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

Subject: Duke Energy Carolinas, LLC (Duke Energy)
Catawba Nuclear Station (CNS), Unit 1
Docket Number 50-413
Mid-Cycle Power Uprate Ascension Startup Report

On April 29, 2016, the NRC issued License Amendment No. 281 for Catawba Nuclear Station, Unit 1, which allowed an increase in the maximum reactor power level from 3411 megawatts thermal (MWth) to 3469 MWth.

Enclosed for your information is the Measurement Uncertainty Recapture (MUR) Mid-Cycle Power Uprate Ascension Startup Report. This report is submitted in accordance with the Catawba Nuclear Station UFSAR Section 14.3.4 which requires the submittal of a startup report following an amendment to the license involving a planned increase in power level.

There are no NRC commitments contained in this letter.

Please direct questions on this matter to Cecil Fletcher, Regulatory Affairs Manager, at (803) 701-3622.

Sincerely,

Tom Simril

Tom Simril
Vice President, Catawba Nuclear Station

IE26
NRR

Enclosure: Catawba Nuclear Station, Unit 1 Mid-Cycle Power Uprate Ascension Startup Report

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Enclosure

Catawba Nuclear Station, Unit 1
Mid-Cycle Power Uprate Ascension
Startup Report

Mid-Cycle Power Uprate Ascension Startup Report
This mid-cycle Startup Report is submitted to the NRC in accordance with the requirements of the Catawba Nuclear Station Updated Final Safety Analysis Report (UFSAR), Section 14.3.4, Startup Report, which requires the submittal of a Startup Report after an amendment to the license involving a planned increase in power level.

On April 29, 2016, the NRC issued License Amendment No. 281 for Catawba Nuclear Station, Unit 1, which allowed an increase in the maximum reactor power level from 3411 megawatts thermal (MWth) to 3469 MWth. A mid-cycle power ascension test was subsequently performed for Unit 1.

The power ascension methodology used at Catawba was to increase power gradually in one phase. Power ascension for Unit 1 was initiated during mid-cycle operations. Plant modifications were performed in previous outages and after License Amendment approval. These actions allowed Unit 1 mid- cycle power ascensions activities to begin. Catawba Unit 1 power ascension occurred on May 21, 2016.

Purpose
This Power Uprate Startup Report is submitted to the NRC to satisfy the reporting requirements of the Catawba's UFSAR section 14.3.4, which requires this report to include the following items.

- Address the Zero Power Test Phase and Power Ascension Test Phase
- Include a description of the measured values of the operating conditions or characteristics obtained during the test program and a comparison of these values with design predictions and specifications.
- Describe corrective actions required to obtain satisfactory operation.
- Include any additional specific details required in license conditions based on other commitments.

Power Uprate Ascension Program Scope
Catawba Unit 1 performed a mid-cycle Margin Recovery Uprate (MUR) in May 2016 to increase the licensed Rated Thermal Power from 3411 MWth to 3469 MWth. Leading Edge Flow Meters (LEFMs) were installed on all four feedwater lines. These meters calculate the feedwater mass flow rate and temperature. These values are used in the Unit 1 plant process computer (OAC) secondary side calorimetric calculation of thermal power.

Prior to the uprate, factory and site testing was performed on the LEFMs to verify that they were performing acceptably. Some rescaling of instrumentation was performed in advance of the uprate. At the time of uprate, final instrument rescaling was completed and a slow, deliberate, and closely monitored power escalation was performed to the new uprated power level.

USFAR chapter 14.3 testing was considered when determining the required testing to be performed for the power uprate. Since this was an at-power uprate, no Zero Power Test Phase (UFSAR section 14.3.2) activities were performed. Similarly, the Flux Symmetry Check - Low Power, Core Power Distribution - Intermediate Power, and HZP to HFP Reactivity Difference (UFSAR section 14.3.3) tests were not applicable. Core Power Distribution - High Power was performed before and after the uprate.

Mid-Cycle Power Uprate Ascension Testing

An extensive testing and monitoring plan was developed and executed to verify performance of the new LEFMs, monitor plant performance, identify any anomalies, and ensure adequate margin is maintained. All LEFM testing was done at power.

Prior to the uprate, the following test activities were successfully completed:

- TN/1/B/EC109743/01E (EC109743 Site Acceptance Test) was performed to verify the LEFMs were installed properly and performing acceptably. This included checks of field wiring, signal quality, and LEFM performance.
- TT/1/B/EC109743/01E (EC109743 - Functional Testing of Leading Edge Flow Meter (LEFM) OAC Gateway Acquisition, Operator Interfaces, and TPBE Input Logic) was performed to verify that the LEFM data was transferring properly to the OAC. The logic on the OAC for processing the LEFM data, calculating venturi corrections, detecting problems, and operator displays was tested and verified to be functioning properly.
- A comparison was made of 30 days of LEFM data vs. OAC venturi data, which verified the LEFMs, were reading consistently with the existing instrumentation.
- Core Power Distribution - High Power was performed on May 19, 2016 before power increase and it verified adequate margin to fuel limits existed.

The uprate test procedure was begun on May 18, 2016. The actual power escalation was performed over several hours on May 21, 2016. The evolution was controlled via test procedure TT/1/A/EC104403/01E (EC104403 - MUR Power Uprate). During the uprate, the following testing was performed:

- Stability of the unit and all major control systems was verified.
- The Main Turbine and Generator Supervisory System and Feedwater Pump Turbine Supervisory Systems and the Hotwell, Condensate Booster and Heater Drain pumps were all verified to indicate no vibration irregularities before and after the uprate.
- The LEFMs were placed into service and the OAC thermal power calculation verified to be functioning correctly.
- A pre-uprate plant data set was recorded including thermography of switchyard and isolated phase busses.
- When the Unit reached stability at the uprated power level, monitoring was continued and a post-uprate plant data set was recorded including thermography of switchyard and isolated phase busses.
- Engineering evaluated the data and determined that there were no issues identified and all acceptance criteria were met.

Data for approximately 500 plant parameters were recorded before and after the uprate. A sample of data were compared to acceptance criteria or existing alarm limits. Engineering evaluated the data to verify that adequate margin was maintained and that there were no unexpected performance issues. Attachment 1 is a summary of the results for key parameters for which criteria were established.

Following the uprate, Core Power Distribution was performed on June 7, 2016. Attachment 2 is a comparison of the before and after uprate flux map results. No issues were identified.

The overall acceptance criteria for the power escalation testing are listed below. All were met.

- All required specifications, measurements, and tolerances within the test procedure are required to be met.
- Control Systems remain stable including:
  a) Turbine Governor Control System
  b) Feedwater Pump Governor Control System
  c) DCS (Digital Control System) Feedwater Pump Speed Control
  d) DCS Steam Generator Level Control
  e) DCS Reactor Temperature Control
  f) DCS Pressurizer and Level Control
- Unit 1 is operating at uprated power level with LEFMs in service and NO unexpected alarms or annunciators.
- Core Power Distribution testing results are satisfactory and show no unexpected changes between the pre- and post-uprate tests.
- Engineering Management has provided concurrence to the Test Coordinator that plant system and equipment performance monitoring and trending indicates no adverse conditions and no margin concerns that could jeopardize continued operation at the uprated power level.

Conclusion

Overall plant performance during power ascension and at the uprated 3469 MWth power level was verified to be acceptable and as expected and predicted with no significant performance or margin concerns. No corrective actions were required. All test procedures were completed successfully.

Attachment 1
Summary Uprate Data

NC = Reactor Coolant CF = Feedwater

Parameter (EU)	Expected Change / Criteria	Pre-uprate	Post-uprate
REACTOR THERMAL POWER, BEST (MWt)	after uprate 3459 MWt to 3469 MWt	3402.67	3462.45
REACTOR THERMAL POWER, BEST (%)	after uprate 99.7% to 100%	98.09	99.81
THERMAL POWER BEST, 5 MIN RUNNING AVG (%)	after uprate 99.7% to 100%	98.09	99.80
TOTAL FEEDWATER FLOW (MLB/HR)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 0.2 MLB/HR	15.21	15.50
S/G A CF FLOW AVERAGE (MLB/HR)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 0.1 MLB/HR	3.93	4.01
S/G B CF FLOW AVERAGE (MLB/HR)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 0.1 MLB/HR	3.58	3.65
S/G C CF FLOW AVERAGE (MLB/HR)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 0.1 MLB/HR	3.86	3.93
S/G D CF FLOW AVERAGE (MLB/HR)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 0.1 MLB/HR	3.67	3.73
TOTAL MAIN STEAM FLOW, MEASURED (MLB/HR)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 0.1 MLB/HR	15.58	15.91
1A S/G MAIN STEAM FLOW CH 1 (%)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 2 %	102.05	104.07
1B S/G MAIN STEAM FLOW CH 1 (%)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 2 %	97.79	100.07
1C S/G MAIN STEAM FLOW CH 1 (%)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 2 %	101.70	103.98
1D S/G MAIN STEAM FLOW CH 1 (%)	3469 MWt recorded value is 1.0265 times recorded value at 3411 MWt; Tolerance: ± 2 %	99.61	101.54
S/G A FEEDWATER INLET TEMP (°F)	3469 MWt recorded value is 2 Deg. F higher than value at 3411 MWt; Tolerance: ± 1 Deg. F	438.74	440.26
S/G B FEEDWATER INLET TEMP (°F)	3469 MWt recorded value is 2 Deg. F higher than value at 3411 MWt; Tolerance: ± 1 Deg. F	438.56	440.16
S/G C FEEDWATER INLET TEMP (°F)	3469 MWt recorded value is 2 Deg. F higher than value at 3411 MWt; Tolerance: ± 1 Deg. F	438.98	440.50
S/G D FEEDWATER INLET TEMP (°F)	3469 MWt recorded value is 2 Deg. F higher than value at 3411 MWt; Tolerance: ± 1 Deg. F	438.31	439.81

Parameter (EU)	Expected Change / Criteria	Pre-uprate	Post-uprate
U1 S/G FINAL FEEDWATER AVERAGE TEMP (°F)	3469 MWt recorded value is 2 Deg. F higher than value at 3411 MWt; Tolerance: ± 1 Deg. F	439.25	440.77
AVERAGE MAIN STEAM PRESSURE (PSIA)	3469 MWt recorded value is 0.995 times recorded value at 3411 MWt; Tolerance: ± 20 PSIA	981.41	979.94
MAIN STEAM PRESSURE A (PSIA)	3469 MWt recorded value is 0.995 times recorded value at 3411 MWt; Tolerance: ± 20 PSIA	981.31	980.03
MAIN STEAM PRESSURE B (PSIA)	3469 MWt recorded value is 0.995 times recorded value at 3411 MWt; Tolerance: ± 20 PSIA	980.29	978.72
MAIN STEAM PRESSURE C (PSIA)	3469 MWt recorded value is 0.995 times recorded value at 3411 MWt; Tolerance: ± 20 PSIA	982.03	980.30
MAIN STEAM PRESSURE D (PSIA)	3469 MWt recorded value is 0.995 times recorded value at 3411 MWt; Tolerance: ± 20 PSIA	981.87	980.35
P/R AVG LEVEL 1 MIN AVG QUADRANT 4 (N-41) (%)	3469 MWt recorded value is 1.0173 times recorded value at 3411 MWt Tolerance: ± 1 %	97.89	99.97
P/R AVG LEVEL 1 MIN AVG QUADRANT 2 (N-42) (%)	3469 MWt recorded value is 1.0173 times recorded value at 3411 MWt Tolerance: ± 1 %	97.81	99.67
P/R AVG LEVEL 1 MIN AVG QUADRANT 1 (N-43) (%)	3469 MWt recorded value is 1.0173 times recorded value at 3411 MWt Tolerance: ± 1 %	97.82	99.78
P/R AVG LEVEL 1 MIN AVG QUADRANT 3 (N-44) (%)	3469 MWt recorded value is 1.0173 times recorded value at 3411 MWt Tolerance: ± 1 %	97.77	99.50
NC LOOP AVG COLD LEG TEMP (°F)	Tcold at 3469 MWt is same as at 3411 MWt; Tolerance: ± 0.2 °F	552.80	552.83
NC LOOP A NARROW RANGE COLD LEG TEMP (°F)	Tcold at 3469 MWt is same as at 3411 MWt; Tolerance: ± 0.2 °F	553.23	553.26
NC LOOP B NARROW RANGE COLD LEG TEMP (°F)	Tcold at 3469 MWt is same as at 3411 MWt; Tolerance: ± 0.2 °F	552.27	552.28
NC LOOP C NARROW RANGE COLD LEG TEMP (°F)	Tcold at 3469 MWt is same as at 3411 MWt; Tolerance: ± 0.2 °F	552.74	552.77
NC LOOP D NARROW RANGE COLD LEG TEMP (°F)	Tcold at 3469 MWt is same as at 3411 MWt; Tolerance: ± 0.2 °F	553.03	553.03
NC LOOP A AVERAGE N/R HOT LEG TEMPERATURE (°F)	Thot at 3469 MWt is 1.0 °F more than at 3411 MWt; Tolerance: ± 0.2 °F	614.13	615.21
NC LOOP B AVERAGE N/R HOT LEG TEMPERATURE (°F)	Thot at 3469 MWt is 1.0 °F more than at 3411 MWt; Tolerance: ± 0.2 °F	610.18	611.13

Parameter (EU)	Expected Change / Criteria	Pre-uprate	Post-uprate
NC LOOP C AVERAGE N/R HOT LEG TEMPERATURE (°F)	Thot at 3469 MWt is 1.0 °F more than at 3411 MWt; Tolerance: ± 0.2 °F	615.24	616.31
NC LOOP D AVERAGE N/R HOT LEG TEMPERATURE (°F)	Thot at 3469 MWt is 1.0 °F more than at 3411 MWt; Tolerance: ± 0.2 °F	612.61	613.59
NC LOOP A AVERAGE TEMP (°F)	Thot at 3469 MWt is 0.5 °F more than at 3411 MWt; Tolerance: ± 0.2 °F	584.35	584.83
NC LOOP B AVERAGE TEMP (°F)	Thot at 3469 MWt is 0.5 °F more than at 3411 MWt; Tolerance: ± 0.2 °F	582.04	582.54
NC LOOP C AVERAGE TEMP (°F)	Thot at 3469 MWt is 0.5 °F more than at 3411 MWt; Tolerance: ± 0.2 °F	584.32	584.85
NC LOOP D AVERAGE TEMP (°F)	Thot at 3469 MWt is 0.5 °F more than at 3411 MWt; Tolerance: ± 0.2 °F	583.35	583.83
NC FLOW BEST 5 MIN RUNNING AVG (GPM)	3469 MWt recorded value is equal to the recorded value at 3411 MWt; Tolerance: ±2% (± 7800 GPM)	391507	391143
NC LOOP A COOLANT FLOW, BEST (GPM)	3469 MWt recorded value is equal to the recorded value at 3411 MWt; Tolerance: ±2% (± 2000 GPM)	98298.64	98165.02
NC LOOP B COOLANT FLOW, BEST (GPM)	3469 MWt recorded value is equal to the recorded value at 3411 MWt; Tolerance: ±2% (± 2000 GPM)	97686.47	97552.52
NC LOOP C COOLANT FLOW, BEST (GPM)	3469 MWt recorded value is equal to the recorded value at 3411 MWt; Tolerance: ±2% (± 2000 GPM)	97590.97	97507.89
NC LOOP D COOLANT FLOW, BEST (GPM)	3469 MWt recorded value is equal to the recorded value at 3411 MWt; Tolerance: ±2% (± 2000 GPM)	97904.82	97963.31
TURBINE FIRST STAGE PRESS 1 (PSIG)	Verify pressure at 3469 MWt is 702.0 psig; Tolerance: ± 7 psig	681.79	696.33
UNIT 1 GENERATOR MEGAWATTS (MW)	Engineering will confirm expected output for plants ambient and subsequent condenser water condition	1215.44	1233.52
CF PUMP A SUCTION FLOW (GPM)	Pump Suction Flow equals recorded flow at 3411 MWt times 1.0265; Tolerance: ± 360 GPM	18537.10	18888.33
CF PUMP A SUCTION TEMP (°F)	Pump Suction Temperature is at recorded temperature at 3411 MWt; Tolerance: + 3 / -1 °F	364.01	365.27
CF PUMP B SUCTION FLOW (GPM)	Pump Suction Flow equals recorded flow at 3411 MWt times 1.0265; Tolerance: ± 360 GPM	16777.19	17098.97
CF PUMP B SUCTION TEMP (°F)	Pump Suction Temperature is at recorded temperature at 3411 MWt ; Tolerance: + 3 / -1 °F	365.34	366.65

Attachment 2
Summary of Core Power Distribution Testing

Core Power Distribution Results		
Date	5/19/16	6/7/16
Power	3402 MWth	3463 MWth
Reaction Rate Error, Max	6.67%	7.29%
Reaction Rate Error, RMS	1.41%	1.47%
Heat Flux Hot Channel Factor (F_Q)	1.772	1.771
Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}$)	1.511	1.516
Axial Offset	-0.209%	-1.084%
Max Quadrant Tilt Ratio	1.00272	1.00299
F_Q Operational Margin	8.75%	6.24%
F_Q RPS Margin	18.24%	16.85%
F_Q Steady State Margin	24.85%	23.44%
$F_{\Delta H}$ Surveillance Margin	15.74%	13.92%
$F_{\Delta H}$ Steady State Margin	20.68%	19.97%