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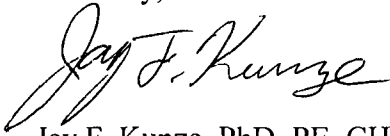
July 20, 2012

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, PhD, PE, CHP
Reactor Administrator,
and Chair and Professor of Nuclear Engineering and Health Physics

c: Mr. Duane Hardesty, and Mr. Greg Schoenebeck
Research and Test Reactors Branch
Office of Nuclear Reactor Regulation
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NRC

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 $0.048\% \Delta k/k \text{ s}^{-1}$ (0.0648 s^{-1}) for all rods.
(e) The shutdown margin was determined to be $(2.0 \pm 0.2)\% \Delta k$, 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 μ W) | Restart |
| 3/4/2011 | CH 1 high | Missed the range change | Restart |
| 3/4/2011 | CH 1 low | Possible loss of signal at very low power (50 μ W) | 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 μ W) | 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 μ W) | Restart |
| 3/8/2011 | CH 1 low | Very low power operation (65 μ W) | 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 | Accidentally 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 | Accidentally switched range twice | Restart |
| 4/2/2011 | CH 3 high | Accidentally 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 1 detector 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 μ F 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 wire 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 connector 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 μ Ci 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 μ Ci 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 |
| Kammerman, 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-measurable, 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