Southern Nuclear

**Cheryl A. Gayheart**
Regulatory Affairs Director

3535 Colonnade Parkway
Birmingham, AL 35243
205 992 5316 tel
205 992 7601 fax

cagayhea@southernco.com

June 15, 2020

Docket No.: 50-321 NL-20-0715

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555-0001

Edwin I. Hatch Nuclear Plant - Unit 1
GNF3 New Fuel Introduction Startup Test Report

Ladies and Gentlemen:

In accordance with Final Safety Analysis Report requirements, Southern Nuclear Operating Company (SNC) hereby submits the Startup Test Report for Cycle 30 for Hatch Nuclear Plant Unit 1 (HNP1). This report summarizes the startup testing performed on HNP1 following the twenty-ninth refueling outage. The report is required due to the first use of GNF3 fuel assemblies loaded for Cycle 30.

The tests demonstrate the successful operation of the HNP1 reactor with the introduction of the GNF3 fuel.

This letter contains no NRC commitments. If you have any questions, please contact Jamie Coleman at 205.992.6611.

Respectfully submitted,

Cheryl A. Gayheart
Director, Regulatory Affairs
Southern Nuclear Operating Company

CAG/tle/scm

Enclosure:
GNF3 New Fuel Introduction Startup Test Report for HNP1 Cycle 30

cc: Regional Administrator, Region II
NRR Project Manager – Hatch Nuclear Plant
Senior Resident Inspector – Hatch Nuclear Plant
RType: CHA02.004

**Edwin I. Hatch Nuclear Plant - Unit 1**
**Startup Test Report**

**Enclosure**

**GNF3 New Fuel Introduction Startup Test Report for HNP1 Cycle 30**

# 1.0 INTRODUCTION

## 1.1 Purpose and Summary

This Hatch Nuclear Plant Unit 1 (HNP1) Startup Test Report is submitted to the Nuclear Regulatory Commission (NRC) in accordance with regulatory commitments contained in the Hatch Nuclear Plant Unit 2 Final Safety Analysis Report (FSAR) Section 13.6.4. This report summarizes the startup testing performed on HNP1 following the twenty-ninth refueling outage. This report is being submitted due to a reload batch of 208 GNF3 fuel assemblies for Cycle 30. The GNF3 fuel design has not previously been utilized in HNP1.

This report consists of a summary of the core design followed by summaries of selected static and dynamic reactor core performance tests conducted prior to and during the beginning-of-cycle startup of HNP1 Cycle 30. These tests demonstrate the successful operation of the HNP1 reactor with the introduction of the GNF3 fuel design into production use.

## 1.2 Plant Description

HNP1 is a General Electric design boiling water reactor (BWR/4). HNP1 is rated at 2804 MW(th) with an approximate output of 920 MW(e), gross. The plant is located on the south side of the Altamaha River, southeast of the intersection of the river with U. S. Highway #1 in the Northwestern sector of Appling County, Georgia.

## 1.3 Post-Refueling Outage Startup Test Description

HNP1 resumed commercial operation on March 18, 2020, after completing a 46-day refueling/maintenance outage. The following core performance tests were performed as part of the post-refueling outage startup test program:

- Core Verification
- Control Rod Drive Timing
- In-Sequence Critical Shutdown Margin Demonstration
- Cold Critical Eigenvalue Comparison
- LPRM Calibration
- APRM Calibration
- Control Rod Scram Time Testing
- Core Performance
- Reactivity Anomaly Calculation

The purpose for, a brief description of, and the acceptance criteria for each of the tests listed above are enumerated in Section 3 of this report.

### 1.4 Post-Refueling Outage Startup Test Acceptance Criteria

Where applicable, a definition of the relevant acceptance criteria for the test is given and is designated either "Level 1" or "Level 2."

Acceptance Criteria:

Level 1 criteria: Data trend, singular value, or information which relates to Technical Specifications margin and/or plant design in such a manner that requires strict observance.

Level 2 criteria: Data trend, singular value, or information relative to system or equipment performance which does not fall under the definition of Level 1 criteria.

Failure to meet Level 1 criteria constitutes failure of the specific test. The Test Lead is required to resolve the problem, and if necessary, the test is repeated. Level 2 criteria do not constitute a test failure or acceptance; they serve as information only.

## 2.0 CORE DESIGN SUMMARY

### 2.1 Cycle/Core Summary

The Cycle 30 core design achieves a full power energy of 15.358 GWd/ST or 633 effective full power days (EFPDs) at 2804 MW(th). This energy includes cycle extension from increased core flow and final feedwater temperature reduction. Two hundred eight (208) fresh GNF3 bundles, divided into four streams enriched to 4.05 w%, 4.16 w%, and 4.28 w% U-235, are loaded in a conventional core configuration for a 24-month fuel cycle. Additionally, there are four once-burned ARMOR GNF2.02 lead test assemblies (LTAs) that are 4.11 w% enriched, one once-burned IronClad GNF2.02 LTA enriched to 4.10 w%, 210 once-burned GNF2.02 bundles and 137 twice-burned GNF2 bundles. The ARMOR and IronClad LTAs are advanced fuel designs aimed at developing fuel with enhanced accident tolerance, thus allowing them to tolerate a loss of active cooling for a longer period of time. The LTAs are sufficiently similar from a neutronic and thermal hydraulic perspective that they may be monitored as GNF2.02 assemblies. GNF2.02 is considered interchangeable with GNF2. One ARMOR LTA assembly was reconstituted as part of the HNP1 Reload 29 Cycle 30 outage. Four fueled ARMOR rods were replaced with solid zircaloy rods in the reconstituted ARMOR LTA. The replacement rods in the reconstituted ARMOR do not contain fuel.

## 2.2 Calculated Reactivity/Thermal Limit Margins

The two parameters which describe the global behavior of the core throughout the cycle are hot excess reactivity (HER) and cold shutdown margin (CSDM). The 0.0 MWd/ST hot excess reactivity is 2.01 % Δk, while the early cycle minimum HER is 1.82 % Δk at 500.0 MWd/ST, and the mid-cycle peak HER is 1.89 % Δk at 2,500.0 MWd/ST. The cycle minimum cold shutdown margin is 1.23 % Δk. Calculated core parameters are delineated in Table 2.1.

Target rod patterns were developed at reasonable exposure increments and 2,210 MWd/ST sequence exchange intervals. Design margins to thermal limits were met for all exposures.

## 2.3 Fuel Summary

Table 2.2 provides a list of all fuel batches loaded in Cycle 30. Note that all fuel contains axially varying fuel lattice types.

Table 2.1, Cycle Calculated Parameters

| Parameter | | | Value | |
|---|---|---|---|---|
| BOC Core Average Exposure | | | 16,907 | MWd/ST |
| Cycle Core Weight | | | 115.5813 | ST |
| Daily Full Power Exposure Capability | | | 24.26 | MWd/ST |
| Cycle Energy[1] | | | | |
| EUP Rated (DOR) | 15,621 | MWd/ST | 644 | EFPD |
| Projected Rated (DOR)[2] | 15,358 | MWd/ST | 633 | EFPD |
| Projected Total (EOC)[3] | 16,346 | MWd/ST | 674 | EFPD |
| Uncertainty in Energy (± 0.3 % Δk) | | | ± 326 | MWd/ST |
| Cold Shutdown Margin | | | | |
| BOC | | | 1.26 | % Δk |
| Cycle Minimum | | | 1.23 | % Δk |
| Hot Excess Reactivity | | | | |
| BOC | 0 | MWd/ST | 2.01 | % Δk |
| Early Cycle Min | 500 | MWd/ST | 1.82 | % Δk |
| Mid-Cycle Peak | 2,500 | MWd/ST | 1.89 | % Δk |
| Core Average Linear Heat Generation Rate (LHGR)[4] | | | 4.62 | kW/ft |

1) Based on an assumed EOC 29 exposure of 16.870 GWd/ST
2) Includes Final Feedwater Temperature Reduction
3) Based on a planned Hatch-1 Cycle 29 shutdown date of February 1st 2020, a 45-day outage, a 98% capacity factor, Final Feedwater Temperature Reduction, and a planned Hatch-1 Cycle 30 shutdown date of February 6th 2022
4) Does not account for the unfueled segments in the LTAs

Table 2.2, Fuel Bundle Batch Descriptions Loaded in Cycle 30

| Batch | IAT | QTY | ID Range | Bundle Type Label |
|---|---|---|---|---|
| Fresh Fuel | | | | |
| H1R29 | 13 | 88 | YLY081 - YLY168 | GNF3-P10DG3B405-15GZ-83AV-150-T6-4665 |
| H1R29 | 14 | 32 | YLY001 - YLY032 | GNF3-P10DG3B428-12GZ-83AV-150-T6-4597 |
| H1R29 | 15 | 40 | YLY169 - YLY208 | GNF3-P10DG3B428-15GZ-83AV-150-T6-4666 |
| H1R29 | 16 | 48 | YLY033 - YLY080 | GNF3-P10DG3B416-13GZ-83AV-150-T6-4598 |
| Once Burned Fuel | | | | |
| H1R28 | 5 | 108 | YLS277 - YLS384 | GNF2-P10DG2B410-14GZ-100T2-150-T6-4511 |
| H1R28 | 6 | 68 | YLS385 - YLS452 | GNF2-P10DG2B403-15GZ-100T2-150-T6-4512 |
| H1R28 | 7 | 32 | YLS453 - YLS484 | GNF2-P10DG2B403-14GZ-100T2-150-T6-4513 |
| H1R28 | 8 | 1 | YLS485 | GNF2-P10DG2B410-14GZ-100T2-150-T6-4511 |
| H1R28 | 9 | 1 | YLS486 | GNF2-P10DG2B410-14GZ-100T2-150-T6-4511 |
| H1R28 | 10 | 1 | YLS487 | GNF2-P10DG2B410-14GZ-100T2-150-T6-4511 |
| H1R28 | 26 | 1 | YLS489 | GNF2-P10DG2B410-14GZ-100T2-150-T6-4511 |
| H1R28 | 27 | 1 | YLS490 | GNF2-P10DG2B410-14GZ-100T2-150-T6-4511 |
| H1R28 | 28 | 1 | YLS491 | GNF2-P10DG2B410-14GZ-100T2-150-T6-4511 |
| H1R28 | 29 | 1 | YLS492 | GNF2-P10DG2B410-14GZ-100T2-150-T6-4511 |
| Twice Burned Fuel | | | | |
| H1R27 | 21 | 47 | YLJ511 - YLJ528<br>YLJ530 - YLJ553<br>YLJ573 - YLJ577 | GNF2-P10DG2B402-15GZ-100T2-150-T6-4391 |
| H1R27 | 22 | 4 | YLJ582 - YLJ585 | GNF2-P10DG2B402-15GZ-100T2-150-T6-4391 |
| H1R27 | 23 | 24 | YLJ586 - YLJ609 | GNF2-P10DG2B399-13GZ-100T2-150-T6-4392 |
| H1R27 | 24 | 37 | YLJ430 - YLJ432<br>YLJ434 - YLJ436<br>YLJ438 - YLJ439<br>YLJ441 - YLJ444<br>YLJ446 - YLJ450<br>YLJ452 - YLJ453<br>YLJ458 - YLJ461<br>YLJ470<br>YLJ472<br>YLJ474 - YLJ477<br>YLJ494 - YLJ501 | GNF2-P10DG2B411-14GZ-100T2-150-T6-4317 |
| H1R27 | 25 | 25 | YLJ618 - YLJ633<br>YLJ637<br>YLJ650 - YLJ657 | GNF2-P10DG2B412-12GZ-100T2-150-T6-4393 |

## 3.0 SUMMARY OF POST-REFUELING OUTAGE STARTUP TEST RESULTS

### 3.1 Core Verification

#### 3.1.1 Purpose

To verify all fuel assemblies have been properly loaded into the reactor core as per the licensed final loading pattern, including fuel bundle location, orientation, and seating.

#### 3.1.2 Acceptance Criteria

Level 1 criteria: Each fuel assembly must be verified to be in its proper location and orientation as specified by the final loading pattern (Licensed Core) and be correctly seated in its respective cell.

Level 2 criteria: N/A

#### 3.1.3 Test Description

The HNP1 Cycle 30 core verification was performed by use of underwater TV cameras to visually inspect the location (by bundle serial number identification), orientation, and seating of each of the 560 fuel assemblies that comprise the as-loaded core.

#### 3.1.4 Test Results

Core verification was performed on February 25, 2020, in accordance with engineering procedures for fuel movement. The visual inspection confirmed all bundles were in their correct location and orientation, and no bundles required reseating.

### 3.2 Control Rod Drive (CRD) Timing

#### 3.2.1 Purpose

To demonstrate the CRD system operates properly following the completion of a core alteration. In particular, this functional test verifies that the insert and withdrawal capability of the CRD system is within acceptable limits.

#### 3.2.2 Acceptance Criteria

Level 1 Criteria: The insert and withdrawal drive time for each CRD must be between 43.2 and 52.8 seconds. In the event that a CRD fails to meet these criteria, the applicable drive must be adjusted and new criteria of 45.4 to 50.2 seconds are applied to the adjusted drive.

Level 2 Criteria: N/A

3.2.3 Test Description

Control rod drive timing is performed once per operating cycle on all CRDs. Normal withdrawal and insertion times are recorded for each of the drives under normal drive water pressure. If acceptable withdrawal and/or insertion cannot be obtained with normal drive water pressure, then the respective needle valve for the applicable withdrawal and/or insertion stroke must be adjusted until an acceptable drive time is achieved in accordance with the above criteria.

3.2.4 Test Results

Control rod drive timing was completed on March 11, 2020 for all 137 CRDs in accordance with plant operating procedures for CRD timing. Each CRD was determined to have, or was adjusted (where necessary) to have, a normal insertion and withdrawal speed as required.

3.3 <u>In-Sequence Critical Shutdown Margin Demonstration</u>

3.3.1 Purpose

To demonstrate the reactor can be made subcritical for any reactivity condition during Cycle 30 operation with the analytically determined highest worth control rod capable of withdrawal, fully withdrawn and all other rods fully inserted.

3.3.2 Acceptance Criteria

Level 1 Criteria: The loaded core must be subcritical by at least 0.38% $\Delta$ K with the analytically determined highest worth control rod capable of being withdrawn, fully withdrawn, and all other rods fully inserted at the most reactive condition during the cycle.

Level 2 Criteria: N/A

3.3.3 Test Description

The in-sequence critical shutdown margin demonstration was performed immediately following the HNP1 Cycle 30 BOC initial criticality with the reactor core in a xenon free state. To account for reactivity effects such as moderator temperature, reactor period, and the one rod out criterion, correction factors were used to adjust the startup condition to cold conditions with the highest worth control rod fully withdrawn.

3.3.4 Test Results

The in-sequence critical shutdown margin demonstration was performed on March 15, 2020 in accordance with core calculation procedures for shutdown margin demonstration. Results of this calculation yielded a CSDM of 1.661% $\Delta$ K. The cycle minimum CSDM was also 1.628% $\Delta$ K. A summary of the shutdown margin demonstration is given in Attachment 1 of this report.

## 3.4 Cold Critical Eigenvalue Comparison

### 3.4.1 Purpose

To compare the critical eigenvalue calculated using the actual cold, xenon free critical control rod configuration (corrected for moderator temperature and reactor period reactivity effects) to the cold critical eigenvalue assumed in the cycle management analysis.

### 3.4.2 Acceptance Criteria

Level 1 Criteria: The cold critical eigenvalue calculated using actual critical data shall not differ from the design cold critical eigenvalue by more than ±1% ΔK.

Level 2 Criteria: N/A

### 3.4.3 Test Description

The cold critical eigenvalue is the assumed value of the PANACEA 3-D core simulator model $K_{eff}$ at which criticality is achieved with the reactor in a xenon free state and the coolant is 68 degrees F. This value is determined based on historical data and used for cycle management analysis by core analysis personnel. Once the actual critical state is achieved during the beginning of cycle startup, the applicable data are provided to core analysis personnel, and the actual (corrected for moderator temperature and reactor period reactivity effects) cold critical eigenvalue is calculated. This value is then compared to the assumed critical eigenvalue as a method of validating rod worths and shutdown margin calculations throughout the cycle. The actual critical eigenvalue is also entered into a database for predicting future cold critical eigenvalues.

### 3.4.4 Test Results

The beginning of cycle startup for HNP1 Cycle 30 was performed on March 15, 2020. The observed reactor core conditions when a critical state was achieved are listed in Attachment 1.

The results of the PANACEA case show the temperature and period-corrected cold eigenvalue to be 1.00563. This is 0.41% ΔK above the design value of 1.0015 and is well within the ± 1.0% ΔK acceptance criteria.

## 3.5 Local Power Range Monitor (LPRM) Calibration

### 3.5.1 Purpose

To calibrate the local power range monitors (LPRMs) by fine-tuning gain adjustment factors (GAFs) such that LPRM readings are equivalent to Traversing Incore Probe (TIP) detector readings. The TIP measurements, in turn, are proportional to the axial flux distribution at selected intervals over the regions of the core where the LPRMs are located. TIP readings are of high precision to allow reliable calibration of LPRM gains.

3.5.2 Acceptance Criteria

Level 1 Criteria: All detector GAFs ≤ 40.

Level 2 Criteria: N/A

3.5.3 Test Description

The LPRM channels were calibrated to make the LPRM readings proportional to the neutron flux in the narrow-narrow water gap at the chamber elevation. This calibration was performed in accordance with engineering procedures for LPRM calibration.

3.5.4 Test Results

Using site procedures, LPRMs were successfully calibrated at 100% power. LPRM Gain Adjustment Factor Values for all operable LPRM channels were within specified limits.

3.6 APRM Calibration

3.6.1 Purpose

To calibrate the APRM system to actual core thermal power as determined by a heat balance.

3.6.2 Acceptance Criteria

Level 1 criteria: The APRM readings must be within a tolerance of 2% of core thermal power as determined from a heat balance.

Level 2 criteria: N/A

3.6.3 Test Description

The APRM gains are adjusted after major power level changes, if required, to read the actual core thermal power as determined by a heat balance performed in accordance with plant operating procedures for APRM adjustment to core thermal power. The heat balance required for the calibration process was obtained from the process computer program OD3 (Core Thermal Power and APRM Calibration) or from the Official Monitor case in accordance with plant operating procedures.

3.6.4 Test Results

APRM calibration was performed in accordance with plant operating procedures at approximately 22%, 24%, 55%, 58%, 60%, 62%, 75%, 89%, 95%, and 99% of Rated Thermal Power. Each APRM was calibrated within a 2% tolerance to read core thermal power as calculated by the heat balance.

3.7 Control Rod Scram Time Testing

3.7.1 Purpose

To demonstrate that the CRD system functions as designed with respect to scram insertion times following the completion of core alterations.

3.7.2 Acceptance Criteria

Level 1 criteria:

(a) The individual scram insertion time for all operable control rods from the fully withdrawn position, based on de-energization of the scram pilot solenoids, with reactor steam dome pressure above 800 psig shall not exceed the following:

| From Fully Withdrawn To Notch Position | Individual Rod Maximum Insertion Time (sec) |
|---|---|
| 46 | 0.44 |
| 36 | 1.08 |
| 26 | 1.83 |
| 06 | 3.35 |

(b) The individual control rods with scram times in excess of those listed in (a) above are to be declared as SLOW with the following restrictions:

1. No more than 10 operable control rods are declared SLOW.
2. No more than 2 operable control rods that are declared SLOW occupy adjacent locations.

(c) The maximum scram insertion time of each control rod, from the fully withdrawn position to position 06, based on the de-energization of the scram pilot solenoid, shall not exceed 7.0 seconds.

Level 2 criteria: N/A

3.7.3 Test Description

The CRD scram time testing was performed in accordance with engineering procedures for control rod scram testing, with the steam dome pressure above 800 psig. The test consists of scramming each control rod, collecting the resulting scram time data, and analyzing the data in accordance with the acceptance criteria noted above.

3.7.4 Test Results

All CRDs were tested in accordance with engineering procedures for control rod scram testing, with the steam dome pressure greater than 800 psig. A summary of the results is given in Attachment 2 of this report.

3.8 Core Performance

3.8.1 Purpose

To evaluate core performance parameters to assure plant thermal limits are maintained during power ascension to rated conditions.

3.8.2 Acceptance Criteria

Level 1 criteria: The following thermal limits are ≤ 1.000 when ≥ 24% RTP:

1. MFLCPR (Maximum Fraction of Limiting Critical Power Ratio)
2. MFLPD (Maximum Fraction of Limiting Power Density)
3. MAPRAT (Maximum Average Planar Linear Heat Generation Ratio).

Level 2 criteria: N/A

3.8.3 Test Description

As power is increased, core thermal limits were evaluated at various levels up to 100%. In accordance with plant operating procedures for core parameter surveillance, demonstration of fuel thermal margin was performed. Fuel thermal margin was confirmed at each level before increasing reactor power further.

3.8.4 Test Results

Thermal limits were continuously monitored during power ascension. The surveillance procedure was performed satisfactorily at various levels as indicated below:

| Thermal Limit | 24.8% | 55.5% | 61.9% | 74.8% | 88.8% | 95.1% | 98.6% |
|---|---|---|---|---|---|---|---|
| MFLCPR | 0.727 | 0.786 | 0.728 | 0.720 | 0.810 | 0.786 | 0.769 |
| MFLPD | 0.763 | 0.646 | 0.600 | 0.631 | 0.830 | 0.856 | 0.866 |
| MAPRAT | 0.256 | 0.405 | 0.388 | 0.460 | 0.658 | 0.708 | 0.726 |

3.9 Reactivity Anomaly Calculation

3.9.1 Purpose

To check for possible reactivity anomalies as the core excess reactivity changes with exposure.

3.9.2 Acceptance Criteria

Level 1 Criteria: The monitored core $K_{eff}$ shall not differ from the predicted core $K_{eff}$ by more than ±1% $\Delta$ K.

Level 2 criteria: N/A

3.9.3 Test Description

After obtaining steady-state conditions following a BOC startup from a refueling outage and every month thereafter, a reactivity anomaly calculation is performed to monitor the core reactivity during the cycle. Verifying the reactivity difference between the monitored and predicted core $K_{eff}$ is within limits provides assurance that plant operation is maintained within the assumptions of the DBA and transient analyses. The core monitoring system calculates the core $K_{eff}$ for the reactor conditions obtained from plant instrumentation. A comparison of the monitored core $K_{eff}$ to the predicted core $K_{eff}$ at the same cycle exposure is used to ensure the difference is within a $\pm$ 1% $\Delta$ K acceptance band.

3.9.4 Test Results

The initial reactivity anomaly calculation for the cycle was performed in accordance with the engineering procedures for reactivity anomaly calculations on March 25, 2020. The monitored core $K_{eff}$ was well within the acceptance criteria range as specified above. The results of this calculation are given in Attachment 3 of this report.

## 4.0 CONCLUSIONS

As indicated by the acceptable results of all the startup testing, operation of the HNP1 reactor is successful with the introduction of the GNF3 fuel.

## ATTACHMENT 1

## IN-SEQUENCE CRITICAL COLD SHUTDOWN MARGIN DEMONSTRATION

| | |
|---|---|
| Sequence | A2 |
| RWM Groups 1 & 2 | Fully Withdrawn |
| RWM Group 4 (RWM Step 5) | 12 control rods at notch 12,<br>5 rods at notch 8 |
| | |
| KSRO | 0.98602 |
| Reactor Coolant Temperature | 163.5°F |
| Reactor Period | 347 sec. |
| Corrected KCRIT | 1.00563 |
| Cold Shutdown Margin | 1.661% ΔK |
| Value of R | 0.00033 ΔK |
| Value of B (conservative bias) | 0.0030 ΔK |
| Minimum Cold Shutdown Margin | 1.628% ΔK |
| Tech Spec Required Shutdown Margin | 0.38% ΔK |

## ATTACHMENT 2

## SCRAM TIME TESTING

| LOCATIONS | TIME IN SECONDS TO NOTCH POSITION | | | |
|---|---|---|---|---|
| | 46 | 36 | 26 | 06 |
| Fastest Rods | | | | |
| 18-31 | 0.257 | 0.719 | 1.185 | 2.131 |
| 34-51 | 0.241 | 0.712 | 1.201 | 2.175 |
| 38-15 | 0.264 | 0.731 | 1.209 | 2.177 |
| 34-35 | 0.253 | 0.729 | 1.228 | 2.180 |
| Slowest Rods | | | | |
| 30-27 | 0.304 | 0.844 | 1.426 | 2.634 |
| 42-47 | 0.394 | 0.905 | 1.451 | 2.548 |
| 46-35 | 0.313 | 0.869 | 1.426 | 2.526 |
| 22-03 | 0.290 | 0.833 | 1.391 | 2.512 |
| **Average (All Rods)** | **0.283** | **0.792** | **1.311** | **2.359** |

## ATTACHMENT 3

## REACTIVITY ANOMALY CALCULATION

UNIT 1 CYCLE 30
SEQUENCE: A2

| | | |
|---|---|---|
| DATE PERFORMED | | 03/25/20 |
| THERMAL POWER ($MW_{th}$) | CMWT | 2796.8 |
| RATED THERMAL POWER ($MW_{th}$) | | 2804.0 |
| CORE FLOW (Mlb/hr) | WT | 76.278 |
| RATED CORE FLOW (Mlb/hr) | | 78.5 |
| CORE XENON CONCENTRATION | | -2.22 |
| XE/RATED | | 0.993 |
| CYCLE EXPOSURE (MWD/sT) | | 128.4 |
| EIGENVALUE | $K_{eff}$ | 1.0091 |

PREDICTED $K_{eff}$ = 1.0095

+1% VALUE = 1.0195 -1% VALUE = 0.9995