

Center for Nuclear Studies Memphis State University

1981
Annual Report
Nuclear Reactor Operations

License R-127, Docket 50-538
AGN-201 Nuclear Reactor, Serial 108

MARCH , 1982

An Equal Opportunity University




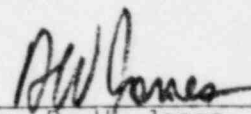
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Center for Nuclear Studies
Memphis State University

1981 ANNUAL REPORT
of
NUCLEAR REACTOR OPERATIONS

AGN-201 Nuclear Reactor, Serial 108
Facility Operating License R-127, Docket 50-538



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ABSTRACT

The 1981 Annual Report of Nuclear Reactor Operations is prepared in accordance with Technical Specification 6.9 of Appendix A to Memphis State University Facility Operating License R-127, Docket 50-538. The report includes the period from January 1 to December 31, 1981. Results of certain reactivity measurements that were made in January, 1982, are also included to provide continuity of data reported during previous years.

Reactor operations during 1981 were primarily for the purpose of operator training and no new or previously untried experiments were performed. The maximum steady-state power level at which the reactor operated was 53 milliwatts. Three unscheduled shutdowns are reported in section B of the report and a copy of Reportable Occurrence 81-1 is included in Appendix A. The reactor required no major safety related corrective maintenance during the year. In December, 1981, the fuel and core fuse were removed from the reactor, inspected and found to be in excellent condition, and reinstalled. Subsequent measurements of core parameters and radiation survey results do not significantly differ from data contained in previous reports of AGN-201 operation.

An upgraded physical security plan was approved in 1981 and is to be implemented upon receipt of additional Special Nuclear Material (SNM) that would increase the amount possessed to levels consistent with criteria established for SNM of Low Strategic Significance. During the period covered by this report, however, no additional reactor fuel has been received and the total amount of SNM on site is less than 700 grams of contained U235. In addition, previously authorized modifications required for operating the reactor above 100 milliwatts have not been incorporated and operations are presently conducted in accordance with the facility license prior to Amendment No. 1.

Section K of this report contains a statistical summary of personnel exposures to radiation as described in Chapter 1, Part 20.407, 10CFR.

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A. REACTOR OPERATING EXPERIENCE

1. Student Training Programs

Three power plant employees participated in training exercises designed by Memphis State University (MSU) to provide research reactor startup experience for cold license candidates. In addition, 27 students from MSU's specialized on-campus Nuclear Skills Training Program performed reactor startups and related training exercises as part of that program's normal curriculum. A total of 186 reactor startups were conducted during the operations training that comprised these programs.

2. Staff Operator Training

Several startups and operations exercises were conducted for the purpose of maintaining and evaluating operator proficiency. As of December 31, 1981, the MSU Center for Nuclear Studies Staff held two Senior Operator licenses and one Operator License for the AGN-201 Reactor.

3. Additional Operations and Operating Experience Summary

Additional reactor operations were conducted for the purpose of satisfying surveillance requirements and routine tests and calibrations.

TOTAL NUMBER OF REACTOR STARTUPS DURING 1981: 202

TOTAL HOURS OF CRITICAL OPERATION DURING 1981: 69.2

<u>Month</u>	<u>Hours</u>	<u>Max. Power (Milliwatts)</u>	<u>Month</u>	<u>Hours</u>	<u>Max. Power (Milliwatts)</u>
Jan	0.67	41	Jul	7.98	44
Feb	10.92	49	Aug	0	0
Mar	0	0	Sep	0	0
Apr	0	0	Oct	0.37	16
May	0.6	50	Nov	0.57	49
Jun	24.77	53	Dec	23.32	50

B. UNSCHEDULED REACTOR SHUTDOWNS

Three unscheduled reactor scrams were experienced during 1981. No operating limits were exceeded and only one of the scrams was considered a Reportable Occurrence as defined by the Facility Operating License.

1. CHANNEL 1 HIGH LEVEL TRIP. On February 12, 1981, a High Level Trip occurred on the Channel 1 Neutron Flux Monitor due to the operator not adequately leveling reactor power following an up-power transient. This channel has a High Level Trip set at 90-95% of full scale indication to prevent overranging the instrument. The trip point corresponds to an actual reactor power of approximately 62 milliwatts. No operating limitations were exceeded nor were any conditions achieved that would have required reactor shutdown, operation of safety systems, or other protective measures required by Technical Specifications.
2. LOSS OF ELECTRICAL POWER. An unplanned interruption of electric power service to the MSU South Campus caused a reactor shutdown on June 8, 1981. An operator training program was in progress and a $\frac{1}{M}$ approach to criticality was being conducted. At the time of the power outage, the reactor was subcritical at a steady-state neutron level. The reactor systems performed as designed and reactor shutdown occurred due to loss of Reactor Control Power which interrupted electrical current to the Control Rod Holding Magnets. This shutdown met criteria established for Reportable Occurrences in the Facility Operating License and a copy of the followup report (81-1) is included herein as Appendix A.
3. CHANNEL 3 RANGE SWITCHING TRANSIENT. On December 15, 1981, an unplanned reactor scram occurred as the result of a spurious electrical noise spike that appeared while switching the Channel 3 Linear Micromicroammeter from the 3×10^{-10} to the 10×10^{-10} scale. At the time of this event, criticality had just been achieved with the

reactor and the operator was in the process of increasing the power level. Reactor power at time of scram was 2.8 milliwatts. Further switching evolutions failed to reproduce the spurious noise transient and reactor operations were resumed.

Eleven additional scrams were caused by trainees during the conduct of student training programs and are classified as training scrams.

C. PREVENTIVE AND CORRECTIVE MAINTENANCE

1. Major Safety Related Corrective Maintenance

None required.

2. Results of Major Surveillance Tests and Inspections

a. Control Rod Drive Assembly Inspection and Lubrication:

This annual surveillance procedure was completed on December 29, 1981. The drive assemblies were found in satisfactory condition with no evidence of abnormal wear or deterioration.

b. Inspection of Core Fuse, Components and Structures:

This five year surveillance requirement was completed on December 29, 1981. The reactor core was disassembled and a thorough inspection of the core fuse and each fuel disc was conducted. Visual evidence of cracking, embrittlement, or other deterioration of the fuel and fission product containment boundaries was not found and all core components appeared to be in excellent condition.

Significant levels of loose-surface contamination were not detected on any of the fuel discs or structural components. The graphite reflector and all lead shielding was intact and no apparent defects could be found. The core was reassembled using the same fuel that has been assigned to this reactor since its fabrication in 1959.

- c. Measurement of Safety and Control Rod Scram and Insertion Times: This annual surveillance procedure was completed on January 6, 1982. The results are included in the 1981 report to provide continuity of reported data.

	<u>Insertion (cm/sec)</u>	<u>Scram (msec.)</u>
Safety No. 1	0.493	130
Safety No. 2	0.434	120
Coarse Rod	0.379	123
Fine Rod	0.524	N/A

- d. Reactivity Measurements: This annual surveillance procedure was completed on January 15, 1982. The results are included in the 1981 report to provide continuity of reported data.

<u>Parameter</u>	<u>% Reactivity</u>
Control Rod Integral Worth:	
Fine	0.32
Coarse	1.23
Reactivity Insertion Rate (max.):	
Safety No. 1	.037/sec
Safety No. 2	.032/sec
Coarse Rod	.028/sec
Fine Rod	.019/sec
Excess Reactivity (Glory Hole empty, all rods IN, 20°C)	.2021
Shutdown Margin (Most reactive rod IN)	2.56

D. CHANGES IN FACILITY DESIGN, PERFORMANCE CHARACTERISTICS, OR
PROCEDURES RELATED TO REACTOR SAFETY

No changes to facility design, performance characteristics, or procedures related to reactor safety were made during 1981. Certain changes have been authorized pursuant to Amendment No. 1 to Facility Operating License No. R-127 (issued March 28, 1980) and are described in MSU's 1980 Annual Report of Nuclear Reactor Operations, Sections D, E, and Appendix E. However, due to circumstances that were previously unanticipated, such changes have not been implemented and facility design, including reactor operations and procedures, are presently maintained within the limitations described in the license prior to amendment.

E. CHANGES WHICH WOULD AFFECT THE FACILITY'S DESCRIPTION

Amendment No. 1 to the Facility Operating License No. R-127 authorizes, upon completion of all modifications described in the application for amendment and written notification thereof, steady-state operation not to exceed 20 Watts and intermittent operation not to exceed 1000 Watts thermal. Upon completion of the approved modifications, the reactor will be redesignated AGN-201H. Revised Technical Specifications to support such operations are included in the license amendment and are described in MSU's 1980 Annual Report of Nuclear Reactor Operations, Appendix E.

Possession limits of Special Nuclear Material (SNM) up to 1400 grams of contained U235 enriched equal to or less than 20% were also authorized. An upgraded physical security plan to satisfy requirements for possession of SNM of Low Strategic Significance was approved by USNRC (Amendment No. 2 to Operating License R-127, April 27, 1981) and authorized for implementation upon possession of such SNM by Amendment No. 3 to Operating License R-127 on May 29, 1981.

As of the date of this report, modifications necessary to permit high power operations have not commenced and the amount of SNM possessed by MSU is less than 700 grams contained U235. Therefore, the license

amendment and the revised security plan have not been implemented. Reactor operations and security procedures, until such time as the revised documents apply, are being conducted in accordance with the Facility Operating License R-127 prior to its amendment.

F. CHANGES TO ADMINISTRATIVE PROCEDURES

1. Revision 6 (5/81) to the AGN-201 Nuclear Reactor Facility Organization and Regulations Manual was approved on July 26, 1981. This revision:
 - a. Incorporated recommendations resulting from an audit conducted by the American Nuclear Insurers (ANI).
 - b. Provided clarification of responsibilities regarding administration and retention of facility records.
 - c. Revised visitor control and key accountability procedures.
 - d. Clarified Operator Qualification procedures.
 - e. Upgraded radiological controls procedures.
2. Revision 1 (11/81) to the AGN-201 Maintenance and Storage Manual was approved on December 11, 1981. This revision promulgated administrative controls procedures for removing and installing reactor fuel.

G. NEW OR UNTRIED EXPERIMENTS

None

H. RADIOACTIVE EFFLUENTS

1. Liquid: None
2. Airborne: None
3. Solid: None

I. ENVIRONMENTAL RADIOLOGICAL SURVEYS PERFORMED OUTSIDE THE FACILITY

Areas of unrestricted access begin at the outside walls of the Reactor Room. A general area radiation survey conducted December 16, 1981, revealed the maximum detectable level of gamma radiation to be 0.22 mR/hr measured upon contact with the outside east wall. The maximum level of neutron radiation measured 0.3 mr/hr at the same location. The reactor was being operated at a steady power level of 50 milliwatts for the duration of the survey.

Random wipes/smears of surfaces both inside and outside the reactor facility did not reveal any loose surface activity above natural background levels.

The reactor was not operated at steady-state power levels above 53 milliwatts during 1981. Therefore, no full power radiation survey results are available.

J. RADIATION EXPOSURES GREATER THAN 100 MILLIREM (50 MREM FOR PERSONS UNDER 18 YEARS OF AGE)

None

K. PERSONNEL EXPOSURE AND MONITORING: 10 CFR 20, Part 407 (a)(2) and PART 407(b)

1. Personnel monitoring was provided for a total of 70 persons during 1981.

2. Statistical Summary:

<u>Estimated Whole Body Exposure (Rems)</u>	<u>Number of Individuals in Each Range</u>
No measureable exposure	24
Measureable exposure less than 0.1	42
0.1 to 0.25	4
0.25 to 0.5	0
0.5 to 0.75	0
0.75 to 1	0
1 to 2	0
2 to 3	0
3 to 4	0
4 to 5	0
5 to 6	0
6 to 7	0
7 to 8	0
8 to 9	0
9 to 10	0
10 to 11	0
11 to 12	0
12+	0

The highest cumulative exposure for an individual during 1981 was 0.142 Rem. The average exposure for the 70 individuals monitored during 1981 was .026 Rem.

L. AUDITS AND INSPECTIONS

Audits and inspections of the AGN-201 Reactor Facility were conducted by the following agencies during 1981.

1. MSU Reactor Safety Committee (RSC):

- a. Reactor Facility Emergency Plan and implementing procedures (2-6-81)
- b. Conformance of facility operation to the Technical Specifications (2-12-81)
- c. Facility Security Plan and implementing procedures (3-10-81)

2. U. S. Nuclear Regulatory Commission (Region II):

- a. Routine, unannounced safeguards inspection including physical security program (Report 50-538/81-01 dated 2-11-81).
- b. Routine, unannounced safety inspection (Report 50-538/81-02 dated 11-04-81).

3. American Nuclear Insurers:

Routine facility inspection including administrative controls, radiation protection, reactor operations, training, records retention and documentation (Report contained in ANI letter dated 3-25-81 RE: ANI Policy NF-251).

APPENDIX A

FOLLOWUP REPORT

to

REPORTABLE OCCURRENCE NO. 81-1

APPENDIX A
(4 pps)

MEMPHIS STATE UNIVERSITY
AGN-201 NUCLEAR REACTOR FACILITY
LICENSE R-127, DOCKET NO. 50-538

FOLLOW-UP REPORT TO REPORTABLE OCCURRENCE NO. 81-1

Date of Report: June 11, 1981
Date of Occurrence: June 8, 1981
Date of NRC Notification: June 9, 1981

1. Reactor.

AGN-201, Serial 108. Located at the Center for Nuclear Studies, Memphis State University, Memphis, Tennessee. Facility Operating License R-127, Docket No. 50-538.

2. Reportable Occurrence.

Electric power service to the Memphis State University Center for Nuclear Studies Facilities was unexpectedly interrupted. The unscheduled power outage occurred during AGN-201 reactor operation and, as a direct result of the event, caused reactor shutdown. Item 6.9.2.a.(7) of the Facility Technical Specifications applies.

3. Conditions at Time of Occurrence.

- a. An operator training program was in progress for the purpose of providing reactor startup experience for students in Memphis State University's Nuclear Skills Related Training Program (NSRT).
- b. The reactor was subcritical and at a steady state neutron level. A startup was in progress with the Safety Rods fully inserted (24 cm), Coarse Control Rod at 17.86 cm, Fine Control Rod at 15 cm, and with an estimated margin of 0.14% reactivity from criticality. The reactor temperature was 21°C.

4. Narrative.

A partial loss of electrical power to the Center for Nuclear Studies Facilities occurred at 3:12 p.m. (CST) on June 8, 1981. The AGN-201 Reactor was being operated by a student under the direct supervision of licensed Senior Operators. At the time of the unscheduled event, the operator was evaluating data to be used for an estimate of the critical rod positions as part of a reactor training startup procedure using a 1/M approach to criticality. The reactor was at a sub-critical, steady state neutron level.

The reactor scrammed, as designed and as required by the Facility Technical Specifications, due to loss of Reactor Control Power which interrupted electrical current to the Control Rod Holding Magnets. Electrical circuits to the neutron flux monitoring instruments, which are connected to a different phase of the power source, remained energized and the reactor power level decay was monitored until normal shutdown readings were obtained. The Fine Control Rod (no scram function) remained inserted to 15 cm and the Safety and Coarse Rod Magnet Assemblies remained at the pre-scram positions. The normal shutdown checkoff was completed at 3:27 p.m. (CST) in accordance with OP-5 with the exception that the Fine Rod remained at the 15. cm position. At 3:40 p.m. (CST), a complete interruption of electric power occurred which deenergized all console instrumentation, alarms, and safety circuits.

The fault was apparently corrected and the electric distribution feeder system was restored to normal at 3:58 p.m. (CST). Three minutes later the Reactor Supervisor reenergized Reactor Control Power to allow the Fine Control Rod and the Holding Magnet Assemblies to be returned to their fully withdrawn positions. The reactor was secured at 4:02 p.m. (CST). Subsequent control and instrumentation checks revealed no abnormalities as a result of the power failure.

The Reactor Supervisor was in the control room at the time that the unplanned event occurred. The Facility Director was notified. The event was reported to the USNRC Region II Office of Inspection and Enforcement (Mr. C. Julian) via telephone and confirmed by mailgram to the Director on June 9, 1981, in compliance with section 6.9.2 of the MSU Facility Technical Specifications.

5. Safety Significance of the Occurrence.

None. A loss of electrical power de-energizes the Safety and Coarse Control Rod Holding Magnets causing a reactor scram and thus assures safe and immediate shutdown in case of a power outage. Reactor systems performed as designed and as required by technical specification 3.3.

6. Cause of Failure.

The interruption of electrical power was apparently caused by a power overload or imbalance of unknown origin on the main distribution feeder to the Center for Nuclear Studies located on the MSU South Campus.

7. Corrective Action.

None. Corrective action to restore and maintain the South Campus electric service feeder is under the cognizance and control of organizations outside the Center for Nuclear Studies and the AGN-201 Reactor Facility.


8. Measures to Prevent Recurrence.

None. Measures to prevent recurrence of an electric power outage of the nature described in this report are not within the capabilities of the Center for Nuclear Studies or AGN-201 Reactor Facility staff.

9. Similar Reportable Occurrences.

MSU Follow-up Reports: #79-1 (1/29/79), #79-2 (3/10/79).

Prepared by:



Reactor Supervisor