UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 2, 2016

Mr. Kelvin Henderson
Site Vice President
Catawba Nuclear Station
Duke Energy Carolinas, LLC
4800 Concord Road
York, NC 29745

SUBJECT: CATAWBA NUCLEAR STATION, UNITS 1 AND 2 - ISSUANCE OF AMENDMENTS REGARDING CHANGES TO TECHNICAL SPECIFICATION 3.4.1, "RCS PRESSURE, TEMPERATURE, AND FLOW DEPARTURE FROM NUCLEATE BOILING (DNB) LIMITS" (CAC NOS. MF6355 AND MF6356)

Dear Mr. Henderson:

The U.S. Nuclear Regulatory Commission (the Commission) has issued the enclosed Amendment Nos. 283 and 279 to Renewed Facility Operating License (RFOL) Nos. NPF-35 and NPF-52, respectively, for the Catawba Nuclear Station, Units 1 and 2 (Catawba 1 and 2). The amendments consist of changes to the RFOLs and Technical Specifications (TSs) in response to your application dated June 12, 2015, as supplemented by letter dated March 11, 2016.

The amendments modify TS Table 3.4.1-1, "RCS [Reactor Coolant System] DNB Parameters," Parameter 3, "RCS Total Flow Rate." Specifically, TS Table 3.4.1-1 is modified by decreasing the minimum required RCS total flow rates from less than or equal to 388,000 gallons per minute (gpm) to less than or equal to 384,000 gpm for Catawba 1, and from less than or equal to 390,000 gpm to less than or equal to 387,000 gpm for Catawba 2.

A copy of the related Safety Evaluation is also enclosed. Notice of Issuance will be included in the Commission's biweekly *Federal Register* notice.

If you have any questions, please contact me by phone at 301-415-4090, or by e-mail at jeffrey.whited@nrc.gov.

Sincerely,

Jeffrey A. Whited, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-413 and 50-414

Enclosures:
1. Amendment No. 283 to NPF-35
2. Amendment No. 279 to NPF-52
3. Safety Evaluation

cc w/enclosures: Distribution via Listserv

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

DUKE ENERGY CAROLINAS, LLC

DOCKET NO. 50-413

CATAWBA NUCLEAR STATION, UNIT 1

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 283
Renewed License No. NPF-35

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment to the Catawba Nuclear Station, Unit 1 (CNS, the facility), Renewed Facility Operating License No. NPF-35, by Duke Energy Carolinas, LLC, dated June 12, 2015, as supplemented by letter dated March 11, 2016, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations as set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. NPF-35 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 283, which are attached hereto, are hereby incorporated into this renewed operating license. Duke Energy Carolinas, LLC, shall operate the facility in accordance with the Technical Specifications.

3. Implementation Requirements:

A. This license amendment is effective as of its date of issuance and shall be implemented within 60 days.

B. Coincident with the implementation of this amendment, the licensee shall revise the CNS Updated Final Safety Analysis Report (UFSAR). The revision shall be implemented in the next periodic update of the UFSAR in accordance with 10 CFR 50.71(e).

FOR THE NUCLEAR REGULATORY COMMISSION

Michael T. Markley, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Operating License
and Technical Specifications

Date of Issuance: June 2, 2016

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

DUKE ENERGY CAROLINAS, LLC

DOCKET NO. 50-414

CATAWBA NUCLEAR STATION, UNIT 2

AMENDMENT TO RENEWED FACILITY OPERATING LICENSE

Amendment No. 279
Renewed License No. NPF-52

1. The Nuclear Regulatory Commission (the Commission) has found that:

   A. The application for amendment to the Catawba Nuclear Station, Unit 2 (CNS, the facility), Renewed Facility Operating License No. NPF-52, by Duke Energy Carolinas, LLC, dated June 12, 2015, as supplemented by letter dated March 11, 2016, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations as set forth in 10 CFR Chapter I;

   B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;

   C. There is reasonable assurance (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations set forth in 10 CFR Chapter I;

   D. The issuance of this amendment will not be inimical to the common defense and security or to the health and safety of the public; and

   E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

2. Accordingly, the license is amended by changes to the Technical Specifications as indicated in the attachment to this license amendment, and paragraph 2.C.(2) of Renewed Facility Operating License No. NPF-52 is hereby amended to read as follows:

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 279, which are attached hereto, are hereby incorporated into this renewed operating license. Duke Energy Carolinas, LLC, shall operate the facility in accordance with the Technical Specifications.

3. Implementation Requirements:

A. This license amendment is effective as of its date of issuance and shall be implemented within 60 days.

B. Coincident with the implementation of this amendment, the licensee shall revise the CNS Updated Final Safety Analysis Report (UFSAR). The revision shall be implemented in the next periodic update of the UFSAR in accordance with 10 CFR 50.71(e).

FOR THE NUCLEAR REGULATORY COMMISSION

Michael T. Markley, Chief
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Attachment:
Changes to the Operating License
and Technical Specifications

Date of Issuance: June 2, 2016

ATTACHMENT TO

LICENSE AMENDMENT NO. 283

RENEWED FACILITY OPERATING LICENSE NO. NPF-35

DOCKET NO. 50-413

AND

LICENSE AMENDMENT NO. 279

RENEWED FACILITY OPERATING LICENSE NO. NPF-52

DOCKET NO. 50-414

Replace the following pages of the Renewed Facility Operating Licenses with the attached revised pages. The revised pages are identified by amendment number and contain marginal lines indicating the areas of change.

Remove	Insert
NPF-35, page 4	NPF-35, page 4
NPF-52, page 4	NPF-52, page 4

Replace the following page of the Appendix A Technical Specifications with the attached revised page. The revised page is identified by amendment number and contains a marginal line indicating the area of change.

Remove	Insert
3.4.1-4	3.4.1-4

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 283, which are attached hereto, are hereby incorporated into this renewed operating license. Duke Energy Carolinas, LLC shall operate the facility in accordance with the Technical Specifications.

(3) Updated Final Safety Analysis Report

The Updated Final Safety Analysis Report supplement submitted pursuant to 10 CFR 54.21(d), as revised on December 16, 2002, describes certain future activities to be completed before the period of extended operation. Duke shall complete these activities no later than December 6, 2024, and shall notify the NRC in writing when implementation of these activities is complete and can be verified by NRC inspection.

The Updated Final Safety Analysis Report supplement as revised on December 16, 2002, described above, shall be included in the next scheduled update to the Updated Final Safety Analysis Report required by 10 CFR 50.71(e)(4), following issuance of this renewed operating license. Until that update is complete, Duke may make changes to the programs described in such supplement without prior Commission approval, provided that Duke evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59 and otherwise complies with the requirements in that section.

(4) Antitrust Conditions

Duke Energy Carolinas, LLC shall comply with the antitrust conditions delineated in Appendix C to this renewed operating license.

(5) Fire Protection Program (Section 9.5.1, SER, SSER #2, SSER #3, SSER #4, SSER #5)*

Duke Energy Carolinas, LLC shall implement and maintain in effect all provisions of the approved fire protection program as described in the Updated Final Safety Analysis Report, as amended, for the facility and as approved in the SER through Supplement 5, subject to the following provision:

> The licensee may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

*The parenthetical notation following the title of this renewed operating license condition denotes the section of the Safety Evaluation Report and/or its supplement wherein this renewed license condition is discussed.

(2) Technical Specifications

The Technical Specifications contained in Appendix A, as revised through Amendment No. 279, which are attached hereto, are hereby incorporated into this renewed operating license. Duke Energy Carolinas, LLC shall operate the facility in accordance with the Technical Specifications.

(3) Updated Final Safety Analysis Report

The Updated Final Safety Analysis Report supplement submitted pursuant to 10 CFR 54.21(d), as revised on December 16, 2002, describes certain future activities to be completed before the period of extended operation. Duke shall complete these activities no later than February 24, 2026, and shall notify the NRC in writing when implementation of these activities is complete and can be verified by NRC inspection.

The Updated Final Safety Analysis Report supplement as revised on December 16, 2002, described above, shall be included in the next scheduled update to the Updated Final Safety Analysis Report required by 10 CFR 50.71(e)(4), following issuance of this renewed operating license. Until that update is complete, Duke may make changes to the programs described in such supplement without prior Commission approval, provided that Duke evaluates each such change pursuant to the criteria set forth in 10 CFR 50.59 and otherwise complies with the requirements in that section.

(4) Antitrust Conditions

Duke Energy Carolinas, LLC shall comply with the antitrust conditions delineated in Appendix C to this renewed operating license.

(5) Fire Protection Program (Section 9.5.1, SER, SSER #2, SSER #3, SSER #4, SSER #5)*

Duke Energy Carolinas, LLC shall implement and maintain in effect all provisions of the approved fire protection program as described in the Updated Final Safety Analysis Report, as amended, for the facility and as approved in the SER through Supplement 5, subject to the following provision:

> The licensee may make changes to the approved fire protection program without prior approval of the Commission only if those changes would not adversely affect the ability to achieve and maintain safe shutdown in the event of a fire.

*The parenthetical notation following the title of this renewed operating license condition denotes the section of the Safety Evaluation Report and/or its supplements wherein this renewed license condition is discussed

Table 3.4.1-1 (page 1 of 1)
RCS DNB Parameters

PARAMETER		INDICATION	No. OPERABLE CHANNELS	LIMITS
1.	Indicated RCS Average Temperature – Unit 1	meter	4	≤ the value specified in the COLR
		meter	3	≤ the value specified in the COLR
		computer	4	≤ the value specified in the COLR
		computer	3	≤ the value specified in the COLR
	Indicated RCS Average Temperature – Unit 2	meter	4	≤ the value specified in the COLR
		meter	3	≤ the value specified in the COLR
		computer	4	≤ the value specified in the COLR
		computer	3	≤ the value specified in the COLR
2.	Indicated Pressurizer Pressure	meter	4	≥ the value specified in the COLR
		meter	3	≥ the value specified in the COLR
		computer	4	≥ the value specified in the COLR
		computer	3	≥ the value specified in the COLR
3.	RCS Total Flow Rate			≥ 384,000 gpm and ≥ the limit specified in the COLR (Unit 1);
				≥ 387,000 gpm and ≥ the limit specified in the COLR (Unit 2)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO

AMENDMENT NO. 283 TO RENEWED FACILITY OPERATING LICENSE NO. NPF-35

AND

AMENDMENT NO. 279 TO RENEWED FACILITY OPERATING LICENSE NO. NPF-52

DUKE ENERGY CAROLINAS, LLC

CATAWBA NUCLEAR STATION, UNITS 1 AND 2

DOCKET NOS. 50-413 AND 50-414

1.0 INTRODUCTION

By letter dated June 12, 2015,[1] as supplemented by letter dated March 11, 2016,[2] Duke Energy Carolinas, LLC (the licensee) submitted a license amendment request (LAR) requesting changes to Technical Specification (TS) Section 3.4.1, "RCS [Reactor Coolant System] Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits," for the Catawba Nuclear Station, Units 1 and 2 (Catawba 1 and 2). Specifically, the licensee proposed to modify TS Table 3.4.1-1, "RCS DNB Parameters," Parameter 3, "RCS Total Flow Rate," limits as follows:

> Catawba 1: From "≥ 388,000 gpm [gallons per minute] and ≥ the limit specified in the COLR [core operating limit report] (Unit 1)," to "≥ 384,000 gpm and ≥ the limit specified in the COLR (Unit 1)"
>
> Catawba 2: From "≥ 390,000 gpm and ≥ the limit specified in the COLR (Unit 2)," to "≥ 387,000 gpm and ≥ the limit specified in the COLR (Unit 2)"

The supplemental letter dated March 11, 2016, provided additional information that clarified the application, did not expand the scope of the application as originally noticed, and did not change the U.S. Nuclear Regulatory Commission (NRC, the Commission) staff's original proposed no significant hazards consideration determination as published in the *Federal Register* on September 1, 2015 (80 FR 52804).

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[1] Agencywide Documents Access and Management System (ADAMS) Accession No. ML15168A009.
[2] ADAMS Package Accession No. ML16102A161.

1.1 Background

The licensee stated in its LAR that over a number of years, a decrease in RCS flow has been observed at Catawba 1 and 2. The RCS flow decrease resulted in a loss of margin relative to the minimum values allowed by TS 3.4.1.

In its letter dated June 12, 2015, the licensee noted that the following factors were evaluated to determine the cause of the decrease to the RCS flow rate:

- crud deposits on the fuel cladding
- crud deposits on the steam generator tubes
- drifting components or an instrumentation calibration issue
- reactor coolant boron concentration changes
- boron concentration effects in the elbow tap tubing runs
- RCS chemistry transients
- RCS chemistry pH and zinc addition programs
- shutdown crud burst pump configuration with hydrogen peroxide addition
- steam generator outage eddy current inspections
- core effects from bypass flow changes or temperature increases
- density effects from elbow tap tubing run temperature differences between the high and low taps
- nitrogen bubbles in the high tap tubing runs due to inadequate venting following nitrogen purge evolutions
- crud buildup in the instrument tubing

After the evaluation, the licensee identified that crud deposits on the fuel cladding and the steam generator tubes appear to be significant contributors for the RCS flow rate decrease.

The licensee proposed TS changes lowering the required RCS total flow limits to compensate for additional flow decrease that could occur during the course of future fuel cycles. In its LAR, the licensee provided the design-basis transient analyses supporting a reduction in the minimum RCS flow allowed by TS 3.4.1 to 384,000 gpm for Catawba 1 and to 387,000 gpm for Catawba 2.

2.0 REGULATORY EVALUATION

As stated in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.92(a), in determining whether an amendment to a license will be issued, the Commission will be guided by the considerations that govern the issuance of initial licenses (e.g., 10 CFR 50.57, "Issuance of operating license") to the extent applicable and appropriate.

Per 10 CFR 50.90, whenever a holder of an operating license desires to amend the license, application for an amendment must be filed with the Commission following, as far as applicable, the form prescribed for original applications. Per 10 CFR 50.34(b), each application for an operating license shall include a final safety analysis report that describes the facility; presents the design bases and the limits on its operation; and presents a safety analysis of the structures, systems, and components and of the facility as a whole. Per 10 CFR 50.36(b), each license authorizing operation of a utilization facility will include TSs, which will be derived from

the analyses and evaluation included in the safety analysis report, and amendments thereto, submitted as part of the application (as applicable to license amendments, the updated final safety analysis report (UFSAR)). Further, the Commission may include such additional TSs as the Commission finds appropriate.

The NRC's regulatory requirements related to the content of the TSs are set forth in 10 CFR Section 50.36, "Technical specifications." This regulation requires that the TSs include items in five categories, including: (1) safety limits; limiting safety system settings, and limiting control settings; (2) limiting conditions for operation (LCOs); (3) surveillance requirements (SRs); (4) design features; and (5) administrative controls. As stated in 10 CFR 50.36(c)(2)(i):

> Limiting conditions for operation are the lowest functional capability or performance levels of equipment required for safe operation of the facility. When a limiting condition for operation of a nuclear reactor is not met, the licensee shall shut down the reactor or follow any remedial action permitted by the technical specifications until the condition can be met.

Currently, Catawba 1 and 2, TS LCO 3.4.1, requires that during MODE 1 (i.e., Power Operations), RCS DNB parameters for pressurizer pressure, RCS average temperature, and RCS total flow rate shall be within the limits specified in TS Table 3.4.1-1. Parameter 3 of TS Table 3.4.1-1 provides unit-specific limits on RCS Total Flow Rate – one specified directly in TS Table 3.4.1-1 and one indirectly in the COLR. In its submittal, the licensee requested to decrease the RCS Total Flow Rate limit specified, on a per-unit basis, in TS Table 3.4.1-1. No other changes are proposed.

Accordingly, to grant the licensee's request, the regulations require that the amended (reduced) RCS Total Flow Rate LCO will properly describe, at a minimum, the lowest functional capability or performance levels required for safe operation.

Under the provisions of 10 CFR Section 50.34, an application for a construction permit must include the principal design criteria (PDC) for a proposed facility. The PDC establish the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety; that is, structures, systems, and components that provide reasonable assurance that the facility can be operated without undue risk to the health and safety of the public. In Appendix A to 10 CFR Part 50, the Commission set forth General Design Criteria (GDC) that establish minimum requirements for the PDC for water-cooled nuclear power plants similar in design and location to plants for which construction permits have been issued by the Commission.

GDC 10, "Reactor design," in Appendix A to 10 CFR Part 50, requires that the reactor core and associated coolant, control, and protection systems shall be designed with appropriate margin to assure that specified acceptable fuel design limits (SAFDLs) are not exceeded during any condition of normal operation, including the effects of anticipated operational occurrences.

GDC 15, "Reactor coolant system design," requires that the RCS and associated auxiliary, control, and protection system shall be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operation, including anticipated operational occurrences. Section 3.1 of the Catawba UFSAR briefly discusses Catawba's PDC, including how the PDC meet the GDC.

Section 50.46(b)(1) of 10 CFR, "Acceptance criteria for emergency core cooling systems for light-water nuclear power reactors," defines the limits to be satisfied regarding the requirements of the analysis for postulated loss-of-coolant accidents (LOCA).

3.0 TECHNICAL EVALUATION

On page 5 of Attachment 1 to its LAR, the licensee provided tables with the RCS flow data for the last eight fuel cycles for Catawba 1 and nine fuel cycles for Catawba 2, spanning approximately 11 years for comparison. The data showed that for the cores with the use of Westinghouse robust fuel assembly (RFA) and RFA-2, the actual amount of the flow decrease was small, but it resulted in a loss of margin relative to the minimum values allowed by TS 3.4.1 for Catawba 1 and 2.

Per 10 CFR 50.36(b), the TSs are derived from the analyses and evaluation included in the safety analysis report. Accordingly, in support of the proposed TS changes, the licensee provided technical analyses, including UFSAR Chapter 15 reanalysis and evaluation.

The NRC staff has reviewed the proposed TS changes and the associated technical analyses to ensure that the proposed changes were properly based on the Catawba UFSAR Chapter 15 reanalysis, which should have considered all applicable events, used appropriate adequate analytical methods and plant initial conditions, and demonstrated acceptable results. Further, the NRC staff assessed whether the amended LCO would provide at least the lowest functional capability or performance levels required for safe operation of the facility.

3.1 Event Categorization for Reanalysis Supporting the Proposed RCS Total Flow Rate Limits

The RCS flow provides driving force to remove the decay heat from the core to avoid fuel failures and to prevent the RCS pressure from exceeding the RCS pressure boundary limits following events discussed in the UFSAR Chapter 15 safety analyses as required by GDC 10 and 15. In support of its LAR, the licensee evaluated these UFSAR analyses to assess the impact of the proposed changes to total RCS flow rates and classified the UFSAR Chapter 15 events into the following three categories:

Category 1 – Events that are bounded by the analysis using the current RCS flow assumption;
Category 2 – Events for which consequences are not sensitive to the RCS flow, events that are bounded by another UFSAR Chapter 15 transient, or events that are not applicable; and
Category 3 – Events for which consequences are affected by the RCS flow changes.

The licensee discussed the categorization of UFSAR Chapter 15 events and the associated bases for each event classified in three event categories with respect to the effects of the RCS flow rate on consequences of each applicable event for Catawba 1 and 2, respectively, in Section 4, Table 1 and Table 2 of its submittal dated June 12, 2015. For the first two categories discussed above, the licensee determined that no reanalysis was required. For the Category 3 events, the licensee provided its analysis and evaluation for each event, identifying the effects of the RCS flow on the fuel performance and RCS pressure response.

The NRC staff has reviewed the event categorization and the associated bases discussed in the licensee's submittals, and finds that all the applicable UFSAR Chapter 15 events were considered. The NRC staff also finds that the events in each of the three categories were correctly identified, appropriately reflecting the effects of a decrease in the RCS flow rates, and adequately considering the results of the UFSAR Chapter 15 regarding the sensitivity of the RCS flow and bounding event identification.

Based on the above, the NRC staff concludes that the event categorization was adequately identified for determining the effects of the RCS flow rate on the response of the UFSAR Chapter 15 events, and the selection of the Category 3 events was acceptable for reanalysis and evaluation in determining the required RCS flow rate limits.

3.2 Methods and Plant Initial Conditions Used in the Analysis of Category 3 Events

The licensee performed the analysis of the applicable Category 3 events, in support of the requested change to RCS minimum flow rates, using the methods documented in the following NRC-approved reports, which were provided by letter dated March 11, 2016, or had been provided previously:

- DPC-NE-3001-P-A, "Multidimensional Reactor Transients and Safety Analysis Physics Parameter Methodology," Revision 0a
- DPC-NE-3000-P-A, "Thermal-Hydraulic Transient Analysis Methodology," Revision 5a
- PC-NE-3002-A, "FSAR Chapter 15 System Transient Analysis Methodology," Revision 4b
- DPC-NE-2005-P-A, "Thermal Hydraulic Statistical Core Design Methodology," Revision 4a[3]

The above methodologies have inherent limitations, conditions, or restrictions imposed by the associated NRC safety evaluation reports (SERs) approving their applications. The acceptability of the licensing analyses is subject to the application being within the limitations of the methodologies used. By letter dated March 11, 2016, the licensee provided a list of restrictions and conditions imposed by NRC SERs for all four reports and confirmed that the reanalysis complied with all the applicable conditions and restrictions.

The NRC staff determined that the reanalysis used the same assumptions and plant initial conditions as those used in the applicable UFSAR Chapter 15 events. The only change to the plant initial condition is the values of the RCS flow rate consistent with the values in the proposed TSs.

Since the methods used in the reanalysis were approved previously by the NRC and are incorporated in TS 5.6.5, "Core Operating Limits Report (COLR)," the use of the methods in the reanalysis was in compliance with all the applicable restrictions and conditions imposed by the NRC SERs approving applications of the methods, and the plant initial conditions, other than the values of the RCS flow rate, remained the same as that used in the analyses for the UFSAR Chapter 15 events, the NRC staff determined that the methods and the plant initial conditions used in the reanalysis are acceptable for supporting the proposed TS RCS flow rates.

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[3] ADAMS Accession No. ML16102A160.

3.3 Results of the Analysis of Category 3 Events

In Attachment 1 to its LAR, the licensee documented the results of its reanalysis for the applicable Category 3 events. Specifically, the results were provided on pages 9 to 12 of Attachment 1 for Catawba 1, and pages 15 to 17 for Catawba 2 in the submittal dated June 12, 2015. The NRC staff's review of these analyses, as well as the information provided by the licensee's letter dated March 11, 2016, is discussed below.

3.3.1 Analysis of Category 3 Events for Catawba 1

The following subsections discuss the NRC staff's evaluation of the licensee's reanalysis of Category 3 events for Catawba 1 that assumed the minimum RCS total flow rate of 384,000 gpm, which is a reduction from 388,000 gpm used in the analysis of record (AOR). For each event, the effects of a 4,000 gpm reduction in RCS total flow on the results of the AOR were identified and evaluated to ensure that the AOR remains the bounding analysis and continues to meet the fuel design limit criteria as discussed in GDC 10, and the reactor coolant pressure boundary design criteria discussed in GDC 15, as referenced in the Catawba UFSAR.

3.3.1.1 Analyses for Events with Plant-Specific Core Bypass Flow

For some Category 3 events, the current AOR assumed a conservative value of the best estimate core bypass flow of 8.5 percent of the total RCS flow, which resulted in a flow of 355,020 gpm (388,000 gpm minus the 8.5 percent bypass flow) passing through the core. The calculated plant-specific best estimate core bypass flow for Catawba 1 was 6.49 percent. At a total RCS flow rate of 384,000 gpm, the flow passing through the core was 359,078 gpm (384,000 gpm minus the 6.49 percent core bypass flow).

On page 5 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the plant-specific best estimate core bypass flow rate was calculated by performing a hydraulic analysis using the THRIVE methodology with input of hydraulic loss coefficients for reactor core internal geometries. The loss coefficients were determined from tests on the 1/7 scale models of the San Onofre Nuclear Generating Station, Connecticut Yankee Nuclear Power Plant, and 3XL pressurized-water reactors (PWRs). The same method was used for the PWRs designed by Westinghouse. For the Catawba applications, the method used was the same as that discussed in Section 4.4 of the Catawba UFSAR and had been used for Catawba since initial operation. The best estimate core flow calculation used fuel properties for Westinghouse 17x17 standard RFA with quick release top nozzle and Jedinstvo debris filter bottom nozzles. The calculations are based on the best estimate fuel assembly thermal hydraulic properties with 1,400 wet annular burnable absorbers (WABAs) and 0 WABAs to bound the best estimate fuel assembly thimble tube bypass condition, along with the best estimate reactor internal hydraulic loss coefficients. Since the existing methods discussed in the Catawba UFSAR were used, and the bounding bypass flow conditions were considered in the core flow calculation, the NRC staff determined that the calculated bypass flow rate of 6.49 percent is acceptable for use in the analysis to support the proposed changes to the RCS flow rate for Catawba 1.

For the reanalyzes of the following Category 3 events, a high heat removal capability was a key parameter to maintain integrity of the fuel rods and RCS pressure boundary during the transient. The lower core flow rates used in the analysis resulted in a lower heat removal capability and were conservative. For these events, the existing AOR (with a net core flow of 355,020 gpm)

remained bounding for Catawba 1 with an RCS flow rate changed to 384,000 gpm (net core flow of 359,078 gpm). Therefore, the NRC staff agrees with the licensee's determination that reanalysis for the following events was not needed since the existing AOR remained bounding:

- Case 3A – Feedwater Malfunction Causing an Increase in Feedwater Flow (full power case)
- (UFSAR Section 15.1.2)
- Case 3B – Partial Loss of Coolant Flow (UFSAR Section 15.3.1)
- Case 3C – Complete Loss of Coolant Flow (UFSAR Section 15.3.2)
- Case 3D – Reactor Coolant Pump Shaft Seizure - Locked Rotor (DNB case) (UFSAR Section15.3.3)
- Case 3E – Uncontrolled Rod Cluster Control Assembly (RCCA) Bank Withdrawal at Power (DNB case) (UFSAR Section 15.4.2)
- Case 3F – Dropped RCCA Rod (UFSAR Section 15.4.3a)
- Case 3G – Single Rod Withdrawal (UFSAR Section 15.4.3d)
- Case 3H – Spectrum of RCCA Ejection Accidents (UFSAR Section 15.4.8)
- Case 3 I – Inadvertent Opening of a Pressurizer Safety or Relief Valve (UFSAR Section 15.6.1)
- Case 3J – Steam Generator Tube Rupture (DNB case) (UFSAR Section 15.6.3)

On page 11 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that it recategorized Case 2G, feedwater line break (FLB) (UFSAR 15.2.8, short-term), from a Category 2 event to Category 3 event discussed in the above section. This change was made because the licensee found that Case 2G needed to be evaluated based on a reduced RCS flowrate, meeting the definition of Category 3 events. The AOR for Case 2G assumed the RCS flow of 388,000 gpm, assuming a core bypass flow of 8.5 percent. The net flow through the core in the current AOR for this FLB case was 355,020 gpm (388,000 gpm minus the 8.5 percent bypass flow). When the lower plant-specific core bypass flow of 6.49 percent was considered, the AOR core flow was lower than that with the proposed RCS flow of 384,000 gpm, which resulted in a net core flow of 359,078 gpm (384,000 gpm minus the 6.49 percent core bypass flow). The lower core flow rate used in the AOR resulted in a lower heat removal capability and was conservative. Therefore, the NRC staff concludes that the AOR for Case 2G remains bounding and acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

For the remaining Category 3 events for Catawba 1, the NRC staff discussion of its evaluation of the licensee's analyses is below.

3.3.1.2 Case 3K – Excessive Increase in Secondary Steam Flow (UFSAR Section 15.1.3)

The increase in steam flow event was originally analyzed with an RCS flow of 382,000 gpm, and the results showed that for the limiting case, approximately 6 percent margin to the overpower delta (Δ) temperature trip, existed during the event. On pages 11-12 of Attachment 3 to its letter dated March 11, 2016, the licensee clarified that the limiting case previously identified in the UFSAR was the case assuming manual rod control with most negative moderator coefficient. As stated in its letter dated June 12, 2015, the licensee reanalyzed the same limiting case assuming a total RCS flow rate of 388,000 gpm and indicated that at least 6 percent margin to the overpower Δ temperature trip existed. The reanalysis demonstrated that the results of the analysis for the event were not sensitive to the RCS flow. Therefore, the NRC staff concludes

that the current AOR remains acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.3 Case 3L – Steam Line Break (UFSAR 15.1.5)

The licensee reanalyzed the limiting steam line break (SLB) case identified in the Catawba UFSAR, an SLB with offsite power maintained, assuming an RCS flow rate of 384,000 gpm. On pages 8-9 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the core bypass flow was assumed to be 9.2 percent, which conservatively bounded the plant-specific core bypass flow of 6.49 percent. As stated in the licensee's letter dated June 12, 2015, the results of the reanalysis showed that the calculated minimum DNB ratio (DNBR) was 1.784. The calculated minimum DNBR was above the W-3S critical heat flux (CHF) correlation limit of 1.45, demonstrating the integrity of fuel rods in the core during the transient. On page 12 of Attachment 3 to its letter dated March 11, 2016, the licensee confirmed that the use of the W-3S CHF correlation limit of 1.45 in the SLB analysis was previously approved by the NRC. Since the results of the fuel integrity exceeded the acceptance criteria for the SLB event, which allowed fuel failure due to low DNBR, the NRC staff concludes that the SLB reanalysis is acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.4 Case 3M – Loss of Normal Feedwater Flow (UFSAR Section 15.2.7)

The short-term DNB for the loss of normal feedwater flow (LONF) event was reanalyzed at the proposed RCS flow rate of 384,000 gpm. On page 9 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the core bypass flow was assumed to be 8.5 percent, which conservatively bounded the plant-specific core bypass flow of 6.49 percent. The calculated minimum DNBR was 2.131, which was above the WRB-2M CHF correlation limit of 1.45, demonstrating the integrity of fuel rods in the core during the transient.

The long-term AOR for the LONF event was performed at an RCS flow rate of 390,000 gpm (instead of 388,000 gpm as corrected on page 13 of Attachment 3 to its letter dated March 11, 2016), with auxiliary feedwater flows conservatively bounding the actual Catawba capacity by at least 10 percent. As stated in the licensee's letter dated June 12, 2015, the results showed that the core maintained sub-cooling of at least 40 degrees Fahrenheit (°F) throughout the transient. The AOR demonstrated existence of significant margin to the acceptance criteria, which was based on maintaining adequate decay heat removal. Therefore, the NRC staff determined that the available sub-cooling margin was sufficient to compensate for a decrease in the margin resulting from a small reduction in the RCS flow rate to 384,000 gpm and met the subcooling requirement for the long-term transient during the LONF event.

Based on the above, the NRC staff concludes that the short-term reanalysis and long-term AOR for the LONF event are acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.5 Case 3N – Feedwater Line Break (UFSAR Section 15.2.8)

On page 11 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the short-term AOR for the FLB event was analyzed assuming a total RCS flow of 388,000 gpm with a core bypass flow of 8.5 percent. The net flow through the core in the current AOR for this FLB case was 355,020 gpm (388,000 gpm minus the 8.5 percent bypass flow). When the lower

plant-specific core bypass flow of 6.49 percent was considered, the AOR core flow was lower than that with the proposed RCS flow of 384,000 gpm, which resulted in a net core flow of 357,000 gpm (384,000 gpm minus the 6.49 percent core bypass flow). The lower core flow rate used in the AOR resulted in a lower heat removal capability and was conservative. Based on the above, the NRC staff concludes that the AOR remained bounding and was adequate to support the RCS flow reduction for the FLB short-term analysis.

In its letter dated June 12, 2015, the licensee stated that the long-term AOR for the FLB event showed the existence of adequate hot-leg sub-cooling, ensuring long-term core cooling capability. The key parameters in this analysis were the heat balance and the ability of auxiliary feedwater to maintain adequate hot-leg sub-cooling. The proposed change in RCS flow did not affect either the heat sources (core decay heat and reactor coolant pump heat) or heat sink parameters (auxiliary feedwater flow and temperature). Therefore, the NRC staff concludes that the current AOR is not significantly impacted by the proposed change in RCS flow rate and that the AOR remains acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.6 Case 3O – Reactor Coolant Pump Shaft Seizure – Locked Rotor (Peak RCS Pressure) (UFSAR Section 15.3.3)

On page 8 of Attachment 3 to its letter dated March 11, 2016, the licensee stated that the peak RCS pressure case for the locked rotor event was reanalyzed using a minimum RCS flow rate of 384,000 gpm. The core bypass flow was assumed to be 9.2 percent, which conservatively bounds the plant-specific core bypass flow of 6.49 percent. The calculated peak RCS pressure of 2,529 pounds per square inch gauge (psig) was below the RCS pressure boundary limit of 2,735 psig. Therefore, the NRC staff concludes that the reanalysis is acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.7 Case 3P - Uncontrolled RCCA Bank Withdrawal from a Subcritical or Low Power Startup Condition (UFSAR Section 15.4.1)

The uncontrolled RCCA bank withdrawal from a subcritical or low power startup condition analysis addressed the adequate core cooling (Case 1) and peak RCS pressure (Case 2) acceptance criteria. On page 14 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that for Case 1, the AOR assumed RCS flow with three reactor coolant pumps (RCP) operational based on nominal flow of 388,000 gpm with two adjustments. The first adjustment was a 1 percent reduction, which incorporated the Catawba TS 3.4.1 allowance to operate to RCS flows between 99 and 100 percent of the RCS flow rate limit specified in the COLR. The second adjustment was a factor to adjust RCS flow at four RCP operation-to-operation with three RCPs. The adjustment of 78 percent was obtained from RCP flow coastdown test. The two flow adjustments resulted in a reduction of the RCS flow from 388,000 gpm to 299,613 gpm, which was consistent with the value presented in Table 15.4 of the Catawba UFSAR. The calculated DNBR of 2.973 in the current AOR showed that there was significant margin between the analysis results and the acceptance criteria of 1.45. Based on the above, the NRC staff determined that the existing margin to the DNBR limit was sufficient to compensate for a decrease in the DNBR margin, resulting from the proposed RCS reduction from 388,000 gpm to 384,000 gpm in meeting the DNBR limit. Therefore, the NRC staff concludes that the DNBR AOR remains valid to support the proposed minimum total RCS flow rate of 384,000 gpm.

In its letter dated June 12, 2015, the licensee indicated that for Case 2 calculating the peak RCS pressure was reanalyzed with an RCS flow of 384,000 gpm. On page 9 of Attachment 3 to its letter dated March 11, 2016, the licensee stated that the core bypass flow was assumed to be 9.2 percent, which conservatively bounds the plant-specific core bypass flow of 6.49 percent. The results showed about 130 pounds per square inch (psi) of margin relative to the RCS pressure boundary limit of 2,735 psig.

Therefore, the NRC staff concludes that the reanalysis is acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.8 Case 3Q – Uncontrolled RCCA Bank Withdrawal at Power (Peak RCS Pressure) (UFSAR Section 15.4.2)

On page 15 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the limiting case identified in the UFSAR for this event was the RCCA bank withdrawal from 8 percent of the full power. In support of the proposed RCS flow reduction, the same limiting case was reanalyzed, assuming an RCS flow rate of 384,000 gpm. As stated on pages 8-9 of Attachment 3 to its letter dated March 11, 2016, the core bypass flow was assumed to be 9.2 percent, which conservatively bounds the plant-specific core bypass flow of 6.49 percent. As stated in the licensee's letter dated June 12, 2015, the results of the reanalysis showed that the peak RCS pressure was 2,708 psig, which was below the RCS pressure boundary limit of 2,735 psig. Therefore, the NRC staff concludes that the reanalysis is acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.9 Case 3R – Startup of an Inactive Reactor Coolant Pump at an Incorrect Temperature (UFSAR Section 15.4.4)

The current AOR was initiated from a power level of 50 percent, assuming RCS flow with three RCPs initially operating. The AOR was based on the calculated three-RCP flow, starting from a nominal full power and four-pump flow of 388,000 gpm. On page 15 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that an existing analysis with different fuel types and with a nominal full power RCS flow of 382,000 gpm calculated similar core responses to the current AOR. The analysis of the AOR and existing cases also showed considerable margins to the limiting DNBR. Therefore, the NRC staff finds that the results of the analysis in meeting the DNBR safety limit were not sensitive to a small change of 4,000 gpm in the RCS flow, and that the available margin to the DNBR limit in the AOR was sufficient to compensate for a decrease in the DNBR. Therefore, the NRC staff concludes that the reanalysis is acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.10 Case 3S – Steam Generator Tube Rupture (UFSAR Section 15.6.3)

The analysis of the steam generator tube rupture (SGTR) event addressed three areas: (1) the potential of fuel cladding damage due to DNB, (2) steam generator (SG) overfill, and (3) radiological consequences. The DNB analysis was performed at 388,000 gpm and evaluated for the identical Case 3J.

On page 16 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that for the SG overfill AOR analysis, a reactor trip was assumed to occur at 3 minutes following the SGTR. Prior to reactor trip, the small reduction in RCS flow would have an inconsequential

impact on the analysis. Upon the reactor trip, a loss of offsite power (LOOP) was assumed to trip the RCPs, resulting in a low pump coastdown flow. The AOR showed that the SG mass reached a maximum value at the transient time of greater than 1 hour following the SGTR event. Therefore, the NRC staff determined that for the overfill analysis, the effect of an assumed small reduction in the initial RCS flow rate was negligible, and the overfill AOR remains acceptable.

On page 16 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the AOR for the dose release calculation was performed at the RCS flow rate of 382,000 gpm, which was lower than the proposed RCS flow rate of 384,00 gpm. In addition, a sensitivity study for dose releases was performed for Catawba 1 at the RCS flow rates of 390,000 gpm and 388,000 gpm. These results confirmed that a small change in the initial RCS and core bypass flow rates had an insignificant effect on the results of the dose releases analyses.

Based on the above, the NRC staff concludes that the AOR for the DNB, SG overfill and dose releases analyses for the SGTR event remains valid, and is acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.1.11 Case 3T – Loss of Coolant Accidents (UFSAR Section 15.6.5)

An RCS flow of 390,000 gpm was assumed in the Catawba large break LOCA (LBLOCA) AOR. In support of the proposed reduced RCS flow rate of 384,000 gpm, the licensee provided an analysis determining the effects of the initial RCS flow reduction on the results of the LBLOCA analysis. The impact analysis was performed by the fuel vendor, Westinghouse, for the licensee using the NRC-approved best estimate LBLOCA methods documented in WCAP-12945-P-A, "Code Qualification Document for Large Break BELOCA." The licensee discussed this analysis on pages 17-19 of Attachment 3 to its letter dated March 11, 2016, which contained Westinghouse proprietary information. The results of the analysis showed that the variations, including the effect of the proposed RCS flow reduction to 384,000 gpm for Catawba 1, did not affect the LBLOCA analysis. The NRC staff reviewed the analysis provided by the licensee and finds that the methods used in the analysis were consistent with those in the NRC-approved topical report, WCAP-12945, and the reduced RCS flow conditions were adequately considered. Therefore, the NRC staff concludes the LBLOCA AOR continues to meet the requirements of 10 CFR 50.46(b)(1) and remains acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

For the Catawba small break LOCA (SBLOCA), the design-basis AOR was performed at an RCS flow of 390,000 gpm. On page 20 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the SBLOCA AOR assumed that a LOOP occurred coincident with reactor trip. The LOOP resulted in an RCP trip, which resulted in the RCS flow being driven by RCP coastdown, natural circulation, two-phase flow, and single-phase vapor, all of which were important in determining the SBLOCA transient, but were not a strong function of the initial RCS flow rate. For the limiting SBLOCA case, the LOOP and coincident reactor trip occurred at about 57 seconds and the calculated PCT was 1,323 °F, which occurred at 3,449 seconds. Since the PCT for the AOR provided a significant margin relative to the acceptable PCT limit of 2,200 °F, and the initial RCS flow would have a negligible effect on the results of the SBLOCA analysis, the NRC staff concludes that the SBLOCA AOR continues to meet the requirements of 10 CFR 50.46(b)(1) and is acceptable for use in support of the proposed minimum total RCS flow rate of 384,000 gpm.

3.3.2 Analysis of Category 3 Events for Catawba 2

The following subsections discuss the NRC staff's evaluation of the licensee's reanalysis of Category 3 events for Catawba 2 that assumed the minimum RCS total flow rate of 387,000 gpm reduced from 390,000 gpm used in the AOR. For each event, the effects of a 3,000 gpm reduction in RCS total flow on the results of the AOR were identified and evaluated to ensure that the AOR remains the bounding analysis and continues to meet the fuel design limit criteria as discussed in GDC 10, and the reactor coolant pressure boundary design criteria discussed in GDC 15, as referenced in the Catawba UFSAR.

3.3.2.1 Analyses for Events with Plant Specific Core Bypass Flow

For some Category 3 events, the current AOR assumed a core bypass flow of 7.5 percent of the total RCS flow, which resulted in a flow rate of 360,750 gpm (390,000 gpm minus the 7.5 percent bypass flow) passing through the core. The calculated core bypass flow for Catawba 2 was 6.71 percent. At a total RCS flow rate of 387,000 gpm, the flow passing through the core was 361,032 gpm (387,000 gpm minus the 6.71 percent core bypass flow). As discussed above, the methods and bypass flow conditions used in the core bypass flow calculation are acceptable, since they were consistent with those discussed in Section 4.4 of the Catawba UFSAR. Therefore, the NRC staff determined that the calculated bypass flow of 6.71 percent is acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm for Catawba 2.

For the analyses of the following Category 3 events, a high heat removal capability was a key parameter to maintain integrity of the fuel rods and RCS pressure boundary during the transient. The lower core flow rates used in the analysis resulted in a lower heat removal capability and were conservative. For these events, the existing AOR (with a net core flow rate of 360,750 gpm) remained bounding for Catawba 2 with an RCS flow rate of 387,000 gpm (net core flow of 361,032 gpm). Therefore, the NRC staff determined that a reanalysis for the following events was not needed since the existing AOR remains bounding:

- Case 6A – Feedwater Malfunction Causing an Increase in Feedwater Flow (full power case) (UFSAR Section 15.1.2)
- Case 6B – Loss of Normal Feedwater Flow (short-term analysis) (UFSAR Section 15.2.7)
- Case 6C – Partial Loss of Coolant Flow (UFSAR Section 15.3.1)
- Case 6D – Complete Loss of Coolant Flow (UFSAR Section 15.3.2)
- Case 6E – Reactor Coolant Pump Shaft Seizure - Locked Rotor (DNB) (UFSAR Section 15.3.3)
- Case 6F – Uncontrolled RCCA Bank Withdrawal at Power (DNB) (UFSAR Section 15.4.2)
- Case 6G – Dropped RCCA Rod (UFSAR Section 15.4.3a)
- Case 6H – Single Rod Withdrawal (UFSAR Section 15.4.3d)
- Case 6 I – Spectrum of Rod Cluster Control Assembly Ejection Accidents (UFSAR Section 15.4.8)
- Case 6J – Inadvertent Opening of a Pressurizer Safety or Relief Valve (UFSAR Section 15.6.1)
- Case 6K – Steam Generator Tube Rupture (DNB) (UFSAR 15.6.3)

On page 11 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that a recategorization was done for Case 5G, FLB (UFSAR 15.2.8, short-term), from a Category 2 event to one of the Category 3 events discussed in the above section. This recategorization was done because the licensee found that Case 5G needed to be evaluated based on a reduced RCS flow rate, meeting the definition of Category 3 events. The AOR for Case 5G used the RCS flow rate of 390,000 gpm with an assumed core bypass flow of 8 percent. The net flow through the core in the current AOR for this FLB case was 358,800 gpm (390,000 gpm minus the 8 percent bypass flow). When the lower plant-specific core bypass flow of 6.71 percent was considered, the AOR core flow was lower than those with the proposed RCS flow rate of 384,000 gpm, which resulted in a net core flow of 361,030 gpm (387,000 gpm minus the 6.71 percent core bypass flow). Therefore, the NRC staff determined that the AOR for Case 5G remains bounding and valid for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

For the remaining Category 3 events for Catawba 2, the NRC staff discussion of its evaluation of the licensee's analyses is below.

3.3.2.2 Case 6L – Steam System Piping Failure (UFSAR Section 15.1.5)

The licensee reanalyzed the SLB event assuming the RCS flow rate of 387,000 gpm. On page 9 of Attachment 3 to its letter dated March 11, 2016, the licensee clarified that the core bypass flow was assumed to be 7.5 percent, which conservatively bounds the plant-specific core bypass flow of 6.71 percent. As stated by the licensee in its letter dated June 12, 2105, the results of the reanalysis showed that the calculated minimum DNBR was 1.987. The calculated minimum DNBR was well above the W-3S CHF correlation limit of 1.45, demonstrating the integrity of fuel rods in the core during the transient. The results of the fuel integrity exceeded the acceptance criteria for the SLB event, which allowed fuel failure due to low DNBR. Therefore, the NRC staff concludes that the SLB analysis is acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

3.3.2.3 Case 6M – Reactor Coolant Pump Shaft Seizure – Locked Rotor (Peak RCS Pressure) (UFSAR Section 15.3.3)

The locked rotor event was reanalyzed using a minimum RCS flow rate of 387,000 gpm in calculating peak RCS pressure. On page 9 of Attachment 3 to its letter dated March 11, 2016, the licensee clarified that the core bypass flow was assumed to be 7.5 percent, which conservatively bounds the plant-specific core bypass flow of 6.71 percent. As stated by the licensee in its letter dated June 12, 2015, the reanalysis calculated a peak RCS pressure of 2,536 psig, which was below the RCS pressure boundary limit of 2,735 psig. Therefore, the NRC staff concludes that the reanalysis is acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

3.3.2.4 Case 6N – Uncontrolled RCCA Bank Withdrawal from a Subcritical or Low Power Startup Condition (UFSAR Section 15.4.1)

This event analysis addressed adequate core cooling (Case 1) and peak RCS pressure (Case 2) acceptance criteria. The AOR for both cases was reanalyzed for a minimum RCS flow rate of 390,000 gpm (instead of 387,000 gpm as corrected on page 22 of Attachment 3 to its letter dated March 11, 2016). As stated in the licensee's letter dated June 12, 2015, the results

of the AOR showed that the minimum DNBR for Case 1 was 3.395, which was well above the WRB-2M CHF correlation limit of 1.45, demonstrating the integrity of fuel rods in the core, and that for Case 2, there is about 150 psig of margin relative to the RCS pressure boundary limit of 2,735 psig. Based on the above, the NRC staff determined that the available margins to the DNBR and RCS boundary pressure limits is sufficient to compensate for a decrease in the DNBR and RCS pressure margins resulting from a small reduction of the RCS flow rate to the proposed flow rate of 387,000 gpm. Therefore, the NRC staff concludes that the AOR remains acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

3.3.2.5 Case 6O – Uncontrolled RCCA Bank Withdrawal at Power (Peak RCS Pressure) (UFSAR Section 15.4.2)

This event was reanalyzed for a minimum RCS flow rate of 387,000 gpm in calculating the peak RCS pressure. On page 9 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the core bypass flow was assumed to be 7.5 percent, which conservatively bounded the plant-specific core bypass flow of 6.71 percent. As stated in the licensee's letter dated June 12, 2015, the results showed that the peak RCS pressure is 2,709 psig, which was below the RCS pressure boundary limit of 2,735 psig. Therefore, the NRC staff concludes that the reanalysis is acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

3.3.2.6 Case 6P – Startup of an Inactive Reactor Coolant Pump at an Incorrect Temperature (UFSAR Section 15.4.4)

As stated in the licensee's letter dated June 12, 2015, the current AOR was initiated from a power level of 50 percent. The analysis assumed RCS flow with three RCPs initially operating and was based on the calculated three-RCP flow rate, starting from a nominal full power and four-pump flow of 388,000 gpm. On page 15 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that an existing analysis with different fuel types and with a nominal full power RCS flow of 382,000 gpm calculated similar core responses to the current AOR. As stated in the licensee's letter dated June 12, 2015, the analysis of the AOR and existing cases also showed considerable margins to the limiting DNBR. Therefore, the NRC staff determined that the results of the analysis in meeting the DNBR safety limit were not sensitive to a small change of 3,000 gpm in the RCS flow and that the available margin to the DNBR limit in the AOR was sufficient to compensate for a decrease in the DNBR margin. Therefore, the NRC staff concludes that the AOR remains acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

3.3.2.7 Case 6Q – Steam Generator Tube Rupture (UFSAR Section 15.6.3)

The analysis of the SGTR event addressed three areas: (1) the potential of fuel cladding damage due to DNB; (2) SG overfill; (3) and radiological consequences. The DNB analysis was performed at 388,000 gpm and evaluated above for identical Case 6K.

On page 16 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that for the SG overfill AOR analysis, a reactor trip was assumed to occur at about 6 minutes following the SGTR. Prior to reactor trip, the small reduction in RCS flow rate would have an inconsequential impact on the analysis. Upon the reactor trip, a LOOP was assumed to trip the RCPs, resulting in a low pump coast down flow. The AOR showed that the SG mass reached a

maximum value at the transient time of greater than 1 hour following the SGTR event. Therefore, the NRC staff determined that for the overfill analysis, the effect of a small reduction in the initial RCS flow rate was negligible, and the overfill AOR remains acceptable.

On page 16 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the AOR for the dose release calculation was performed at the RCS flow rate of 382,000 gpm, which was lower than the proposed RCS flow rate of 387,00 gpm. In addition, a sensitivity study for dose releases was performed for Catawba 1 at the RCS flow rates of 390,000 gpm and 388,000 gpm. The results confirmed that a small change in the initial RCS and core bypass flow rates had an insignificant effect on the results of the dose releases analyses.

Based on the above, the NRC staff concludes that the AOR for the SGTR remains acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

3.3.2.8 Case 6R – Loss of Coolant Accidents (UFSAR Section 15.6.5)

An RCS flow rate of 390,000 gpm was assumed for the Catawba LBLOCA AOR. In support of the proposed reduced RCS flow to 387,000 gpm, the licensee provided an analysis determining the effects of the initial RCS flow reduction on the results of the LBLOCA analysis. The impact analysis was performed by the fuel vendor, Westinghouse, for the licensee using the NRC-approved best estimate LBLOCA methods documented in WCAP-12945. The licensee discussed this analysis on pages 17-19 of Attachment 3 to its letter dated March 11, 2016, which contained Westinghouse proprietary information. As stated in the licensee's letter dated June 12, 2015, the results of the analysis showed that the variations, including the effect of the proposed RCS flow reduction to 387,000 gpm for Catawba 2, in the global model calculations did not affect the LBLOCA analysis. The NRC staff reviewed the analysis and finds that the methods used in the analysis were consistent with that included in the NRC-approved topical report, WCAP-12945, and the reduced RCS flow conditions were adequately considered. Therefore, the NRC staff concludes that the LBLOA AOR continues to meet the requirements of 10 CFR 50.46(b)(1) and remains acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

An RCS flow rate of 390,000 gpm was assumed in the Catawba SBLOCA AOR. On pages 19-20 of Attachment 3 to its letter dated March 11, 2016, the licensee indicated that the SBLOCA AOR assumed that a LOOP occurred coincident with reactor trip. The LOOP resulted in an RCP trip, which resulted in the RCS flow being driven by RCP coastdown, natural circulation, two phase flow, and single-phase vapor, all of which were important in determining the SBLOCA transient, but were not a strong function of the initial RCS flow rate. For the limiting SBLOCA case, the LOOP and coincident reactor trip occurred at about 57 seconds, and the calculated PCT was 1,323 °F, which occurred at 3,449 seconds. Since the PCT for the AOR provided a significant margin relative to the acceptable PCT limit of 2,200 °F, and the initial RCS flow would have a negligible effect on the results of the SBLOCA analysis, the NRC staff concludes that the SBLOCA AOR continues to meet the requirements of 10 CFR 50.46(b)(1) and is acceptable for use in support of the proposed minimum total RCS flow rate of 387,000 gpm.

3.4 Proposed Changes to TS 3.4.1

Catawba TS LCO 3.4.1 requires that the RCS DNB parameters for pressurizer pressure, RCS average temperature, and RCS total flow rate be within the limits in Table 3.4.1-1. Parameter 3, "RCS Total Flow Rate," limits of Table 3.4.1-1, specifies the minimum RCS total flow rates for Catawba 1 and 2. Its associated Surveillance Requirement (SR), SR 3.4.1.3, requires verification of RCS total flow rate to meet the LCOs for the minimum total flow rate. Measuring RCS total flow rate is required in accordance with the surveillance frequency control program. In its LAR, the licensee proposed changes to the TSs reducing the required RCS total flow rate for Catawba 1 and 2. Specifically, as stated above, the licensee proposed to modify TS Table 3.4.1-1, "RCS DNB Parameters," Parameter 3, "RCS Total Flow Rate," limits as follows:

> Catawba 1: From "≥ 388,000 gpm and ≥ the limit specified in the COLR (Unit 1)," to "≥ 384,000 gpm and ≥ the limit specified in the COLR (Unit 1)"
>
> Catawba 2: From "≥ 390,000 gpm and ≥ the limit specified in the COLR (Unit 2)," to "≥ 387,000 gpm and ≥ the limit specified in the COLR (Unit 2)"

As discussed above, the NRC staff has reviewed the information provided by the licensee in support of the changes to the minimum total RCS flow rate and has concluded that the changes are acceptable. Further, the NRC staff has reviewed the above proposed changes to TS Table 3.4.1-1, and finds that the LCO will continue to meet the requirements of 10 CFR 50.36(c)(2)(i) after the changes have been implemented. As shown above in the evaluation of the reanalysis of the Catawba UFSAR Chapter 15 accidents, the proposed RCS total flow rates were used as the minimum flow rates in the reanalysis that showed that the applicable DNBR limits were met, satisfying the GDC 10 requirements; the limits of reactor coolant pressure boundary were met, satisfying the GDC 15 requirements; and the PCT limit was met, satisfying the requirements of 10 CFR 50.46(b)(1). Thus, the proposed RCS total flow rates will continue to provide at least the lowest functional capability or performance levels required for safe operation. Therefore, the NRC staff concludes that the changes to the TS are acceptable.

3.5 Technical Conclusion

Based on its review, as discussed above, the NRC staff finds that the licensee used the previously NRC-approved methodologies for the reanalysis of the UFSAR Chapter 15 events in support of the proposed TS changes. The NRC staff also finds that the results of the reanalysis reflecting the proposed decreased minimum total RCS flowrates in the TS are acceptable. The NRC staff concludes that the results of the reanalysis showed that the applicable DNBR limits were met, satisfying the requirements of GDC 10, related to the fuel integrity; the limits of reactor coolant pressure boundary were met, satisfying the requirements of GDC 15, related to the reactor coolant pressure boundary limits; the PCT limit was met, satisfying the requirements of 10 CFR 50.46(b)(1), related to the ECCS performance criteria; and the minimum RCS total flow rates used in the reanalysis were correctly reflected in the proposed LCO in the TSs, satisfying the requirements of 10 CFR 50.36(c)(2)(i), related to the LCO in the TSs continuing to provide at least the lowest functional capability or performance levels required for safe operation. Therefore, the NRC staff concludes that the proposed TS Table 3.4.1-1, "RCS DNB Parameters," Parameter 3, "RCS Total Flow Rate," limits are acceptable.

4.0 STATE CONSULTATION

In accordance with the Commission's regulations, the South Carolina State officials were notified of the proposed issuance of the amendments. The State officials had no comments.

5.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes TS. The NRC staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding as published in the *Federal Register* on September 1, 2015 (80 FR 52804). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

6.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) there is reasonable assurance that such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: Summer Sun

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If you have any questions, please contact me by phone at 301-415-4090, or by e-mail at jeffrey.whited@nrc.gov.

Sincerely,

/RA/

Jeffrey A. Whited, Project Manager
Plant Licensing Branch II-1
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. 50-413 and 50-414

Enclosures:
1. Amendment No. 283 to NPF-35
2. Amendment No. 279 to NPF-52
3. Safety Evaluation

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