

**Idaho State University
AGN-201M Reactor Facility
License R-110, Docket No. 50-284
Annual Operating Report for 2022 Calendar Year**

1. Narrative Summary

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

No major changes to the Facility Design, Performance Characteristics, and Operating Procedures were made in 2021. However, several replacement ion chambers were ordered as backups for Channels 2 and 3.

B. Results of major Surveillance Tests and Measurements

- 1) The period, count rate, and power level measuring channels were calibrated and set points were verified. Channels 1, 2, & 3 were tested on 08/16/2022.
- 2) Power level (08/22/2022) and period check (08/22/2021) experiments were performed with satisfactory results.
- 3) The shield water tank was inspected (08/17/2022) and no leaks or excessive corrosion were observed. The Water Level interlock tested satisfactorily (08/17/2022).
- 4) The Seismic Displacement & Temperature interlocks were tested and found satisfactory on 08/17/2022 and 08/22/22.
- 5) Control element capsules (cladding) were inspected (08/25/2022) and found to be in good condition with no evidence of deterioration since the previous inspection
- 6) The control rod drive mechanisms were inspected (08/25/2022) and tested with satisfactory results.
- 7) Ejection times were measured for all SCRAM-able rods (SR-1, SR-2, and CCR) and were found to be 0.15, 0.15, and 0.15 seconds, respectively. The requirement that ejection times be less than 1 second is satisfied.
- 8) The reactivity worth of the Fine Control Rod, Safety Rods 1 and 2, and the Course Control Rod were measured. The time to drive each rod fully into the core was measured as part of performing Maintenance Procedure 1. The largest reactivity insertion rate is $0.0302 \frac{\% \Delta k}{k} / s$, which is less than the tech spec limit of $0.065 \frac{\% \Delta k}{k} / s$.
- 9) The shutdown margin (SDM) with the most reactive SCRAM-able rod and the Fine Control Rod fully inserted was determined to be $2.215 \frac{\% \Delta k}{k}$ (at maximum allowable k excess $0.65 \frac{\% \Delta k}{k}$). This value meets the tech spec requirement that the SDM be greater than $1 \frac{\% \Delta k}{k}$.

C. NRC Inspections

The annual inspection was conducted by Craig Bassett on June 13 – June 16, 2022. No violations or findings of significance were identified.

2. Operating History and Energy Output

The reactor was operated at power levels up to 4.5 Watts for a total of 126.67 Watt-hours of thermal energy during this reporting period. A summary of monthly operations for 2021 is given in Table I.

Table I. Summary of Monthly Reactor Operations
 (1 January 2022 through 31 December 2022)

Year Totals		
January	0.0095	Watt-hr
February	12.5127	Watt-hr
March	35.5755	Watt-hr
April	16.4035	Watt-hr
May	6.5633	Watt-hr
June	0.0000	Watt-hr
July	0.0000	Watt-hr
August	7.8000	Watt-hr
September	10.9573	Watt-hr
October	5.6632	Watt-hr
November	10.1038	Watt-hr
December	0.8065	Watt-hr
Total	106.3953	Watt-hr
	0.1064	kWatt-hr

The 0.1064 kWatt-hr consumed 5.4 μgrams of U-235 using Equation (1)

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

During the calendar year, several students went through reactor operator training. During the calendar year, four students took NRC licensing exams, one Reactor Operator (RO) and two Senior Reactor Operator (SRO) licenses were awarded..

3. Unscheduled Events and Inadvertent SCRAMS

A. Inadvertent SCRAMS and Actions Taken

There were 20 inadvertent scrams during this reporting period. Table II summarizes the inadvertent scrams, known or suspected cause, actions taken and resolution.

Table II. Summary of Inadvertent Scrams
 (1 January 2022 through 31 December 2022)

Inadvertent scrams					
Date	Time	Scram Type	Cause	Resolution	Action
1/31/22	14:54	Channel 3 Low	Operator Error	Instruct operator to pay attention to console	Restart
2/9/22	16:54	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Shutdown
2/14/22	13:02	Channel 3 Low	Electrical Noise		Restart
2/14/22	13:23	Channel 3 Low	Electrical Noise		Restart
2/17/22	10:55	Channel 3	Electrical Noise		Shutdown
2/17/22	15:54	Period	Bunmped Equipment		Restart
3/3/22	15:37	Channel 3 High	FCR Stuck	Repair FCR	Shutdown
3/9/22	10:22	Channel 3 Low	Operator Error	Instruct operator to pay attention to console	Restart
3/29/22	10:26	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Restart
4/12/22	12:00	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Restart
4/15/22	14:21	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Restart
4/19/22	10:32	Channel 2 Low	Electrical Noise		Restart
4/21/22	10:35	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Shutdown
9/15/22	11:37	Power Outage	Power Outage		Restart

9/27/22	17:34	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Restart
9/30/22	9:31	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Restart
10/19/22	16:46	Channel 3 Low	Operator Error	Instruct operator to pay attention to console	Shutdown
11/3/22	17:54	Seismic Interlock	Electrical Noise		Shutdown
12/15/22	13:07	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Shutdown
12/15/22	14:30	Channel 3 High	Operator Error	Instruct operator to pay attention to console	Shutdown

4. Safety Related Corrective Maintenance

Table III. Summary of Safety Related Maintenance
 (1 January 2022 through 31 December 2022)

Safety related Corrective Maintenance	
Date Performed	Description
2/10/22	Testing on the potential ability to run down SR1 and SR2 at end of operation instead of scrambling to reduce wear on control rods. Modifications wouldn't meet Technical Specification requirements, so not implemented.
2/15/22	Removed and reinstalled rod drives to test compatability with spare parts from new rod drive design.
2/24/22	Removed and reinstalled SR1 to investigate SR1 getting stuck on 2-23-22. Fuse F14 replaced. Lead screws cleaned and lubricated with white lithium grease.
3/3/22	FCR stuck in full in position. Removed rod drive to repair limit switch. Reinstalled rod drive into reactor.
8/22/22	Investigating Channel 2 low signal. Previous change of plugging Channel 1 Pre-Amplifier into isolation transformer causes errant signal into Channel 2. Reverted change and all channels return to operational condition.

5. Modifications

A. Changes in Facility Design – None

B. Changes to Procedures

Updates to OP1 and OP1 Logsheet to be better organized and operator friendly.

C. Changes to Experiments – None

D. Reactor Safety Committee

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

Kermit Bunde – Chair (DOE-ID)
Mary Lou Dunzik-Gougar, PhD – Reactor Administrator (Assoc. Dean, ISU)
George Imel, PhD – Assistant Reactor Administrator (Prof., ISU)
Jonathan Scott – Reactor Supervisor
Mason Jaussi – Radiation Safety Officer
Robert Boston, PE, CHP (DOE-ID Manager)
Jay F. Kunze, PhD, PE, CHP (Emeritus Prof., ISU)
Benjamin Baker, PhD (INL)
Mark Cox (INL)
Jason Andrus, PE (INL)

6. Summary of Changes Subject to 10 CFR 50.59 Analyses –

ISU-50.59-2022-2 reviews using an immersion water heater in the reactor tank in order to maintain water temperature in cold months.

7. Radioactive Effluents

A. Liquid Waste – Total Activity Released – None

B. Gaseous Waste – Total Estimated Activity Released

The AGN-201 Reactor was operated for 106.39 Watt-hours at power levels up to approximately 4.5 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 2.2087 μCi 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 2022 through 31 December 2022)

Year Totals Ar-41		
January	0.0002	μCi
February	0.2598	μCi
March	0.7385	μCi
April	0.3405	μCi
May	0.1363	μCi
June	0.0000	μCi
July	0.0000	μCi
August	0.1619	μCi
September	0.2275	μCi
October	0.1176	μCi
November	0.2097	μCi
December	0.0167	μCi
Total	2.2087	μCi

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

C. Solid Waste – Total Activity – None

8. Environmental Radiation survey

One environmental radiation surveys were completed in 2022, it was performed on 11/17/2022.

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 specified in Section 15.4 of the ISU Radiation Safety Manual. Personnel are issued dosimeters by the Radiation Safety Department if they meet the criteria of Section 15.1 of the ISU Radiation Safety Manual. All monitored personnel were below dose limits for calendar year 2022

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 2021 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 2022 through 31 December 2022)

Estimated Whole-Body Exposure Range (mrem):	Number of Individuals in Each
No Observable Dose	173
1.0 mrem*	11
1.0 mrem < Dose < 5.0 mrem	4
5.0 mrem < Dose < 10.0 mrem	0
10.0 mrem < Dose < 15.0 mrem	0
Dropped Dosimeter**	1
Total Number of Individuals Reported:	189
*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 189 visitors to the facility during 2022 received a measurable dose that would exceed the annual 0.1 rem dose limit of 10 CFR 20.1301 for members of the public. Therefore, the average and maximum doses received by the personnel and the public are within NRC guidelines.

Report Prepared by:
 Jonathan Scott
 AGN-201m Reactor Supervisor
 Completed: March 03, 2023

Reviewed and Approved by:
 Jonathan Scott
 AGN-201m Reactor Supervisor
 Completed: March 3, 2023

Dr. Mary Lou Dunzik-Gougar
 AGN-201m Reactor Administrator
 Completed: