	Range Change Error	Restart
10/9/12	16:32	Channel 1 Low	Suspected Signal Irregularity	Restart
10/10/12	13:08	Channel 3 High	Noise in Range 3x10^(-8) & 10x10^(-9)	Restart
	18:06	Channel 3 High	Signal Irregularity	Restart
10/11/12	10:41	Channel 1 High	Range Change Error	Restart
	10:48	Period	Removing the Start Up Source	Restart
	12:38	Channel 1 High	Range Change Error	Restart
	13:50	Ch1 low	Loss of Signal	Restart
	14:29	Period	Raising Detector Caused Additional Signal Noise	Restart
10/16/12	13:28	Loss of Power	Building Loss Power Briefly	Restart
10/17/12	12:06	Channel 1 Low	Loss of Signal	Restart
	19:40	Period	Bumping of the Console	Restart
10/18/12	14:27	Channel 3 High	Range Change Error	Restart
		Channel 3 Low	Range Change Error	Restart
10/19/12	13:25	Channel 3 High	Range Change Error	Restart
	16:35	Bumped Console	Bumped Chair into Console	Restart
10/23/12	9:53	Period	Power Transient	Restart
	12:14	Period	Signal Irregularity	Restart
	13:23	Channel 2 Low	Suspected Signal Irregularity	Restart
	15:37	Period	Electrical Transient* (Period within Range)	Restart
	17:58	Period	Electrical Transient* (Period within Range)	Restart
10/24/12	15:44	Channel 3 High	Range Change Error	Restart
10/29/12	19:50	Channel 3 High	Range Change Error	Restart
	20:34	Channel 3 High	Range Change Error	Restart
	20:36	Channel 3 High	Range Change Error	Restart
10/30/12	9:28	Channel 1 Low	Loss of Signal	Restart
10/31/12	9:43	Channel 3 High	Range Change Error	Restart
11/1/12	13:27	Not Indicated	Activating Channel 1 Solenoid	Restart
11/5/12	9:59	Channel 1 Low	Suspected Electrical Transient*	Restart
	10:03	Period	Suspected Electrical Transient*	Restart
	21:30	Channel 3 High	Range Change Error	Restart
	21:49	Channel 1 Low	Suspected Electrical Transient*	Restart
11/7/12	19:48	Channel 1 Low	Loss of Signal	Restart
11/8/12	10:15	Channel 3 High	Operator Error (Training)	Restart
	11:14	Channel 3 Low	Suspected Electrical Transient*	Shutdown
11/9/12	13:19	Channel 1 Low	Under Estimation of Oscillator Reactivity	Restart
	16:46	Channel 1 Low	Suspected Electrical Transient*	Shutdown

11/13/12	12:58	Loss of Power	Loss of Power to Circuit	Shutdown
11/15/12	13:37	Period	Raising Detector Caused Additional Signal Noise	Restart
11/21/12	14:28	Channel 3 High	Signal Irregularity During Range Change	Restart
12/13/12	13:43	Channel 3 Low	Range Change Error	Restart
	13:52	Period	Inserted Poly Rod Too Quickly	Restart
	14:12	Period	Raising Detector Caused Additional Signal Noise	Restart
	15:52	Channel 3 Low	Signal Irregularity	Restart
	16:00	Period	Raising Detector Caused Additional Signal Noise	Restart
12/14/12	11:53	Channel 1 Low	Operator Error	Restart
12/20/12	12:59	Period	Raising Detector Caused Additional Signal Noise	Restart
12/21/12	12:43	Channel 1 Low	Suspected Electrical Transient*	Restart
	13:01	Channel 1 Low	Suspected Electrical Transient*	Restart
	15:00	Channel 3 High	Range Change Error	Restart
12/27/12	14:06	Channel 1 Low	Signal Irregularity During Range Change	Restart
12/28/12	16:15	Channel 1 Low	Suspected Electrical Transient*	Restart
12/31/12	10:47	Channel 1 Low	Suspected Signal Irregularity	Restart
	11:06	Channel 1 High	Non-Reproducible Rate Meter Issue	Restart

* Electrical transients are signal & power irregularities associated with using older vacuum tube based analogue circuitry.

4. Safety-Related Corrective Maintenance:

1/31/2012: Channel 3 detector changed its response output and was replaced with a comparable BF3 tube. In addition the SHV connector was replaced with one designed for RG-59 cable and recalibrated.

3/6/2012: The down indicator switch on the FCR had been knocked out of place, causing the drive to continue to drive out despite being in the bottom position and the interlock OK light bulb failed. The switch was repositioned for proper operation and the light bulb replaced.

3/14/2013: A bad cable connection causing a short, preventing the magnet to energize, was located. A bypass cable fixed the problem and the main cable connection fixed to return normal functionality.

3/21/2012: The Channel 3 detector lost signal, a connection problem was the likely cause. The detector chamber was removed and all connecting cables were replaced with new connections, returning functionality to the system.

5/25/2012: The rod drop box was rebuilt with new wiring after a significant amount of troubleshooting.

5/30/2012: A power outage cause damage to Channel 2. Vacuum tubes V-12, V-14 & V-17, power line fuse, and the 1.5-volt battery were replaced.

6/5/2012: Magnet current was found to be high (0.9 mA) and after replacing the V-7 vacuum tube the current returned to a normal 0.6 mA.

8/30/2012: Channel 1 was having signal problems due to improper cabling and connectors. The system was rebuilt in a way so that the detector's position does not stress the signal cable and removes the need to raise the detector.

10/4/12: The analogue position display primary gear broke so that the tens digit wouldn't turn. The unit was replaced with a comparable spare.

12/3/12: Channel 2 failed pre-start checks. The F-1 (250V 3A) fuse, V-13 6Y6GA vacuum tube, V-12 6BW4 vacuum tube, and the V-1 6BW4 vacuum tube was replaced in Channel 2 to return functionality.

12/12/12: During operation the Safety Rod 1 dropped out properly, however the chassis jammed in position. It was found that the twin drive screws were uneven; they were greased and reset into position. In addition there was a problem with the "up" microswitch; the microswitch and the wiring were replaced.

5. Modifications.

A. Changes in Facility Design.

None.

B. Changes to Procedures.

None.

C. Experiments.

Experimental procedure 12 Oscillator Experiment was revised to have descriptions for both linear and rotary oscillators and guidelines for operating them simultaneously.

D. Reactor Safety Committee.

As of the end of the reporting period, membership of the Reactor Safety Committee (RSC) consisted of the following individuals:

Frank H. Just – Chair (retired from INL)
Jay F. Kunze - Reactor Administrator
Adam L. Mallicoat - Reactor Supervisor
Richard R. Brey – Department Chair
Peter Farina – Radiation Safety Officer
Robert Boston, PE, CHP (DOE-ID)
Kermit Bunde (DOE-ID)

Richard E. McCracken (retired from INL)

6. Summary of Changes Reportable under 10 CFR 50.59.

The paper chart recorder set up for the detector channels 2 & 3 were changed to utilize a digital chart recorder. The new recorder is capable recording data and displaying the response over time and cannot impact reactor operation as installed. The data is stored on a removable flash drive for easy analysis and storage.

7. Radioactive Effluents.

A. Liquid Waste - Total Activity Released: None.

B. Gaseous Waste - Total Estimated Activity Released: 14.4 μCi of Ar-41.

The AGN-201 Reactor was operated for 148 watt-hours at power levels up to approximately 4.9 watts. At this power level Ar-41 production is negligible and substantially below the effluent concentration limit given in 10 CFR 20 Appendix B, Table 2. The total activity of Ar-41 released to the environment was conservatively estimated at 14.4 μCi. This activity corresponds to the total activity of all gaseous radioactive effluent from the facility. A monthly summary of calculated gaseous releases is given in Table IV.

Table IV. Summary of Monthly Gaseous Radioactive Effluent Releases
(1 January 2012 through 31 December 2012)

Month	Ar-41 (μCi)
January	0.0
February	1.0
March	1.2
April	1.7
May	0.8
June	0.8
June	0.6
August	1.4
September	3.0
October	1.5
November	1.7
December	0.6
Total	**14.4**

C. Solid Waste - Total Activity: None.

8. The latest environmental radiation surveys, performed at the facility boundary while the reactor was operating at 60% of full licensed power (3.0 watt), measured a maximum combined neutron and gamma dose equivalent rate of less than 2.0 mrem hr^{-1} at the outside walls of the building proximal to the reactor. The total equivalent dose rate at 100% power at these locations was less than 4 mrem hr^{-1}.

9. Radiation Exposures.

The Radiation Safety Officer reviews personnel radiation exposures quarterly. Annual reports of ionizing radiation doses are provided by the Radiation Safety Officer to all monitored personnel as required under the provisions of 10 CFR 19.

Personnel with duties in the reactor laboratory on either a regular or occasional basis have been issued radiation dosimeters by the Idaho State University Technical Safety Office. The duty category and whole body exposure for the 2012 monitoring period of personnel are summarized in Table V:

Table V. Personnel Radiation Monitored for 1/1/2011-12/31/2011

Name	Exposure by Type (mrem)		
	Deep	Lens	Shallow
Aryal, Harishchandra	2	2	2
Baker, Ben	50	49	46
Baral, Madhav	2	2	1
Bishart, Bishara	1	1	1
Bundy, Deric	3	4	10
Burrows, Ian J	7	6	6
Gorham, Mackenzie	<1	<1	<1
Horkley, Matt	2	2	1
Imel, George	<1	<1	<1
Jash, Soumadipta	<1	<1	<1
Kamerman, David	<1	<1	<1
Krieger, Michael	11	12	12
Kunze, Jay	<1	<1	<1
Langbehn, Adam	7	6	6
Loveland, Ryan	14	13	12
Lum, Edward	1	1	1
Mallicoat, Adam	2	2	1
Misner, Jesse	3	3	2
Nelson, Alan	2	2	2
Nelson, Marcus	<1	<1	<1
Nimmagadda, Jyothier Kumar	<1	<1	<1
Riley, Tony	3	2	2
Steele, Dallin	<1	<1	<1

Stewart, Trevor	3	3	2
Tam, Austin	1	1	<1
Tormohlen, Derick	<1	<1	<1
Wachs, Katelyn	2	3	3
Chaczko, Malwina	<1	<1	<1
Isaacs, Daniel	<1	<1	<1
McBeath, Scott	<1	<1	<1
Nelson, Katherine	3	2	2
Hart, Paul	<1	<1	4

The 10 CFR 20.1201 occupational dose limits to adults are: total 5 rem, lens of eye 15 rem, shallow 50 rem, and deep 50 rem. The doses received for all reactor laboratory personnel during 2012 are well below the dose limits of 10 CFR 20.1201, and well below ISU ALARA limits (1 REM per year, 0.3 REM per quarter).

Anytime a member of the public visits the reactor pin dosimeters are issued for the extent of the tour. A minimum of 1 dosimeter to every 5 people is issued for a representative group dose. During the 2012 calendar year there were 476 recorded visitors to the facility. A summary of the public dose exposure is presented in Table VI.

Table VI. Summary Whole-Body Exposures to the Public
(1 January 2012 through 31 December 2012)

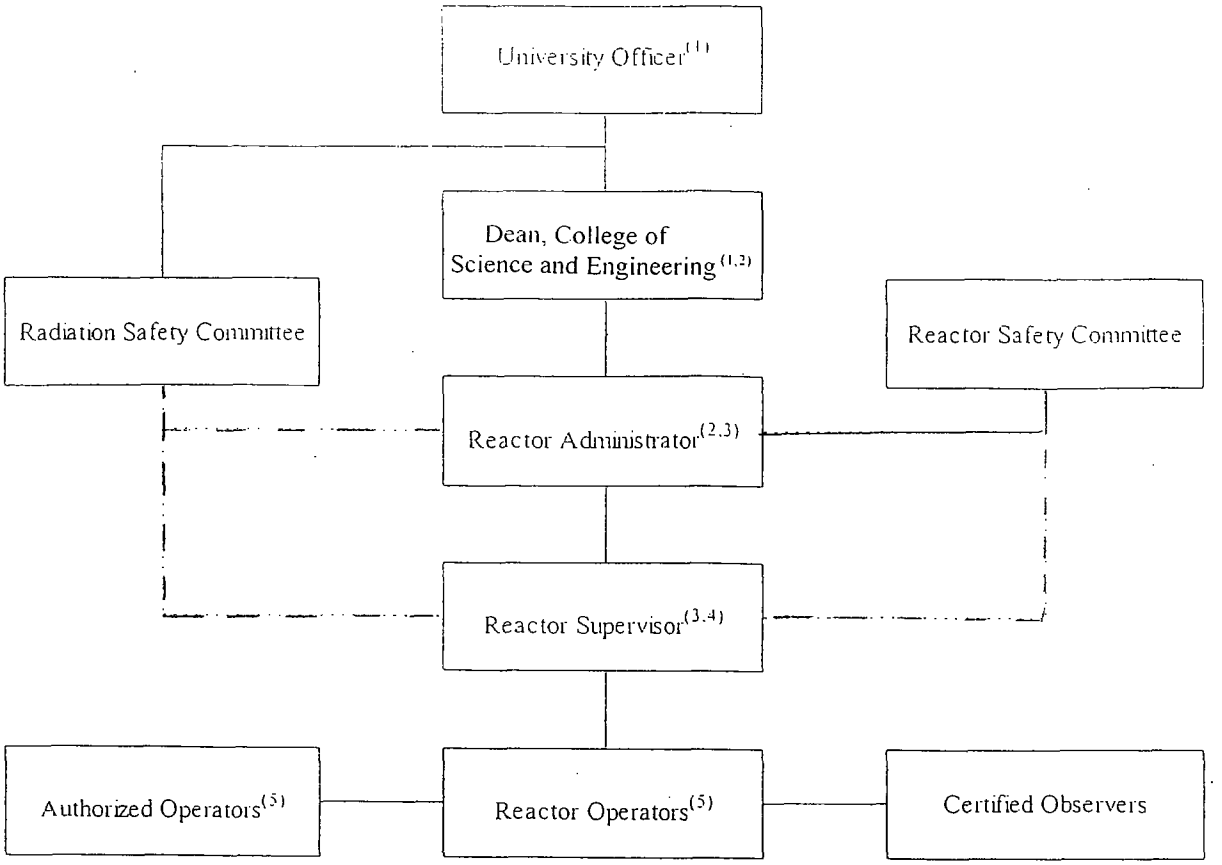
Estimated whole-body exposure range (mrem):	Number of individuals in each range:
No Observable Dose	433
1.0 mrem*	30
Greater than 1.0 but below 5.0 mrem	12
Greater than 5.0 but below 10.0 mrem	1
Total number of individuals reported	476

*Below 1.0 mrem is considered un-measureable

None of the 476 visitors to the facility during 2012 received a measurable dose that would exceed the annual 0.5 rem dose limit of 10 CFR 20.1301. Note there was only one reading that was above 5 mrem, this is likely due to the shock of dropping the dosimeter.

Therefore, the average and maximum doses received by personnel and the public are well within NRC guidelines.

Report prepared by: Adam Mallicoat, Reactor Manager/Supervisor
August 30th, 2012
Adam Mallicoat



[1] University Officer and Dean of the College of Science and Engineering may be the same individual

[2] The Reactor Administrator could be the Dean of Science and Engineering, or the Chair or a faculty member of the Department of Nuclear Engineering and Health Physics. However, regarding NRC licenses, the Reactor Administrator reports to the Dean of the College of Science and Engineering and not necessarily through the Department of Nuclear Engineering and Health Physics, which is a department in the College of Science and Engineering.

[3] The Reactor Supervisor reports to the Reactor Administrator, and may not necessarily report through the Chair of the Nuclear Engineering and Health Phys8ics Department.

[4] Requires a NRC Senior Reactor Operators (SRO) License

[5] Requires a NRC Reactor Operators License (or an SRO license), except per 10 CFR 55.13

Figure 1. Administrative Organization of the ISU AGN-201 Reactor Facility, NRC License R-110, chain of command in regard to nuclear operation and safety. Dotted lines represent communication channels.

Persons holding positions on the Administrative organization shall meet or exceed the qualification requirements of ANSI/ANS-15.4-1988, "Selection and Training of Personnel for Research Reactors."

6.1.5 **Reactor Operators**

Reactor Operators shall be responsible for the manipulation of the reactor controls, monitoring of instrumentation, operation of the reactor-related equipment, and maintenance of the complete and current records during operation of the facility. Reactor Operators shall hold a valid Reactor Operator's license issued by the U.S. Nuclear Regulatory Commission.

Idaho State University
AGN-201M Reactor Facility
License R-110, Docket No. 50-284
Annual Operating Report for 2012 Calendar Year

1. Narrative Summary

A. Changes in Facility Design, Performance Characteristics, and Operating Procedures:

There were no changes in facility design, performance characteristics, and operating procedures relating to reactor safety or operations during the reporting period.

B. Results of Major Surveillance Tests and Inspections:

(1) Channel tests performed on all safety channels and scram interlocks were found to be satisfactory and within specifications. Channels 1, 2, & 3 were tested 8/10/2012, 5/2/2012, & 8/20/2012 respectively.

(2) Power level (4/2/2012) and period check (3/22/2012) experiments were performed with satisfactory results.

(3) The shield water tank was inspected (6/11/2012) and no leaks or excessive corrosion were observed. The water level interlock tested satisfactorily (6/11/2012).

(4) The seismic displacement & temperature interlocks were tested and found satisfactory (7/26/2012).

(5) (a) Control element capsules (cladding) were inspected (6/28/12) and found to be in good condition with no evidence of deterioration since the previous inspection.

(b) The control rod drive mechanisms were inspected (6/28/12) and tested with satisfactory results.

(c) Ejection times were measured for all SCRAM-able rods and found to be less than 1 seconds

(d) The reactivity worth of all safety and control rods were measured, as well as the time required to drive each rod to its fully inserted position. Reactivity insertion rates were determined to be less than $0.042\%\Delta k/k\ s^{-1}$ ($\$0.058\ s^{-1}$) for all rods.

(e) The shutdown margin was determined to be greater than $2.2\%\Delta k/k$ ($3.0) with both the most reactive SCRAM-able rod and the fine control rod fully inserted. 8/15/12.

(f) All surveillances were within the appropriate Technical Specification requirements.

2. Operating History and Energy Output.

The reactor was operated at power levels up to 4.9 watts for a total of 148 watt-hours of thermal energy during this reporting period. A summary of monthly operations for 2012 is given in Table I.

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The 0.148 kWh consumed 7.5 micrograms of U-235. During the calendar year, a number of students went through reactor operator training. During the calendar year, four students took NRC licensing exams. Two were awarded Reactor-Operator (RO) licenses and one was awarded a Senior Reactor-Operator (SRO) license. Two operator-licenses were terminated during the year because students left the university.

3. A. Unscheduled Shutdowns and Corrective Actions Taken.

None.

B. Inadvertent Scrams and Action Taken.

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	16:21	Channel 1 Low	Operator Error	Shutdown
2/2/12	14:13	Channel 1 High	Range Change Error	Restart
	14:43	Not Indicated	Suspected Electrical Transient*	Shutdown
2/8/12	16:09	Channel 3 High	Range Change Error	Restart
	16:19	Channel 1 High	Range Change Error	Restart
	16:22	Period	Operator Error	Restart
2/9/12	13:51	Channel 3 High	Signal Irregularity	Restart
	14:17	Period	Operator Error	Restart
	15:03	Period	Insertion of Source	Restart
	15:13	Channel 1 High	Range Change Error	Restart
2/13/12	23:36	Channel 1 Low	Low Power Operation	Restart
	0:02	Channel 1 High	Low Power Operation	Restart
2/16/12	13:35	Channel 1 Low	Loss of Signal	Restart
	14:07	Channel 1 Low	Loss of Signal	Restart
2/22/12	13:50	Magnet Over-Current	Magnet Current SCRAM Set Too Low	Restart
2/27/12	17:14	Channel 3 High	Range Change Error	Restart
	18:04	Not Indicated	Suspected Electrical Transient*	Shutdown
3/21/12	15:56	Channel 1 Low	Loss of Signal	Shutdown
4/2/12	16:52	Channel 1 Low	Loss of Signal	Restart
4/4/12	11:11	Channel 1 Low	Loss of Signal	Restart
4/9/12	16:38	Magnet Over-Current	Magnet Current SCRAM Set Too Low	Restart
5/9/12	16:48	Channel 3 High	Signal Irregularity	Restart
	17:06	Channel 3 High	Signal Irregularity	Restart
5/15/12	16:40	Channel 3 High	Signal Irregularity & Range Change Error	Restart
	19:43	Channel 3 High	Over Estimation of Oscillator Reactivity	Restart
5/18/12	11:37	Channel 3 High	Range Change Error	Restart
	14:36	Not Indicated	Range Change Error	Restart
5/23/12	16:47	Magnet Over-Current	Suspected Electrical Transient*	Restart
	17:18	Magnet Over-Current	Suspected Signal Interference & Detector is Insulated	Restart
5/24/12	11:14	Magnet Over-Current	Suspected Electrical Transient*	Shutdown
6/5/12	16:27	Period	Chanel #1 Raise Interference	Restart
6/6/12	16:37	Channel 1 High	Range Change Error	Restart

7/13/12	15:42	Channel 3 High	Operator Error (Training)	Restart
	15:50	Channel 3 High	Operator Error (Training)	Restart
	16:10	Channel 3 Low	Signal Irregularity	Restart
8/7/12	16:47	Channel 1 Low	Suspected Electrical Transient*	Restart
8/8/12	16:18	Channel 1 Low	Removing the Start Up Source	Restart
	16:30	Channel 1 Low	Signal Irregularity	Restart
8/10/12	13:10	Channel 1 Low	Suspected Signal Irregularity	Restart
	13:29	Channel 1 Low	Detector Stuck When Raise Pressed	Investigate & Restart
	14:28	Channel 1 Low	Suspected Signal Irregularity	Restart
8/30/12	13:34	Channel 1	Supervisor Re-Set Time Constant During Operation	Shutdown
8/31/12	10:39	Channel 1 Low	Signal Irregularity	Shutdown
	14:59	Channel 3 High	Range Change Error	Restart
	15:08	Channel 1 High	Suspected Signal Irregularity	Shutdown
9/5/12	20:24	Channel 3 High	Range Change Error	Restart
	21:33	Channel 3 High	Range Change Error	Restart
9/6/12	11:26	Channel 1 Low	Range Change Error	Restart
	11:35	Channel 1 Low	Range Change Error	Restart
9/6/12	17:35	Channel 3 High	Occurred During Range Change	Restart
	17:41	Raise Button	Raising Detector Caused Additional Signal Noise	Restart
9/7/12	12:38	Channel 1 Low	Suspected Signal Irregularity	Restart
	12:58	Channel 1 Low	Suspected Signal Irregularity	Restart
9/12/12	14:52	Channel 3 High	Operator Error (Training)	Restart
9/13/12	9:11	Channel 3 High	Operator Error	Restart
	9:33	Channel 3 High	Erratic Response Changing to 3x10^(-9) Range	Restart
	10:10	Channel 3 High	Erratic Signal	Restart
	10:23	Channel 3 High	Operator Error	Restart
	14:00	Not Indicated	Occurred During Raising Ch #1	Restart
	14:38	Channel 3 High	Signal Irregularity During Range Change	Restart
9/14/12	12:59	Not Indicated	Occurred During Raising Ch #1	Restart
	14:07	Channel 1 Low	Suspected Signal Irregularity	Shutdown
9/15/12	11:28	Channel 3 High	Range Change Error	Restart
	15:07	Channel 3 High	Signal Irregularity During Range Change	Restart
9/18/12	9:58	Channel 3 Low	Accidently Hitting the Console	Restart
9/19/12	19:40	Channel 3 High	Range Change Error	Restart
	19:55	Channel 1 High	Range Change Error	Restart
9/24/12	14:37	Period scram	Raising Detector Caused Additional Signal Noise	Adjust Cable & Restart
	20:01	Channel 1 Low	Operator Error	Restart
9/25/12	12:59	Channel 1 Low	Suspected Electrical Transient*	Investigate & Restart

	14:09	Channel 1 Low	Suspected Electrical Transient*	Restart
9/27/12	11:42	Channel 1 Low	Raising Detector Caused Additional Signal Noise	Restart
	14:39	Raise Button	Raising Detector Caused Additional Signal Noise	Restart
10/1/12	20:29	Channel 3 High	Signal Irregularity During Range Change	Restart
10/5/12	10:34	Channel 3 High	Range Change Error	Restart
10/9/12	16:32	Channel 1 Low	Suspected Signal Irregularity	Restart
10/10/12	13:08	Channel 3 High	Noise in Range 3x10^(-8) & 10x10^(-9)	Restart
	18:06	Channel 3 High	Signal Irregularity	Restart
10/11/12	10:41	Channel 1 High	Range Change Error	Restart
	10:48	Period	Removing the Start Up Source	Restart
	12:38	Channel 1 High	Range Change Error	Restart
	13:50	Ch1 low	Loss of Signal	Restart
	14:29	Period	Raising Detector Caused Additional Signal Noise	Restart
10/16/12	13:28	Loss of Power	Building Loss Power Briefly	Restart
10/17/12	12:06	Channel 1 Low	Loss of Signal	Restart
	19:40	Period	Bumping of the Console	Restart
10/18/12	14:27	Channel 3 High	Range Change Error	Restart
		Channel 3 Low	Range Change Error	Restart
10/19/12	13:25	Channel 3 High	Range Change Error	Restart
	16:35	Bumped Console	Bumped Chair into Console	Restart
10/23/12	9:53	Period	Power Transient	Restart
	12:14	Period	Signal Irregularity	Restart
	13:23	Channel 2 Low	Suspected Signal Irregularity	Restart
	15:37	Period	Electrical Transient* (Period within Range)	Restart
	17:58	Period	Electrical Transient* (Period within Range)	Restart
10/24/12	15:44	Channel 3 High	Range Change Error	Restart
10/29/12	19:50	Channel 3 High	Range Change Error	Restart
	20:34	Channel 3 High	Range Change Error	Restart
	20:36	Channel 3 High	Range Change Error	Restart
10/30/12	9:28	Channel 1 Low	Loss of Signal	Restart
10/31/12	9:43	Channel 3 High	Range Change Error	Restart
11/1/12	13:27	Not Indicated	Activating Channel 1 Solenoid	Restart
11/5/12	9:59	Channel 1 Low	Suspected Electrical Transient*	Restart
	10:03	Period	Suspected Electrical Transient*	Restart
	21:30	Channel 3 High	Range Change Error	Restart
	21:49	Channel 1 Low	Suspected Electrical Transient*	Restart
11/7/12	19:48	Channel 1 Low	Loss of Signal	Restart
11/8/12	10:15	Channel 3 High	Operator Error (Training)	Restart
	11:14	Channel 3 Low	Suspected Electrical Transient*	Shutdown
11/9/12	13:19	Channel 1 Low	Under Estimation of Oscillator Reactivity	Restart
	16:46	Channel 1 Low	Suspected Electrical Transient*	Shutdown

11/13/12	12:58	Loss of Power	Loss of Power to Circuit	Shutdown
11/15/12	13:37	Period	Raising Detector Caused Additional Signal Noise	Restart
11/21/12	14:28	Channel 3 High	Signal Irregularity During Range Change	Restart
12/13/12	13:43	Channel 3 Low	Range Change Error	Restart
	13:52	Period	Inserted Poly Rod Too Quickly	Restart
	14:12	Period	Raising Detector Caused Additional Signal Noise	Restart
	15:52	Channel 3 Low	Signal Irregularity	Restart
	16:00	Period	Raising Detector Caused Additional Signal Noise	Restart
12/14/12	11:53	Channel 1 Low	Operator Error	Restart
12/20/12	12:59	Period	Raising Detector Caused Additional Signal Noise	Restart
12/21/12	12:43	Channel 1 Low	Suspected Electrical Transient*	Restart
	13:01	Channel 1 Low	Suspected Electrical Transient*	Restart
	15:00	Channel 3 High	Range Change Error	Restart
12/27/12	14:06	Channel 1 Low	Signal Irregularity During Range Change	Restart
12/28/12	16:15	Channel 1 Low	Suspected Electrical Transient*	Restart
12/31/12	10:47	Channel 1 Low	Suspected Signal Irregularity	Restart
	11:06	Channel 1 High	Non-Reproducible Rate Meter Issue	Restart

* Electrical transients are signal & power irregularities associated with using older vacuum tube based analogue circuitry.

4. Safety-Related Corrective Maintenance:

1/31/2012: Channel 3 detector changed its response output and was replaced with a comparable BF3 tube. In addition the SHV connector was replaced with one designed for RG-59 cable and recalibrated.

3/6/2012: The down indicator switch on the FCR had been knocked out of place, causing the drive to continue to drive out despite being in the bottom position and the interlock OK light bulb failed. The switch was repositioned for proper operation and the light bulb replaced.

3/14/2013: A bad cable connection causing a short, preventing the magnet to energize, was located. A bypass cable fixed the problem and the main cable connection fixed to return normal functionality.

3/21/2012: The Channel 3 detector lost signal, a connection problem was the likely cause. The detector chamber was removed and all connecting cables were replaced with new connections, returning functionality to the system.

5/25/2012: The rod drop box was rebuilt with new wiring after a significant amount of troubleshooting.

5/30/2012: A power outage cause damage to Channel 2. Vacuum tubes V-12, V-14 & V-17, power line fuse, and the 1.5-volt battery were replaced.

6/5/2012: Magnet current was found to be high (0.9 mA) and after replacing the V-7 vacuum tube the current returned to a normal 0.6 mA.

8/30/2012: Channel 1 was having signal problems due to improper cabling and connectors. The system was rebuilt in a way so that the detector's position does not stress the signal cable and removes the need to raise the detector.

10/4/12: The analogue position display primary gear broke so that the tens digit wouldn't turn. The unit was replaced with a comparable spare.

12/3/12: Channel 2 failed pre-start checks. The F-1 (250V 3A) fuse, V-13 6Y6GA vacuum tube, V-12 6BW4 vacuum tube, and the V-1 6BW4 vacuum tube was replaced in Channel 2 to return functionality.

12/12/12: During operation the Safety Rod 1 dropped out properly, however the chassis jammed in position. It was found that the twin drive screws were uneven; they were greased and reset into position. In addition there was a problem with the "up" microswitch; the microswitch and the wiring were replaced.

5. Modifications.

A. Changes in Facility Design.

None.

B. Changes to Procedures.

None.

C. Experiments.

Experimental procedure 12 Oscillator Experiment was revised to have descriptions for both linear and rotary oscillators and guidelines for operating them simultaneously.

D. Reactor Safety Committee.

As of the end of the reporting period, membership of the Reactor Safety Committee (RSC) consisted of the following individuals:

Frank H. Just – Chair (retired from INL)
Jay F. Kunze - Reactor Administrator
Adam L. Mallicoat - Reactor Supervisor
Richard R. Brey – Department Chair
Peter Farina – Radiation Safety Officer
Robert Boston, PE, CHP (DOE-ID)
Kermit Bunde (DOE-ID)

Richard E. McCracken (retired from INL)

6. Summary of Changes Reportable under 10 CFR 50.59.

The paper chart recorder set up for the detector channels 2 & 3 were changed to utilize a digital chart recorder. The new recorder is capable recording data and displaying the response over time and cannot impact reactor operation as installed. The data is stored on a removable flash drive for easy analysis and storage.

7. Radioactive Effluents.

A. Liquid Waste - Total Activity Released: None.

B. Gaseous Waste - Total Estimated Activity Released: 14.4 μCi of Ar-41.

The AGN-201 Reactor was operated for 148 watt-hours at power levels up to approximately 4.9 watts. At this power level Ar-41 production is negligible and substantially below the effluent concentration limit given in 10 CFR 20 Appendix B, Table 2. The total activity of Ar-41 released to the environment was conservatively estimated at 14.4 μCi. This activity corresponds to the total activity of all gaseous radioactive effluent from the facility. A monthly summary of calculated gaseous releases is given in Table IV.

Table IV. Summary of Monthly Gaseous Radioactive Effluent Releases
(1 January 2012 through 31 December 2012)

Month	Ar-41 (μCi)
January	0.0
February	1.0
March	1.2
April	1.7
May	0.8
June	0.8
June	0.6
August	1.4
September	3.0
October	1.5
November	1.7
December	0.6
Total	**14.4**

C. Solid Waste - Total Activity: None.

8. The latest environmental radiation surveys, performed at the facility boundary while the reactor was operating at 60% of full licensed power (3.0 watt), measured a maximum combined neutron and gamma dose equivalent rate of less than 2.0 mrem hr^{-1} at the outside walls of the building proximal to the reactor. The total equivalent dose rate at 100% power at these locations was less than 4 mrem hr^{-1}.

9. Radiation Exposures.

   The Radiation Safety Officer reviews personnel radiation exposures quarterly. Annual reports of ionizing radiation doses are provided by the Radiation Safety Officer to all monitored personnel as required under the provisions of 10 CFR 19.

   Personnel with duties in the reactor laboratory on either a regular or occasional basis have been issued radiation dosimeters by the Idaho State University Technical Safety Office. The duty category and whole body exposure for the 2012 monitoring period of personnel are summarized in Table V:

Table V. Personnel Radiation Monitored for 1/1/2011-12/31/2011

Name	Exposure by Type (mrem)		
	Deep	Lens	Shallow
Aryal, Harishchandra	2	2	2
Baker, Ben	50	49	46
Baral, Madhav	2	2	1
Bishart, Bishara	1	1	1
Bundy, Deric	3	4	10
Burrows, Ian J	7	6	6
Gorham, Mackenzie	<1	<1	<1
Horkley, Matt	2	2	1
Imel, George	<1	<1	<1
Jash, Soumadipta	<1	<1	<1
Kamerman, David	<1	<1	<1
Krieger, Michael	11	12	12
Kunze, Jay	<1	<1	<1
Langbehn, Adam	7	6	6
Loveland, Ryan	14	13	12
Lum, Edward	1	1	1
Mallicoat, Adam	2	2	1
Misner, Jesse	3	3	2
Nelson, Alan	2	2	2
Nelson, Marcus	<1	<1	<1
Nimmagadda, Jyothier Kumar	<1	<1	<1
Riley, Tony	3	2	2
Steele, Dallin	<1	<1	<1

Stewart, Trevor	3	3	2
Tam, Austin	1	1	<1
Tormohlen, Derick	<1	<1	<1
Wachs, Katelyn	2	3	3
Chaczko, Malwina	<1	<1	<1
Isaacs, Daniel	<1	<1	<1
McBeath, Scott	<1	<1	<1
Nelson, Katherine	3	2	2
Hart, Paul	<1	<1	4

The 10 CFR 20.1201 occupational dose limits to adults are: total 5 rem, lens of eye 15 rem, shallow 50 rem, and deep 50 rem. The doses received for all reactor laboratory personnel during 2012 are well below the dose limits of 10 CFR 20.1201, and well below ISU ALARA limits (1 REM per year, 0.3 REM per quarter).

Anytime a member of the public visits the reactor pin dosimeters are issued for the extent of the tour. A minimum of 1 dosimeter to every 5 people is issued for a representative group dose. During the 2012 calendar year there were 476 recorded visitors to the facility. A summary of the public dose exposure is presented in Table VI.

Table VI. Summary Whole-Body Exposures to the Public
(1 January 2012 through 31 December 2012)

Estimated whole-body exposure range (mrem):	Number of individuals in each range:
No Observable Dose	433
1.0 mrem*	30
Greater than 1.0 but below 5.0 mrem	12
Greater than 5.0 but below 10.0 mrem	1
Total number of individuals reported	476

*Below 1.0 mrem is considered un-measureable

None of the 476 visitors to the facility during 2012 received a measurable dose that would exceed the annual 0.5 rem dose limit of 10 CFR 20.1301. Note there was only one reading that was above 5 mrem, this is likely due to the shock of dropping the dosimeter.

Therefore, the average and maximum doses received by personnel and the public are well within NRC guidelines.

Report prepared by: Adam Mallicoat, Reactor Manager/Supervisor
August 30th, 2012
Adam Mallicoat