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July 20, 2012

NRC Public Document Room
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

SUBJECT: **Transmittal of Annual Report for Nuclear Reactor License R-110**

Enclosed is the Annual Report for the calendar year 2011 for the AGN-201 Nuclear Training Reactor at Idaho State University, licensed under NRC Reactor License R-110

Sincerely,

Jay F. Kunze

Jay F. Kunze, PhD, PE, CHP
Reactor Administrator,
and Chair and Professor of Nuclear Engineering and Health Physics

c: Mr. Duane Hardesty, and Mr. Greg Schoenebeck
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ANNUAL REPORT
Calendar Year 2011
for the
AGN-201 Training Reactor
under
NRC License # R110

Submitted to:
The Research and Test Reactors Branch
of the
Office of Nuclear Reactor Regulation
U.S. NUCLEAR REGULATORY
COMMISSION

by
IDAHO STATE UNIVERSITY
College of Science and Engineering
Pocatello, Idaho 83209

July 20, 2012

Idaho State University
AGN-201M Reactor Facility
License R-110, Docket No. 50-284
Annual Operating Report for 2011 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) Tests performed on all safety channels (and scram interlocks SP-1 8/11/11, SP-2 5/26/11, SP-3 10/6/11) were found to be satisfactory and within specifications.

(2) Power level (5/19/11) and period check (5/26/11) experiments were performed with satisfactory results.

(3) The shield water tank was inspected (6/21/2011) and no leaks or excessive corrosion were observed.

(4) The seismic displacement interlock was tested and found to operate satisfactorily (8/8/2011).

(5) (a) Control rod element capsules (cladding) were inspected (8/19/11) and found to be in good condition with no evidence of deterioration since the previous inspection.

(b) The control rod drive mechanisms were inspected (8/19/11) and tested with satisfactory results.

(c) Ejection times were measured (8/19/11) 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 during lab experiments, as well as the time required to drive each rod to its fully inserted position (8/19/11). Reactivity insertion rates were determined to be less than $0.048\%\Delta k/k\ s^{-1}$ ($\$0.0648\ s^{-1}$) for all rods.

(e) The shutdown margin was determined to be $(2.0\pm0.2)\%\Delta k$, which is greater than the required $1.0\%\Delta k/k$ ($1.35) with both the most reactive SCRAM-able rod and the fine control rod fully inserted.

(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 299 hours generating 13 watt-days (312 watt-hours) of thermal energy during this reporting period. A summary of monthly operations for 2011 is given in Table I.

Table I. Summary of Monthly Reactor Operations
(1 January 2011 through 31 December 2011)

Month	Energy (W-hr)
January	0.00
February	0.01
March	32.93
April	67.32
May	125.73
June	40.99
June	15.98
August	1.99
September	0.00
October	12.65
November	9.74
December	4.25
Total	311.59

3. A. Unscheduled Shutdowns and Corrective Actions Taken.

None.

B. Inadvertent Scrams and Action Taken.

There were 84 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 2011 through 31 December 2011)
Fix Formatting and Descriptions

Date	Scram Type	Cause	Action
3/2/2011	CH 1 low	Boron proved too reactive to maintain criticality	Restart
3/2/2011	CH 3 low	Quick removal of boron sample shocked electronics	Restart with less reactive Boron position
3/2/2011	CH 3 high	Pulled source at low power level, greatly affected response at low level	Restart to 10 mW before removal
3/2/2011	CH 1 low	Loss of signal while raising detector	Restart
3/2/2011	CH 3 high	Turned dial wrong direction	Restart
3/2/2011	CH 1 high	Missed range change	Restart
3/3/2011	CH 3 low	Likely changed range too early	Restart & watch Ch3 closely
3/3/2011	CH 2 low	Very low power operation (100 μW)	Restart
3/4/2011	CH 1high	Missed the range change	Restart
3/4/2011	CH 1 low	Possible loss of signal at very low power (50 μW)	Restart

3/4/2011	CH 1 high	Missed range change	Restart
3/4/2011	CH 3 high	Scram level on Ch 3 has drifted near 3 W	Restart, approach 3 W cautiously
3/5/2011	CH 3 high	Turned dial too early in down ranging	Restart
3/5/2011	CH 3 high	Missed the range change	Restart
3/5/2011	CH 3 high	Missed the range change	Restart
3/7/2011	CH 3 low	Very low power operation (100 μW)	Restart
3/7/2011	Power loss	Eric Burget's foot hit the power plug to the console	Restart
3/8/2011	CH 1 low	Very low power operation (65 μW)	Restart
3/8/2011	CH 1 low	Very low power operation (65 μW)	Restart
3/16/2011	CH 1 high	Moved dial in wrong direction	Restart
3/16/2011	CH 3 high	Upper scram limit is unusually low (~80% of range at 10mW)	Restart and recalibrate next week
3/16/2011	CH 1 high	Accidently switched CH 1 counter clockwise	Restart
3/16/2011	CH 3 low	Missed channel switch	Restart
3/16/2011	CH 3 high	Channel 3 trip high at 10mW	Restart
3/16/2011	CH 3 high	Channel 3 trip high at 100mW	Restart
3/16/2011	CH 2	Channel 2 scram while approaching 2.5W	Restart
3/16/2011	CH 1	Channel 1 trip low (likely loss of signal)	Restart
3/18/2011	CH 2 high	CH 2 scram high at approximately 2.8 W	Restart, don't go to 3 W
3/18/2011	CH 2 high	Scrammed CH 2 high around 3 W	Restart
3/18/2011	CH 2 high	Scrammed CH 2 high around 3 W	Restart
3/19/2011	CH 1 low	Accidently switched range twice	Restart
4/2/2011	CH 3 high	Accidently changed in wrong direction	Restart
4/2/2011	CH 1 high	Missed range change (10 mW)	Restart
4/2/2011	CH 3 high	Missed range change (500 uW)	Restart
4/2/2011	Period high	CH 2 period high	Restart, withdrawal sample more slowly
4/2/2011	Period high	CH 2 period high	Restart, withdrawal more slowly and decrease sample size
4/2/2011	Period high	Inserted CCR and FCR quickly in attempt to produce a positive period for experiment	Restart
4/2/2011	CH 1 low	Ch 1 dropped to "0" for no apparent reason	Watch CH 1 for abnormal behavior
4/2/2011	CH 1 low	Ch 1 signal dropped	Watch CH 1 for abnormal behavior
4/2/2011	CH 1 low	Possible bad power supply connection	Restart
4/2/2011	CH 1 high	Moving Ch 1 detector down to reset (1 mW)	Restart
4/7/2011	Unknown	Pressing the raise button on CH 1	Will talk to reactor supervisor
4/19/2011	CH 1 high	Missed the range change on CH 1	Restart
4/19/2011	CH 3 high	Missed the range change on CH 3	Restart

4/25/2011	CH 3 high	Operator in training missed range change	Restart
5/2/2011	CH 1 high	Missed the range change on CH 1	Restart
5/5/2011	CH 3 high	Missed the range change on CH 3	Restart
5/6/2011	CH 2 high	Operator in training reached scram setting around 3.6 W	Restart
5/9/2011	CH 1 high	Fail to switch ranges at 1 W	Restart
5/9/2011	CH 2 high	Attempting operation at 3.4 W reached current scram setting	Restart
5/9/2011	CH 2 high	Attempting operation at 3.4 W reached current scram setting	Restart
5/17/2011	Ch 2 High	Channel 2 scram point has shifted lower to ~3.3 W	Restart
5/17/2011	Ch 2 High	Channel 2 scram point has shifted lower to ~3.2 W	Restart & Ch 2 recalibrated
5/17/2011	Ch1 Raise Button failed	Will mechanically activate raise temporarily	Restart
5/17/2011	Ch 1 High	Missed range change	Restart
5/18/2011	Ch 2 High	Reached scram set point of 4.8 W	Restart, proceed to 4.6 W
5/18/2011	Ch 2 High	Shifted calibration or electrical transient at 4.6 W	Restart
5/19/2011	Ch 2 High	Reached scram set point of 4.5 W during power calibration	Restart
6/6/2011	Ch 1 Low	Signal lost while pressing raise button	Restart
6/9/2011	Ch 3 High	Range change in wrong direction	Restart
6/9/2011	Ch 3 High	Range change too slow	Restart
6/14/2011	Ch 1	Signal lost while pressing raise button	Restart
6/14/2011	Ch 1	Missed range change	Restart
6/14/2011	Ch 1 Low	Ch 1 signal lost briefly	Restart
6/14/2011	Ch 1 Low	Ch 1 signal lost briefly	Restart
6/14/2011	Ch 1 Low	Ch 1 signal lost briefly	Restart
6/20/2011	Ch 3 High	Range change in wrong direction	Restart
6/23/2011	Ch 3 Low	Loss of signal while raising Ch 1detector but Ch 3 sensetrol indicated first	Restart
7/18/2011	Ch 3 High	Operator in Training Error	Restart
7/18/2011	Ch 1 High	Operator in Training Error	Restart
7/18/2011	Ch 1 High	Operator in Training Error	Restart
10/10/2011	Ch 1 Low	Ch 1 Signal Loss	Restart
10/11/2011	Ch 1 Low	Ch 1 Signal Loss	Restart
10/11/2011	Ch 1 Low	Ch 1 Signal Loss	Restart
10/15/2011	Ch 1 Low	Missed range change	Restart
10/20/2011	Ch 1 High	Missed range change when pulling source	Restart
10/20/2011	Power Loss	Eric Burget's foot hit the power plug to the console	Restart
10/24/2011	Ch 2 Period	Removed Cd from glory hole	Restart

10/27/2011	Ch 2 Period	Period experiment from adding 4 cm of FCR	Restart
10/27/2011	Ch 2 Period	Period experiment from adding FCR in 1 cm increments	Restart
12/14/2011	Ch 1 Low	Missed range change	Restart
12/15/2011	Ch 1 Low	Signal lost while pressing raise button	Restart
12/15/2011	Ch 1 Low	Signal lost while pressing raise button	Restart
12/16/2011	Ch 3 High	Scramed while changing range	Restart

4. Safety-Related Corrective Maintenance

1/14/11-2/16/11: The period 2 light would not turn on and the magnets would not energize. A loose connection was found on the K5 pin controlling energizing magnets and a bad solder joint was found on the K-6 pin of the 5663 tube in V-2. The period 2 reset was found to have been badly damaged and was replaced. The wire connecting sensitrol 1 & 2 was found damaged and replaced. K-5 pin 5 had completely detached. The V-2 tube was replaced with a comparable 6463. There was a bad connection from the K-6 relay to the 50 μF C-3 capacitor. The period 2 reset was found to be damaged and was replaced.

2/18/11-2/24/11: The console indication lights failed to turn on with the console. A damaged wire was found between the F-2 fuse and the power supply. The connection was replaced but the problem persisted. Trouble suspected in S-1 switch and V-6 tube. After further bench testing it was found that: S-1 was not making proper electrical connections, a frayed fire was shorting on B+ at I-8, the motor on the start-up delay circuit was failing, the startup switch was a crude short mechanism rather than a switch, a bad solder connection was found on V-9, a bad solder connection on terminal block 4 to relay K-5 pin 14, pins 3 & 4 were damaged on J-13, and both J-13 & J-22 were in need of a rebuild. All problem connections, components and cables were repaired or replaced with exact components or modern equivalents. An array of checks was performed before further operation.

3/10/11: The channel 2 & 3 outputs had become noisy and not as useful to the operator. The output of channel 2 was found to be badly assembled and was replaced, removing feedback response. The signal cable to the chart recorders were replaced, from unshielded wire to shielded wire, reducing the electronic noise.

3/21/11-3/25/11: Upon inspection the 50 mV connector to channel 2 was found to be damaged and was replaced. The following General Preventative Maintenance followed: a bad connection between grounding strip and bar was repaired and repositioned, the channel 1, 2, & 3 rails were repositioned for easier maintenance, a 4 pin quick disconnect was added to pass through wiring on the scram drawer for easier maintenance, and a crude daisy chain connector, that was found to be cracked from age, was replaced to a proper terminal bus bar (to prevent electrical shorting).

3/31/11: The plastic mechanical float stop for channel 1 was replaced with a comparable machined aluminum cylinder that was made to be a direct replacement.

4/13/11-4/14/11: The magnet current read-out stopped working. The wires were found to be too small for load. Replacing with appropriate wire returned full functionality.

5/3/11-5/4/11: Channel 1 signal cable was found to be using an old RG62 cable with old tin type BNC connectors. The cable was conservatively replaced with RG58 cable and new copper tip BNC connectors. Channel 2 signal cable was found to be an odd mix of connectors and wire types. Starting at the cable breaching the tank Amphenol cable type 71 was patch attached to an Amphenol bulkhead connector with a BNC adaptor, then to a BNC RG58 cable to a BNC RG 59 to a BNC to SHV converter. The channel 2 signal cable was repaired to only use Amphenol 71 and RG 59 (which are comparable). The smaller RG58 was causing electrical heating.

5/9/11: Magnets on glow bulb burnt out, magnet current read out remained functional in interim, appropriate bulbs were ordered and replaced on arrival. Channel 2 signal was found to be oscillating between two values about every 40 seconds without signal being connected. The 6Y6YGA tube would attempt to power up but would drop down to a lower voltage before reaching operating voltage. The tube was replaced and SP2 checks preformed.

5/26/11: Multiple tubes seemed to be shorting between the plate and filament. It was found that poor insulation of the wires attached to the vacuum tubes was causing the behavior. All pertinent old wires were replaced.

8/16/11: The inner PVC housing & channel 1 detector configuration came loose, lowering the detector closer to the reactor, doubling its signal, and preventing operation as limited by the range of the rate meter. The detector was re-secured back into position using the original configuration.

8/23/11: During MP-1 the CCR would drop before reaching the full up position. After some testing it was suspected that the problem was not mechanical but electrical. All vacuum tubes tested okay, 3 potentiometers were found worn and replaced, which returned full functional motion of the CCR.

10/15/11: The channel 1 power supply was found to have failed and was sending a 60 Hz signal to the preamp, which in turn caused the preamp to fail. The power supply was replaced with an identical model and the preamp replaced with a comparable modern alternative.

12/15/11: Additional Note: It was discovered that the loss of signal on Channel is likely being caused by an ill-fitting connecter being jarred by the solenoid detector release. (The repair was accomplished after December 31, 2011.)

5. Modifications.

A. Changes in Facility Design.

None.

B. Changes to Procedures.

None.

C. Experiments.

An amendment was made to the 1979 oscillator procedure to allow for EP7 to be preformed

in the experimental port. The new oscillator was vetted using 10 CFR 50.59.

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 (PE) – Chair (retired)
Jay F. Kunze (PhD, PE, CHP)- Reactor Administrator, NE Department Chair
Adam L. Mallicoat - Reactor Supervisor
Richard R. Brey (PhD, CHP) – Director of Health Physics
Thomas F. Gesell (PhD) (Emeritus)
Robert Boston (PE, CHP) (DOE-ID)
Kermit Bunde (PE) (DOE-ID)
Richard E. McCracken (retired from INL)

6. Summary of Changes Reportable under 10 CFR 50.59.

None.

7. Radioactive Effluents.

A. Liquid Waste - Total Activity Released: None.

B. Gaseous Waste - Total Estimated Activity Released: 30 μCi of Ar-41.

The AGN-201 Reactor was operated for 299 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 30 μCi from the "Glory hole". This activity corresponds to the total activity of all gaseous radioactive effluent from the facility. A monthly summary of estimated gaseous releases is given in Table IV.

Table IV. Summary of Monthly Gaseous Radioactive Effluent Releases
(1 January 2011 through 31 December 2011)

Month	Ar-41 (μCi)
January	0.00
February	0.001
March	3.20
April	6.55
May	12.24
June	3.99
June	1.55
August	0.19
September	0.00
October	1.23

November	0.95
December	0.41
Total	30.32

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 0.17 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 1 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 2011 monitoring period of personnel are summarized in Table V:

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

Name	Duty Category	Exposure by Type (mrem)		
		Deep	Lens	Shallow
Baker, Ben A	Regular	32	34	47
Bisharat, Bishara	Regular	<1	<1	<1
Bonebrake, Eric M	Regular	106	107	109
Bundy, Deric	Occasional	3	4	10
Burgett, Eric A	Regular	101	101	102
Burrows, Ian J	Occasional	1	1	2
Gaines, Mark B	Regular	21	21	26
Guatam, Bibek	Occasional	39	39	35
Imel, George	Regular	<1	<1	2
Soumadipta, Jash	Occasional	<1	<1	4
Kamerman, David	Occasional	<1	<1	3
Kleinrath, Verena	Occasional	5	5	11
Kreiger Michael	Regular	<1	<1	<1
Kunze, Jay	Regular	<1	<1	<1
Langbehn, Adam	Occasional	<1	<1	<1
Loveland, Ryan	Regular	<1	<1	<1
Mallicoat, Adam	Regular	7	7	9
Moon, Jarrett	Occasional	<1	<1	<1

Nelson, Marcus	Regular	<1	<1	<1
Jyothier, Kumar	Occasional	4	5	18
Riley, Tony R	Regular	19	19	19
Russell, Try	Occasional	<1	<1	<1
Shannon, Dennis	Occasional	4	4	5
Sheppard, Jordan	Occasional	<1	<1	<1
Smarma, Sarvagya	Occasional	16	17	18
Steele, Dallin	Occasional	<1	<1	<1
Tormohlen, Derik	Occasional	17	17	23
Turnbull, James	Regular	<1	<1	9
Vainionpan, Jaakko	Occasional	<1	<1	<1
Wendt, Brycen L	Occasional	<1	<1	<1

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 2011 are well below the dose limits of 10 CFR 20.1201, and well below ISU ALARA limits of 1 Rem per year.

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 2011 calendar year there were 470 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 2011 through 31 December 2011)

Estimated whole-body exposure range (mrem):	Number of individuals in each range:
No Observable Dose	447
1.0 mrem*	16
Greater than 1.0 but below 5.0 mrem	7
Total number of individuals reported	470

*Below 1.0 mrem is considered un-measureable, and 5 mrem is likely the minimum reliable reading.

None of the 470 visitors to the facility during 2010 received a measurable dose that would exceed the annual 500 mrem dose limit of 10 CFR 20.1301.

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
July 18, 2012