The Catholic University of America

School of Engineering & Architecture
Mechanical Engineering Department

# Reactor Restart Report

AGN-201 Nuclear Reactor, Serial #101
Facility Operating License R-31
Docket 50-77

August 9, 1979

Dr. David D. Ebert
Reactor Supervisor

Mr. Warren E. Keene
Radiation Safety Officer

Dr. Edward D. Jordan
Reactor Administrator

Dr. Yun C. Whang
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## ABSTRACT

This report presents the reactor restart procedures and results which verify that the reactor has been restarted and operated in accordance with the Facility Technical Specifications.

Background and Introduction

The reactor was placed in the shutdown condition on February 22, 1975 and not operated again until May 9, 1979. Repair work was initiated on June 15, 1978 by Dr. David Ebert and Mr. Windsor Dempsey. Dr. Ebert received a Senior Reactor Operators License[1] on January 17, 1979 and the Reactor Operating License was extended for another 20 years on March 12, 1979[2]. Repair and necessary paperwork to verify and document conformance to the new Technical Specifications was completed on May 8, 1979.

The reactor was restarted on May 9, 1979 following the approved Reactor Restart Procedures (approved by the Reactor Safety Committee).[3] In the subsequent months following restart, 1) a power calibration, 2) control rod calibrations, 3) measurement of $k_{ex}$ and, 4) verification of shut down margins were performed and observed to be both consistent with previously determined values and to conform with the Technical Specifications.[2] The reactor is now being operated on a routine basis.

Details

A. Prestartup Maintenance and Surveillance

The following list presents the prestartup items which were checked and verified to conform with the Technical Specifications.[2]

1. Shield tank level test and calibration
2. Shield tank temperature test and calibration
3. Seismic displacement test and calibration
4. Thermal column water level check
5. Emergency lighting check
6. Channel 1 count rate, plateau, safety circuit calibration
7. Channel 2 level, period, safety circuit calibration
8. Channel 3 level, and safety circuit calibration
9. Visual inspection and leakage check
10. Control rod insertion and scram time calibration
11. Reactor scram from loss of electrical power
12. Radiation monitoring equipment calibration
13. Control rod drive inspection, lubrication
14. CUA Reactor Safety Committee review of the startup procedure and the operating and emergency procedures

B. Reactor Restart Procedures and Results

1- REACTOR RESTART PROCEDURES

1. Verify that all the maintenance and tests are in conformance with the Tech Specs. and have been carried out and documented.

2. Perform items 1-9a of the Prestartup Checkout Procedure, but leave the Cd foil inserted in the glory hole position.

3. Undertake a 1/M plot as SR #1 is inserted, estimating the critical position of each step.

4. Assuming that the reactor is still subcritical with the SR #1 inserted, estimate the subcritical neutron multiplication constant (k) under the conditions that all rods are out of the core (ARO) and the Cd foil inserted. This k will be $K_o \cong 1 - \frac{\Delta\rho_{SR1}}{1-R_1}$ where $R_1$ is the ratio of the neutron detector readings of SR #1 out to inserted ($R_1 < 1$). $R_1$ can be computed for each detector and applied, and then averaged and applied. $\Delta\rho_{SR1}$ is the assumed reactivity worth of SR #1 ( $\sim$ 0.0125).

5. $K_0$ should be less than 0.9654. This number is obtained by
$1.0 + k_{ex} - 3(\Delta\rho_{SR1}) - \Delta\rho_{FR} = 1.0 + 0.0045 - 3(0.0125) - 0.0016 = 0.9654$
This is the ARO shutdown k referenced to 20°C, assuming the Cd has no negative reactivity worth. If $K_o$ is not <0.9654, step 6 should not be undertaker until the discrepancy is resolved. Return to the ARO condition. Record

6. all three neutron detector readings. Withdraw the Cd foil in approximately 1 inch increments, performing 1/M calculations at each step. Also, estimate the reactivity worth of the change in Cd position using the relation.

$$\Delta\rho_{Cd} \cong (1-k_o)(1-R_o)$$

where $R_0$ is the ratio of detector readings at the initial condition to the present position of the Cd. $k_o + \Delta\rho_{cd}$ should be less than approximately 0.9654 otherwise the estimates for SR and CR and/or $k_{ex}$ are in error. If this is not the case, Step 7 should not be undertaken until the descrepancy is resolved.

7. From the above information, assuming that the Cd foil has been removed, estimate and verify a. that the shutdown margin (without Cd foil) is $\geq 2\%\ \Delta k/k$ with the most reactive rod inserted; b. that the estimated $k_{ex}$ is $< 0.65\%\ \Delta k/k$ c; that the reactor will be subcritical with the least reactive SR or CR withdrawn.

a). $k_{shut} = k_o + \Delta\rho_{cd}$
Verify $k_{shut} + \Delta\rho_{SR1} \leq 0.98$ or $k_{shut} \leq 0.9675$

b). $1 + k_{ex} \cong k_{shut} + 3(\Delta\rho_{SR1}) + \Delta\rho_{FR}$
or $k_{ex} \cong k_{shut} - 1 + 0.0391$
Verify $k_{ex} \leq 0.65\%\ \Delta k/k$

c). If. b). is satisfied, then c). will be satisfied if $\Delta\rho_{SR1} \cong 0.0125\ \Delta k/k$

8. Provided that all the above conditions have been satisfied or discrepancies resolved, 1/M measurements should be undertaken as the SR #1 and 2 are inserted. After SR #1 has been inserted it should be scrammed according to Prestartup Check 9b. Likewise, after SR #1 and 2 have been inserted they should be scrammed according to Prestartup check 9c.

9. Criticality should be achieved at the lowest practical power level since a power calibration has not been undertaken for 5 years (approximately 1mW).

10. As soon as practical after the initial criticality, the following tests should be performed:

a. Power Calibration

b. Control Rod Calibrations

c. Measurement of $K_{ex}$

d. Verify that:

i. Shutdown margin $\geq 2\% \frac{\Delta k}{k}$ with the most reactive rod inserted.

ii. The reactor would be subcritical with the least reactive CR or SR removed.

## II. Reactor Restart Procedure Results

1. Refer to the operations log

2 & 3. See Appendix A for copies of the appropriate sections of the operations log. The pertinent data is put in tabular form in Table 1 and plotted in Figure 1.

4. $k_o \cong 0.79$

5. $k_o < 0.9654$

6. See Table 1 and Figure 1.

$\Delta\rho_{cd} \cong 2.73\% \ \Delta k/k$

$k_o + \Delta\rho_{cd} \approx 0.82 < 0.9654$

7.a) $k_{shut} \approx 0.8173 < 0.9675$

b) $k_{ex} \approx -0.1436 < 0.00065$

c) Since b) is satisfied, so is c).

8. See Table 1 and Figure 1 and Appendix A

9. See Table 1 and Figure 1 and Appendix A. Criticality achieved at approximately 1½ mW power on May 5, 1979.

10. a) Power Calibration Results:

Channel #1 = 584K cpm/100 mW

Channel #2 = 114% / 100 mW

Channel #3 = $4.3 \times 10^{-9}$ Amps/100 mW

These factors are consistent with those obtained in the past years of operation.

b) Control Rod Calibration Results:

The integral rod worth for the fine control rod is given in Figure 2. The total worth of the fine control rod was determined to be 0.142% $\Delta k/k$ and the differential worth was measured to be 76 μρ/cm in the linear region of the range. The differential rod worth for the coarse control rod was determined to be 607 μρ/cm. The total worth of the coarse control rod was inferred to be 1.14% $\Delta k/k$. These values are consistent with those obtained in the past years of operation.

c) $k_{ex}$ Calculation:

The excess reactivity at 20°C which would result if all the control and safety rods were inserted was determined to be 0.435% $\Delta k/k$. This value is less than the Tech. Spec. limit of 0.65% $\Delta k/k$ and is consistent with the value obtained in the past years of operation.

d) i. The shutdown margin with the most reactive rod inserted at 20.5°C was determined to be -2.0% $\Delta k/k$. The choice of 20.5°C was chosen because this was the lowest temperature at which the reactor was operated since May 9, 1979. This particular Limiting Condition for Operation (LCO) therefore defines the minimum temperature for operation when the glory hole is empty and the normal material in the Access Ports.

ii. The shut down margin with theleast reactive coarse or safety rod removed and the other rods inserted was determined to be -0.71% $\Delta k/k$ at 20.5°C. This value is within the limits established by the Tech. Specs.

References

1. Senior Operator License No. 3426, Docket No.55-6671, January 17, 1979.

2. Amendment No.7 to the Facility Operating License No.R-31, Docket No. 50-77, March 12, 1979.

3. CUA Reactor Safety Committee Meeting Minutes, May 2, 1979.

TABLE 1

Inverse Multiplication Results

| ondition | Date & Page | Ch 1 | | Ch 2 | | Ch 3 | | Ave |
|---|---|---|---|---|---|---|---|---|
| | | cpm | 1/M | % | 1/M | $\times 10^{-12}$ amp | 1/M | 1/M |
| . ARO, Cd In | 5/2/79 560 | 140 | 1.0 | 0.017 | 1.0 | 0.80 | 1.0 | 1.0 |
| 2. SR#1 In, Cd In | " " | 149 | 0.94 | 0.018 | 0.95 | 0.86 | 0.93 | 0.94 |
| 3. ARO, Cd Out | " " | 160 | 0.88 | 0.019 | 0.89 | 0.94 | 0.85 | 0.87 |
| . ARO, Cd In | 5/7/79 562 | 135 | 1.0 | 0.018 | 1.0 | 0.80 | 1.0 | 1.0 |
| 3. ARO, Cd Out | " " | 150 | 0.90 | 0.02 | 0.90 | 0.95 | 0.84 | 0.88 |
| 4. SR#1 In, Cd Out | " " | 200 | 0.68 | 0.023 | 0.78 | 1.15 | 0.70 | 0.72 |
| 5. SR#1 1 & 2 In Cd Out | " " | 250 | 0.54 | 0.04 | 0.45 | 1.90 | 0.42 | 0.47 |
| . ARO, Cd In | 5/9/79 565 | 150 | 1.0 | 0.018 | 1.0 | 0.85 | 1.0 | 1.0 |
| 8. ARO, Cd Out | " " | 175 | 0.86 | 0.018 | 1.0 | 0.95 | 0.89 | 0.92 |
| 5. SR#1 & 2 In Cd Out | " " | 290 | 0.52 | 0.032 | 0.56 | 1.9 | 0.45 | 0.51 |
| 6. SR#1 & 2 In Cd Out, FR at 15 cm | " " | 300 | 0.50 | 0.038 | 0.47 | 2.0 | 0.43 | 0.47 |
| 7. " & CR at 5 cm | " " | 320 | 0.47 | 0.04 | 0.45 | 2.4 | 0.35 | 0.42 |
| 9. " & CR at 10 cm | " " | 360 | 0.42 | 0.045 | 0.40 | 2.7 | 0.31 | 0.38 |
| 9. " & CR at 15 cm | " " | 490 | 0.31 | 0.073 | 0.25 | 4.2 | 0.20 | 0.25 |
| 10." & CR at 17.5 cm | " " | 900 | 0.17 | 0.12 | 0.15 | 7.0 | 0.12 | 0.15 |
| 11." & CR at 19.0 | " " | 1650 | 0.091 | 0.25 | 0.072 | 13.0 | 0.065 | 0.076 |
| 12." & CR at 20.0 | " " | ← critical → | | | | | | 0 |

Fig. 1 Reactor Startup 1/M Plots

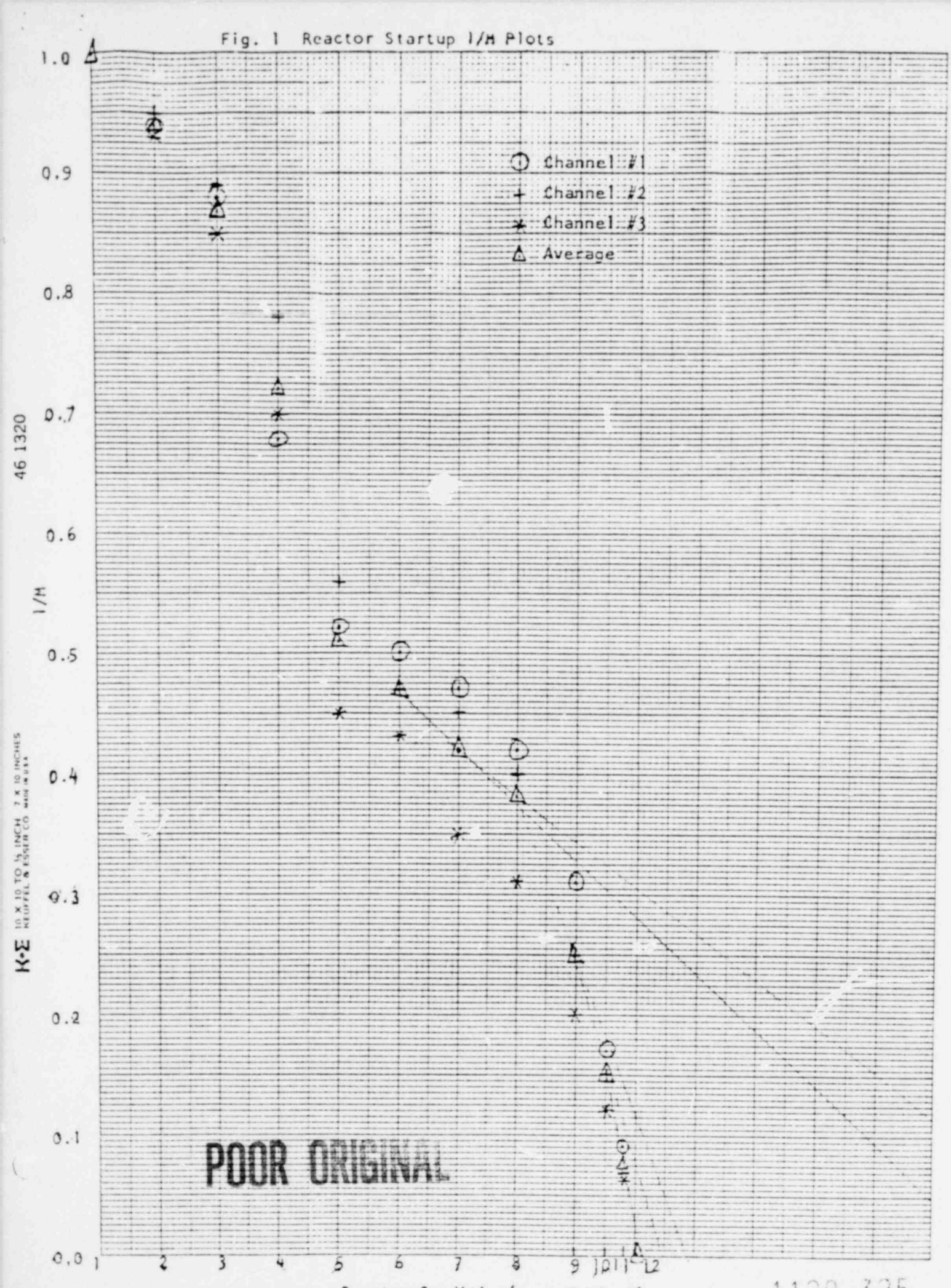
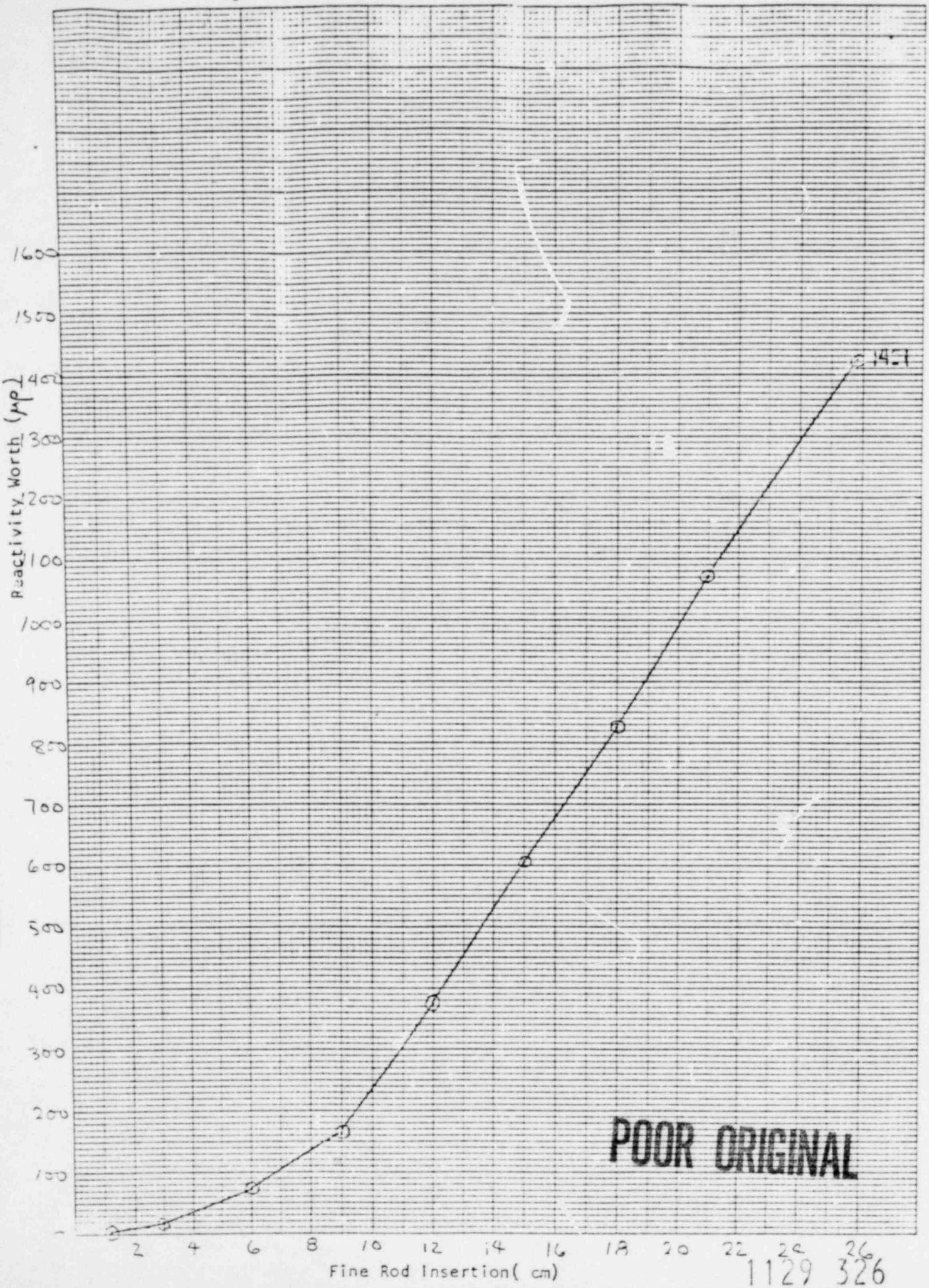


Fig. 2 Fine Control Rod Integral Worth Plot




46 1320

K·E 10 X 10 TO 14 INCH 7 X 10 INCHES KEUFFEL & ESSER CO. MADE IN U.S.A.

Appendix A

AGN-201: Serial #101

Reactor Operations Log

Page # 559

Run # —

Date 2 MAY 79

Reactor Operator W. DEMPSEY Senior Reactor Operator DR. DAVID ERENT

Reason for Operation PRESTART UP CHECK

Authorized Experiments ONLY PRE STARTUP CHECK AUTHORIZED

Special Operating Limitations NOT AUTHORIZED TO INSERT CONTROL RODS

Shield Water Temperature 18.8 (°C) Estimated Excess Reactivity (%Δk/k)

## Prestartup Checklist

1. All Reactor Neutron Detectors Working ✓
2. Radiation Survey:
   Meter type and number VICTOREEN E-120
   Calibration 11-3-78 WEEKEND
   Max. survey reading 0.015 MR/HR ONLY
   Location REACTOR PIT
3. Safety Feature Checks:
   Thermal column seal ✓
   Manhole cover seal ✓
   Access port fillers installed ✓
   Cd in glory hole ✓
   Water temp. switch in place ✓
   Skirt area OK ✓
4. Area Radiation Monitor Check ✓
   Alarm setpoint 17 MR/HR = 100% = 1k
5. Control Rod Drive Settings Check 25.5 ✓
6. Nearby Persons Informed ✓
7. Key in Console and Power On ✓
8. Instrument Calibration and Level Trip Setpoints:
   a. No temporary wiring installed ✓
   b. Channel 1:
      i. High voltage 2400 (VDC)
      ii. Zero check ✓
      iii. Calibrate 3600 (cpm)
      iv. High level trip 93 (%fs)
      v. Low level trip 10 (%fs)
      vi. Operate 140 (cpm)
   c. Channel 2:
      i. Low level trip 0.0015 (%fp)
      ii. High level trip 100 (%fp)
      iii. High Cal. 100 ✓ (%fp)
      iv. Zero check .0001 ✓ (%fp)
      v. Low Cal. .01 ✓ (%fp)
      vi. Period scram ✓ (sec)
      vii. Operate .017 (%fp)
   d. Channel 3:
      i. Zero check ✓
      ii. Calibration check OK ✓
      iii. Low level trip 10 (%fs)
      iv. High level trip 93 (%fs)
      v. Recorder OK ✓
      vi. Operate .8x10 (Ω)
9. Rod Control Interlocks and Scram Checks:
   a. Sequence interlocks OK ✓
   b. Safety 1 Scram OK ✓
   c. Safety 1 and 2 scram OK ___
10. Cd Removed from the Glory Hole ___
11. Calculate $k_{excess}$ ___

Completed by W. Dempsey

Approved by D. D. Ebert
Senior Reactor Operator

Reviewed by D D Ebert
Reactor Supervisor

May 3, 1979
Date

AGN-201; Serial #101
Reactor Operations Log

Page # 560
Run # _____
Date 5/2/79

Reactor Operator W. Dempsey Senior Reactor Operator D. Ebert
Activity Repair / Maintenance / Pre-Restart testing *
* See Reactor Restart Procedures for more info.

| TIME | DETAILS |
|---|---|
| 17:30 | Connect rod drive cables. |
| 18:30 – 20:30 | Perform Prestartup checks through 9a in preparation for Restart Procedures. |
| 20:38 | Emergency light operation check |
| 17:00 | Implement radiation monitor. Alarm at 100% power. DDE O.K. |
| 21:07 | Insert SR#1 |
| 21:12 | SR#1 inserted - 1/M calculation |
| 21:33 | ~~SD~~ Manual Scram |
| 21:36 | Power off |
| 21:43 | Withdrawn Cd. - 1/M calculation |

1/M Readings

| ~~ARO, Cd In~~ | ch 1 | | ch 2 | | ch 3 (x10⁻¹² amp) | | Ave |
|---|---|---|---|---|---|---|---|
| ARO, Cd In | 140cpm | 1.0 | 0.017% | 1.0 | 0.80 | 1.0 | 1.0 |
| SR1 In, Cd In | 149 | 0.94 | 0.018 | 0.95 | 0.86 | 0.93 | 0.94 |
| ARO, Cd out | 160 | 0.875 | 0.019 | 0.694 | 0.94 | 0.851 | 0.8733 |
| | | | | | | | |
| | | | | | | | |

$R_o \simeq 1 - \frac{\Delta\rho_{SR1}}{1-R_1} = 1 - \frac{0.0125}{1-0.94} = 0.79$ (k shutdown ARO, Cd in)

$\Delta\rho_{cd} \simeq (1-k_o)(1-R_o) = (1-0.79)(1-0.87) = 2.73\%\ \Delta k/k$

$k_o + \Delta\rho_{cd} = 0.79 + 0.0273 \simeq$ [illegible]

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Run # —

Reactor Operations Log

Date May 7, 1979

Reactor Operator Windsor Dempsey Senior Reactor Operator David D. Ebert

Reason for Operation Pre Prestartup check.

Authorized Experiments only up to and including step 8 of restart procedures authorized

Special Operating Limitations

Shield Water Temperature 19.5 (°C) Estimated Excess Reactivity (%Δk/k)

## Prestartup Checklist

1. All Reactor Neutron Detectors Working ✓

2. Radiation Survey: NSE #543
   Meter type and number Eberline E 120
   Calibration 11/3/78 - W. Keene
   Max. survey reading ~~.02~~ 0.2 mr/hr.
   Location Control rod drive cover.

3. Safety Feature Checks:
   Thermal column seal ✓
   Manhole cover seal ✓
   Access port fillers installed ✓
   Cd in glory hole ✓
   Water temp. switch in place ✓
   Skirt area OK ✓

4. Area Radiation Monitor Check ✓
   Alarm setpoint 0.7 mr/hr. = 1K = 100% power

5. Control Rod Drive Settings Check 75.5

6. Nearby Persons Informed ✓

7. Key in Console and Power On ✓

8. Instrument Calibration and Level Trip Setpoints:
   a. No temporary wiring installed ✓
   b. Channel 1:
      i. High voltage 2400 (VDC)
      ii. Zero check ✓
      iii. Calibrate 3600 (cpm)
      iv. High level trip 93 (%fs)
      v. Low level trip 11 (%fs)
      vi. Operate 135 (cpm)
   c. Channel 2: ~~Calibrate~~ High voltage ✓
      i. Low level trip 0.0015 (%fp)
      ii. High level trip 100 (%fp)
      iii. High Cal. 100 (%fp)
      iv. Zero check .0001 (%fp)
      v. Low Cal. 0.01 (%fp)
      vi. Period scram ✓ ~~(sec)~~
      vii. Operate 0.018 (%fp)
   d. Channel 3: ~~Calibrate~~ High voltage
      i. Zero check ✓
      ii. Calibration check OK ✓
      iii. Low level trip 10 (%fs)
      iv. High level trip 91 (%fs)
      v. Recorder OK ✓
      vi. Operate 0.8x10 ~~12%~~ decades

9. Rod Control Interlocks and Scram Checks:
   a. Sequence interlocks OK ✓
   b. Safety 1 Scram OK ✓
   c. Safety 1 and 2 scram OK ✓

10. Cd Removed from the Glory Hole ✓

11. Calculate $k_{excess}$

Completed by Winston Rampton

Approved by David D. Ebert
Senior Reactor Operator

Reviewed by David D. Ebert, May 8, 1979
Reactor Supervisor Date

POOR ORIGINAL

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AGN-201; Serial #101
Reactor Operations Log

Run # —

Date May 7, 1974

Reactor Operator W. Dempsey Senior Reactor Operator D. W. Ehert

Activity Prestartup check.

| TIME | DETAILS |
|---|---|
| 17:46 | Connect control rod drive cables |
| 18:18 | Unscrew SR#1 dashpot slightly to get engage light work |
| 20:00 | Remove SR#1 fix for proper operation - put back into reactor. |
| 20:32 | Scram SR#1 with Cd inserted |
| 20:32 | withdrawn Cd w/ ARO |

1/M Readings

| | | ch 1 cpm | | ch 2 % | | ch 3 NO $\gamma$ | | Ave |
|---|---|---|---|---|---|---|---|---|
| | ARO, Cd out | 150 | 1 | 0.02 | 1 | 0.95 | 1 | 1 |
| 20:38 | SR#1 in, Cd out | 200 | 0.75 | 0.023 | 0.87 | 1.15 | 0.83 | 0.81 |
| 20:53 | SR#1&2 in, Cd out | 250 | 0.6 | 0.04 | 0.5 | 1.90 | 0.85 | 0.53 |

| | |
|---|---|
| 21:00 | Insert SR#1 & 2 and scram on all three channels. |
| 21:25 | Remove SR#2 to investigate sticking engage microswitch. |

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Run # 53
Date May 9, 1979

AGN-201: Serial #101
Reactor Operations Log

Reactor Operator W. Dempsey Senior Reactor Operator DR. David Ebert
Reason for Operation INITIAL RESTART UP
Authorized Experiments PROCEED ACCORDING TO PRESTARTUP PROCEDURE
Special Operating Limitations DO NOT EXCEED 1% POWER
Shield Water Temperature 17.8 (°C) Estimated Excess Reactivity .4475% (%Δk/k)

Use p. 55E Prestartup Checklist for calibration

1. All Reactor Neutron Detectors Working ✓

2. Radiation Survey:
Meter type and number Gm SN273 (ASE543) EBERLINE E120
Calibration 11-3-78 KEENE
Max. survey reading .15 MR/HR
Location PERIM SKIRT AREA

3. Safety Feature Checks:
Thermal column seal ✓
Manhole cover seal ✓
Access port fillers installed ✓
Cd in glory hole ✓
Water temp. switch in place ✓
Skirt area OK ✓

4. Area Radiation Monitor Check ✓
Alarm setpoint ✓

5. Control Rod Drive Settings Check 755

6. Nearby Persons Informed ✓

7. Key in Console and Power On ✓

8. Instrument Calibration and Level Trip Setpoints:
a. No temporary wiring installed ✓
b. Channel 1:
i. High voltage 2400 (VDC)
ii. Zero check ✓
iii. Calibrate 3600 (cpm)
iv. High level trip 95% (%fs)
v. Low level trip 12% (%fs)
vi. Operate 150 (cpm)
c. Channel 2:
i. Low level trip .001% (%fp)
ii. High level trip 100 (%fp)
iii. High Cal. ✓ (%fp) 100%
iv. Zero check ✓ (%fp) .0001%
v. Low Cal. ✓ (%fp) .01%
vi. Period scram ✓ (sec)
vii. Operate ✓ (%fp) .018%
d. Channel 3:
i. Zero check ✓
ii. Calibration check OK ✓
iii. Low level trip 10 (%fs)
iv. High level trip 93 (%fs)
v. Recorder OK ✓
vi. Operate ✓ (%fs) $.85 \times 10^{-12}$

9. Rod Control Interlocks and Scram Checks:
a. Sequence interlocks OK ✓
b. Safety 1 Scram OK ✓
c. Safety 1 and 2 scram OK ✓

10. Cd Removed from the Glory Hole ✓

11. Calculate $k_{excess}$ ✓

Completed by W. Dempsey Approved by D. D. Ebert
Senior Reactor Operator

Reviewed by DD Ebert, May 9, 1979
Reactor Supervisor Date

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POOR ORIGINAL

Operations Data

Initial
From 2/22/75 Run # 529

1. Initial Control Rod Lower Limit Positions:
   Fine control rod 120 (cm)
   Coarse control rod 0087 (cm)

2. Power Limit Instrument Readings:
   Channel 1 ~114cK (cpm)
   Channel 2 170 (%fp)
   Channel 3 5x10⁻¹ (amp)

3. Channel Meter Readings from Neutron Source:

| Channel | All Rods Out | Only Safety Rods In |
|---|---|---|
| #1 (cpm) | 175 | 290 |
| #2 (%fp) | .018 | .032 |
| #3 (amp) | $.95 \times 10^{-12}$ | $1.9 \times 10^{-12}$ |

4. Approach to Criticality 1034 (Time) Criticality Attained 1200 (Time)

5. Power, Meter Readings, and Rod Positions:

| Time | Channel 1 (cpm) | Channel 2 (% power) | Channel 3 (amp) | Fine Control Rod (cm) | Coarse Control Rod (cm) |
|---|---|---|---|---|---|
| 1037 | ~~300~~ | .038% | $2 \times 10^{-12}$ | 15.00 | 00.87 (04 I) |
| 1044 | 320 | .04 | ~~$2 \times 10^{-12}$~~ | 15.00 | 05.00 IN |
| 1100 | 360 | .045 | $2.7 \times 10^{-12}$ | 15.00 | 10.00 |
| 1100 | 490 | .073 | $4.2 \times 10^{-12}$ | 15.00 | 15.00 |
| 1133 | 900 | .12 | $7.0 \times 10^{-12}$ | ~~17.50~~ 15.00 | 17.50 |
| 1137 | 1650 | .175 | $1.3 \times 10^{-11}$ | ~~19.00~~ 15.00 | 19.00 |
| 1200 | 12K | 1.8% | $8.5 \times 10^{-11}$ | ~~20.00~~ 15.00 | 20.00 |
| 1217 | 10K | 1.6% | $8 \times 10^{-11}$ | 14.39 | 20.00 |

6. Remarks:
Time THE ESTIMATED CRITICAL POSITION FR 15cm AND CR 20 CM
10:34 Fine Rod inserted to 15cm.
10:44 CR INSERTED 5cm
11:00 CR INSERTED 10 cm
11:10 CR " 15 cm
11:19 CR " 17.50 cm
11:29 CR " 19.00 cm
11:38 CR " 20.00 cm
12:13 Steady power level condition (RR2) ; stability satisfied
12:19 MANUAL SCRAM

POOR ORIGINAL

7. Shutdown Check List.
   a. Manner MANUAL
   b. All rods down ✓
   c. Console power off
   d. Cd in glory hole
   e. Recorder standby/off
   f. Console and skirt doors locked
   g. Keys returned to SRO

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| Time | a | b | c | d | e | f | g | Ch 1 (CPM) | Ch 2 (%fp) | Ch 3 (amps) | Initial |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1219 | MANUAL | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 160 | .019 | $.8 \times 10^{-12}$ | WD |
| | | | | | | | | | | | |