

# Idaho State UNIVERSITY

College of Science and Engineering  
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26 June 2019

To: NRC Public Document Room  
U.S. Nuclear Energy Commission  
Washington, DC 20555-0001

Subject: Transmittal of Annual Report for License R-110 (AGN-201)

Please find attached the Annual Report for the AGN-201 Reactor at Idaho State University, license R-110, Docket # 50.284.

Thank you,

**Mary Lou Dunzik-Gougar**  
Digitally signed by Mary Lou  
Dunzik-Gougar  
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NRK

**Idaho State University  
AGN-201M Reactor Facility  
License R-110, Docket No. 50-284  
Annual Operating Report for 2018 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 during the reporting period.

B. Results of major Surveillance Tests and Inspections:

- 1) The period, count rate, and power level measuring channels were calibrated and set points were verified. Channels 1, 2, & 3 were tested on 07/17/2018, 07/17/2018, & 07/23/2018 respectively.
- 2) Power level (03/15/2018) and period check (07/17/2018) experiments were performed with satisfactory results.
- 3) The shield water tank was inspected (07/16/2018) and no leaks or excessive corrosion were observed. The water level interlock tested satisfactorily (07/16/2018).
- 4) The Seismic Displacement & temperature interlocks were tested and found satisfactory on 07/16/2018.
- 5) Inspections
  - a) Control element capsules (cladding) were inspected (08/14/2018) and found to be in good condition with no evidence of deterioration since the previous inspection
  - b) The control rod drive mechanisms were inspected (08/14/2018) and tested with satisfactory results.
  - c) Ejection times were measured (08/17/2018) for all SCRAM-able rods (SR-1, SR-2, and the CCR) and were found to be 0.104, 0.240, and 0.110 seconds respectively. The requirement that ejection times be less than 1 second is satisfied.
  - d) The reactivity worth of all safety and control rods were measured (2/08/2018) as well as the time required to drive each rod to its fully inserted position (2/08/2018). The largest reactivity rate was  $0.0274\% \Delta k/k \text{ s}^{-1}$  ( $0.03677 \text{ s}^{-1}$ ), which is less than the prescribed limit of  $0.065\% \Delta k/k \text{ s}^{-1}$ .
  - e) On 2/08/18 the shutdown margin with both the most reactive SCRAM-able rod and the fine control rod remaining fully inserted was determined to be  $1.85\% \Delta k/k$  ( $2.483$ ) (at maximum allowable  $k$  excess  $0.65\% \Delta k/k$ ) and satisfies the requirement that it be greater than  $1\% \Delta k/k$ .

f) All Surveillances were within the appropriate Technical Specification requirements.

C. NRC Inspections

The annual inspection was conducted on June 11-14 no findings of significance were identified. No violations were found during the inspection.

2. Operating History and Energy Output

The reactor was operated at power levels up to 4.3 Watts for a total of 128.8 Watt-hours of thermal energy during this reporting period. A summary of monthly operations for 2018 is given in Table I.

Table I. Summary of Monthly Reactor Operations  
 (1 January 2018 through 31 December 2018)

Year Totals		
January	2.4650	Watt-hr
February	27.3245	Watt-hr
March	22.1123	Watt-hr
April	17.5963	Watt-hr
May	6.0478	Watt-hr
June	1.4275	Watt-hr
July	37.3127	Watt-hr
August	11.3543	Watt-hr
September	1.8778	Watt-hr
October	1.2784	Watt-hr
November	0.0047	Watt-hr
December	0.0480	Watt-hr
Total	128.8493	Watt-hr
	0.1288	kWatt-hr

The 0.1288 kWatt-hr consumed 6.56 μgrams of U-235 using Equation (1)

$$g_{U235} = (Whr) \left( \frac{3600 J}{1 Whr} \right) \left( \frac{6.242 \cdot 10^{12} MeV}{1 J} \right) \left( \frac{1 Fission}{200 MeV} \right) \left( \frac{1.17 atoms U235}{1 Fission} \right) \left( \frac{1 mol U235}{6.022 \cdot 10^{23} atoms U235} \right) \left( \frac{235 g U235}{1 mol U235} \right) \quad (1)$$

During the calendar year, a number of students went through reactor operator training. During the calendar year, 4 students took NRC licensing exams, 2 students reattempted previously failed sections of the NRC licensing exam, and 6 were awarded Reactor Operator (RO) licenses, 0 were awarded a Senior Reactor Operator (SRO) license. 0 students did not pass the RO License Examination.

3. Unscheduled Events and Inadvertent SCRAMS

A. Unscheduled Shutdowns and Corrective Actions Taken – None

B. Inadvertent SCRAMS and Actions Taken

There were 37 inadvertent scrams during this reporting period. Table II summarizes the inadvertent scrams, known or suspected cause, and actions taken.

Table II. Summary of Inadvertent Scrams  
 (1 January 2018 through 31 December 2018)

Inadvertent scrams				
Date	Time	Scram Type	Cause	Action
1/18/18	1620	Period	Electrical Noise	Shutdown & Investigate
1/22/18	1601	Period	Electrical Noise	Restart
1/25/18	1542	Period	Electrical Noise	Restart
2/5/18	1600	Period	Electrical Noise	Restart
2/5/18	1606	Period	Electrical Noise	Restart
2/6/18	1556	CH#3 Low	Operator Error	Restart
2/8/18	1512	Period	Electrical Noise	Restart
2/8/18	1520	CH#3 High	Channel 3 Needle Stuck Up	Restart
2/8/18	1603	Period	Electrical Noise	Shutdown & Investigate
2/25/18	1222	CH#1 Low	Operator Error	Shutdown & Investigate
3/13/18	936	CH#2 High	Channel 2 Prestart Check	Restart
4/25/18	1535	CH#3 High	Operator Error	Restart
4/25/18	1601	CH#2 High	Operator Error	Restart
4/30/18	1132	CH#1 Low	Electrical Noise	Restart
5/6/18	1658	CH#1 Low	Electrical Noise	Restart
5/22/18	1421	Period	Electrical Noise	Shutdown & Investigate
5/25/18	1449	CH#3 High	Operator Error	Restart
6/5/18	1151	CH#1 Low	Operator Error	Restart
6/12/18	1808	CH#1 Low	Electrical Noise	Restart
6/12/18	1814	Scram	Electrical Noise when CCR lever Moved	Restart
6/22/18	1859	CH#1 Low	Wrong range, Possible electrical noise	Restart
6/23/18	1351	Period	Electrical Transient	Restart
7/6/18	908	CH#3 High	Operator Error	Restart
7/10/18	1112	CH#3 Low	Channel 3 Noise	Restart
7/10/18	1429	Period	Electrical Noise	Restart
7/11/18	1113	Period	Electrical Noise	Restart
7/20/18	1415	Period	Electrical Noise	Restart
7/20/18	1415	Period	Electrical Noise	Restart
7/20/18	1415	Period	Electrical Noise	Restart
8/10/18	1540	Period	Electrical Noise	Restart
8/23/18	1452	Period	Electrical Noise	Restart
8/31/18	1405	Period	Electrical Noise	Restart
9/19/18	912	Period	Electrical Noise	Restart
10/25/18	945	Period	Electrical Noise	Restart
10/25/18	1106	CH#3 Low	Electrical Noise	Restart
10/25/18	1204	CH#1 low, CH#3 low	Electrical Noise	Shutdown & Investigate
12/10/18	1112	manual	Operator Error	Restart

4. Safety Related Corrective Maintenance

**Table III. Summary of Safety Related Maintenance  
 (1 January 2018 through 31 December 2018)**

Safety Related Corrective Maintenance	
Date Performed	Description
1/18/2018	The CCR Magnet assembly remained stuck while the CCR fully exits without issue. Realignment of the of the threads on the magnet assembly carriage
1/19/2018	The CCR Magnet assembly remained stuck while the CCR fully exits without issue. addition of lubricant to the lead screw and loosening of the chain drive for the CCR.
1/24/2018	Shield temperature trip point was adjusted from 16.5 °C to 15.4 °C
2/2/2018	Shielding was removed from access ports 2 & 3 for measurement. Dimensions of access ports found to be 100 mm with plugs being 97 mm. The shielding was reinserted.
2/5/2018	The CCR was binding. Adjustment to the CCR drive was made. CCR continues to jam. More adjustments were made and retested. Continuing fine tuning until acceptable results.
2/6/2018	The CCR bound. Use of manual insertion method applied and showed no issues.
2/7/2018	Replace the CCR up light socket, and fixed a loose connect. Replace screw on distribution board.
2/7/2018	Replaced 2 12AX7 vacuum tube in channel 2, replaced 5663 vacuum tube in scram chasis
2/7/2018	adjust channel 1 voltage 2.2 kV to 2.0 kV. Setting of 2.2kV too high per plotted values.
2/8/2018	Replace 2 6CB6 vacuume tubes in channel 2
2/14/2018	Adjusted low level trip and high trip point for channel 3
2/23/2018	CCR failed to insert CCR fast/slow toggle switch replaced
3/2/2019	Romved CCR drive for inspection for senior design project and test
3/23/2018	Correcting Rod drive movement, taken out and microswitch inspected to reveal a problem
3/28/2018	Removed CCR rod drive to replace "up" microswitch
4/2/2018	Maintenance continued on "up" microswitch
4/3/2018	Maintenance continued on CCR rod drive
6/23/2018	Checking vaccum tubes on channel 2, channel 3, and the scram chasis, replaced 1 6CB6 Vacuum Tube in channel 3
7/11/2018	Radiation Survey for channel 2 Vaccum tube testing
7/16/2018	SP 4 was performed, SP5 was performed, & SP 6 was performed
7/17/2018	SP 1 was performed, SP 2 was performed
7/18/2018	Removed CCR rod Drive to test encoder continuity
7/20/2018	Vacuum tube Testing for electrical noise events
7/23/2018	SP 3 was Performed
8/14/2018	MP1 was performed a rod insertion time test was performed
8/17/2018	MP1 was performed and the rod drop rime was tested and a startup to test was performed
10/25/2018	Performed survey experiment on the oscillator found no contamination
11/5/2018	Encoder demonstraiton and measurements
11/8/2018	Test of CCR movement insertion and removal
11/9/2018	Installation of CCR drive
11/14/2018	Verified proper CCR movement
11/16/2018	Removal and test of encoders on rod drives
11/19/2018	Removal of control rods to test fit and insertion time
11/21/2018	Testing the new console functionality with coarse rod outside core
12/6/2018	Verified Skirt door wiring and testing rod drive functionality

5. Modifications

- A. Changes in Facility Design – None
- B. Changes to Procedures – None
- C. Changes to Experiments – None
- D. Reactor Safety Committee

As of 12/14/2018 Maxwell Daniels stepped down as Reactor Supervisor and Reactor Administrator. Mary Lou Dunzik-Gougar took up the role of interim Reactor Supervisor as permissible by the Technical Specifications.

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

Kermit Bunde, PE – Chair (DOE-ID)  
Mary Lou Dunzik-Gougar, PhD – Reactor Administrator & Interim Reactor Supervisor  
George Imel, PhD – Assistant Reactor Administrator  
Richard R. Brey, PhD, CH{ – Radiation Safety Officer  
Robert Boston, PE, CHP, Deputy Manager (DOE-ID)  
Benjamin Baker, former SRO (INL)  
Jay F. Kunze, PhD, PE, CHP – Former Reactor Administrator

6. Summary of Changes Subject to 10 CFR 50.59 Analyses – None
7. Radioactive Effluents
  - A. Liquid Waste – Total Activity Released – None
  - B. Gaseous Waste – Total Estimated Activity Released

The AGN-201 Reactor was operated for 128,849.3 Watt-hours at power levels up to approximately 4.0 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 2.6748  $\mu\text{Ci}$  using Equation (2). 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 2018 through 31 December 2018)

Year Totals Ar-41		
January	0.0512	μCi
February	0.5672	μCi
March	0.4590	μCi
April	0.3653	μCi
May	0.1255	μCi
June	0.0296	μCi
July	0.7746	μCi
August	0.2357	μCi
September	0.0390	μCi
October	0.0265	μCi
November	0.0001	μCi
December	0.0010	μCi
Total	2.6748	μCi

$$A_{Ar-41} (Ci) = \frac{\sigma_{Ar-40} * Y_{Ar-40} * m_{Ar-40} * (0.961) * P(Whr) * M_{U-235} * \left( \frac{3600}{Whr} \right) * \lambda_{Ar-41}}{M_{Ar-40} * E_R * m_{U-235} * \sigma_{U-235} * (3.7 \times 10^{10} \frac{Bq}{Ci})} \quad (2)$$

where

$\sigma(Ar-40)$	=	0.66	b
Ar-40 Abund	=	0.996003	
m(tot Ar-40)	=	0.006907335	g in 433.74 cm <sup>3</sup> (core+Graphite+Pb) of glory hole
$\phi_{th}$ to $\phi_{tot}$	=	0.961	
M(U-235)	=	235.04	gU/mol
1 Whr	=	3600	J
$\lambda(Ar-41)$	=	0.000105214	sec <sup>-1</sup>
M(Ar-40)	=	39.96	gAr/mol
Energy Recov	=	3.2041E-11	J
m(Tot U-235)	=	672.93	g
$\sigma(f U-235)$	=	587	b
Ci	=	37000000000	
Activity Coef	=	2.07594E-08	Ci/(Whr)

C. Solid Waste – Total Activity – None

## 8. Environmental Radiation survey

The latest environmental radiation survey, performed at the facility boundary while the reactor was operating at 3.8 Watts, 76% of full licensed power, measured a maximum combined neutron and gamma dose equivalent rate of 0.36 μrem hr<sup>-1</sup> or less at the outside

walls of the building proximal to the reactor. The requirement that the total equivalent dose rate be less than 2.0 mrem hr<sup>-1</sup> was satisfied.

9. Radiation Exposure

The Radiation Safety Officer reviews personnel radiation exposure 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 whole-body exposures for the 2018 monitoring period of personnel are summarized in Table V.

Table V. Personnel Radiation Monitored  
 (1 January 2018 through 31 December 2018)

Name	Exposure by Type (mrem)		
	Deep	Lens	Shallow
Abbs, Michaela	M	1	4
Banbury, Skyler	4	4	2
Beatty, Matthew W	3	3	4
Crome, Carl	13	13	14
Daniels, Maxwell J	10	10	15
Deaven, Jenna	M	M	M
Ercanbrack, Spencer	3	3	6
Imel, George	1	1	4
Kunze, Jay F	2	2	3
Lamb, Patience	2	3	4
Moreno Leon, Pedro	8	8	9
Pollock, Theodore	M	M	M
Pope, Chad L	2	2	3
Van Der Velden, Benjami	4	4	4
Yockey, Wesley	7	7	10

Dose Equivalents below the minimum measurable quantity for the current monitoring period are recorded as "M."

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 2018 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).



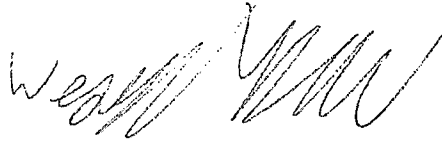
**Table VI. Summary of Whole-Body Exposures to the Public  
 (1 January 2018 through 31 December 2018)**

Estimated Whole-Body Exposure Range (mrem):	Number of Individuals in Each Range:
No Observable Dose	240
1.0 mrem*	22
1.0 mrem < Dose < 5.0 mrem	20
5.0 mrem < Dose < 10.0 mrem	6
10.0 mrem < Dose < 15.0 mrem	0
Dropped Dosimeter**	8
<b>Total Number of Individuals Reported:</b>	<b>296</b>
*Below 1.0 mrem is considered un-measurable      **When a dosimeter is dropped, the value indicated is altered from the true value. All individuals who dropped dosimeters are assumed to have no observable dose.	

None of the 296 visitors to the facility during 2018 received a measurable dose that would exceed the annual 0.5 rem dos limit of 10 CFR 20.1301. Therefore, the average and maximum doses received by the personnel and the public are within NRC guidelines.

Report Prepared by:

Wesley Yockey  
 AGN-201m Reactor Operator  
 21 June 2019



Reviewed and Approved by:

Dr. Mary Lou Dunzik-Gougar  
 AGN-201m Interim Reactor Supervisor & Reactor Administrator  
 26 June 2019

Mary Lou Dunzik-Gougar

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