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Duke Energy Carolinas, LLC (Duke Energy)

Oconee Nuclear Station (ONS), Units 1, 2, and 3
Docket Numbers 50-269, 50-270, and 50-287
Renewed License Numbers DPR-38, DPR-47, and DPR-55

Subject: License Amendment Request (LAR) to Add High Flux Trip for 3 Reactor Coolant Pump Operation
License Amendment Request No. 2014-05, Supplement 1

On May 19, 2015, Duke Energy submitted a License Amendment Request (LAR) proposing to add a Reactor Protective System (RPS) Nuclear Overpower - High Setpoint trip for three (3) reactor coolant pump (RCP) operation to Technical Specification Table 3.3.1-1. By letter dated August 6, 2015, the Nuclear Regulatory Commission (NRC) requested Duke Energy submit supplemental information to enable the NRC Staff to complete the acceptance review for the LAR.

The enclosure provides the supplemental information. If there are any additional questions, please contact Boyd Shingleton, ONS Regulatory Affairs, at (864) 873-4716.

I declare under penalty of perjury that the foregoing is true and correct. Executed on August 20, 2015.

Sincerely,

Scott L. Batson
Vice President
Oconee Nuclear Station

Enclosure: Duke Energy Response to Acceptance Review Information Request

A001
NRR

cc w/enclosure:

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ENCLOSURE

Duke Energy Response to Acceptance Review Information Request

Enclosure
Duke Energy Response to Acceptance Review Information Request

NRC Information Request 1

Provide a more in-depth discussion on which regulatory criteria are applicable to the LAR. The LAR cited 10 CFR 50.36 as its regulatory basis. 10 CFR 50.36 states that limiting conditions for operation (LCO's) must be established for items meeting one of the four criteria cited in the regulation. Specifically, provide which of the 50.36 criteria are applicable to the proposed new setpoint, and a discussion of whether the existing TS requirements are sufficient to ensure operation within the bounds of the accident analysis.

Duke Energy Response

The NRC's regulatory requirements related to the content of the Technical Specification (TS) are contained in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.36. Paragraph (c)(2)(i) of 10 CFR 50.36 states that Limiting Conditions for Operation (LCOs) are the lowest functional capability or performance levels of equipment required for safe operation of the facility. Paragraph (c)(2)(ii) of 10 CFR 50.36 lists four criteria for determining whether particular items are required to be included in the TS LCOs. The third criterion applies to a structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier. The Nuclear Overpower - High Setpoint trip function meets Criterion 3. The proposed change adds an additional trip setpoint for three reactor coolant pump (RCP) operation. A new trip function is not added.

In MODES 1 and 2, the Nuclear Overpower - High Setpoint trip, along with other Reactor Protective System (RPS) trips, are required to be OPERABLE because the reactor can be critical in these MODES. These trips are designed to take the reactor subcritical to maintain the TS Safety Limits during anticipated transients and to assist the ESPS in providing acceptable consequences during accidents. While the existing overpower protection for three reactor coolant pump (RCP) operation (provided by the Nuclear Overpower Flux/Flow/Imbalance trip function) is adequate, the proposed Nuclear Overpower flux trip setpoint for three RCP operation provides improved protection for power excursion events initiated from three RCP operation, most notably the small steam line break accident. The Nuclear Overpower flux trip provides an absolute setpoint that can be actuated regardless of transient or Reactor Coolant System (RCS) flow conditions. The faster response time provides additional departure from nucleate boiling (DNB) and RCS protection than provided by the slower acting nuclear overpower flux/flow/imbalance trip function. The proposed high flux trip setpoint will result in significant margin improvement to the departure from nucleate boiling ratio (DNBR) acceptance criterion.

NRC Information Request 2

Provide the regulatory basis for the new reactor trip. Please describe which regulations the new reactor trip is intended to comply with (e.g., 10 CFR Part 100, GDC 10 or alternative criteria that establish the Oconee licensing basis).

Duke Energy Response

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

The regulation of GDC 20 of Appendix A to 10 CFR Part 50, "Protection System Functions," requires protection system functions to be designed to 1) to initiate automatically the operation of appropriate systems including the reactivity control systems, to assure that specified acceptable fuel design limits are not exceeded as a result of anticipated operational occurrences and (2) to sense accident conditions and to initiate the operation of systems and components important to safety.

The principal design criteria (PDC) for ONS were developed in consideration of the seventy General Design Criteria for Nuclear Power Plant Construction Permits proposed by the Atomic Energy Commission (AEC) in a proposed rule-making published for 10CFR Part 50 in the Federal Register on July 11, 1967. The ONS, Units 1, 2, and 3, construction permits were issued on November 6, 1967, preceding the issuance of the GDC specified in 10 CFR 50 Appendix A. The proposed trip setpoint is intended to comply with PDC 6 and 14, which are comparable to GDC 10 and 20, respectively.

PDC 6 specifies that the reactor core shall be designed to function throughout its design lifetime without exceeding acceptable fuel damage limits which have been stipulated and justified. The core design, together with reliable process and decay heat removal systems, shall provide for this capability under all expected conditions of normal operation with appropriate margins for uncertainties and for transient situations which can be anticipated, including the effects of the loss of power to recirculation pumps, tripping out of a turbine generator set, isolation of the reactor from its primary heat sink, and loss of all off-site power. ONS Updated Final Safety Analysis Report (UFSAR) Section 3.1.6 states that the reactor is designed with the necessary margins to accommodate, without fuel damage, expected transients from steady-state operation including the transients given in the criterion. The design margins allow for deviations of temperature, pressure, flow, reactor power, and reactor turbine power mismatch. Above 15 percent power, the reactor is operated at a constant average coolant temperature and has a negative power coefficient to damp the effects of power transients. The Reactor Control System will maintain the reactor operating parameters within preset limits, and the Reactor Protective System will shut down the reactor if normal operating limits are exceeded by preset amounts

PDC 14 specifies that core protective systems, together with associated equipment, shall be designed to act automatically to prevent or to suppress conditions that could result in exceeding acceptable fuel damage limits. ONS UFSAR Section 3.1.14 states that the ONS reactor design meets this criterion by reactor trip provisions and engineered safety features. The ONS Reactor Protective System is designed to limit reactor power which might result from unexpected reactivity changes, and provides an automatic reactor trip to prevent exceeding acceptable fuel damage limits.

NRC Information Request 3

Provide a description of the accident analysis that demonstrates the 80.5% reactor trip setpoint is adequate to meet the applicable AAO*/Accident acceptance criteria. The description should be at a level consistent with the description of accidents in the FSAR and include the analysis codes and methods, key analysis assumptions as well as the applicable acceptance criteria.

*AAO should be AOO (anticipated operational occurrence) per telecon with Randy Hall, ONS NRR Project Manager on August 11, 2015.

Duke Energy Response

The main accident for which credit will be taken for the proposed three RCP High Flux Trip setpoint is the UFSAR Chapter 15.17 Small Steam Line Break (SSLB) transient initiated from three RCP operation. Other accidents initiated from three RCP operation could credit the proposed trip function, but the motivation for the proposal is the SSLB transient analysis. The accident starts at the maximum power level allowed when operating with three RCPs and is analyzed in such a manner as to maximize the primary system overcooling and subsequent power increase while avoiding and/or delaying a valid RPS trip signal. The existing three RCP SSLB credits two flux related RPS trip functions. The first is the existing TS High Flux trip function and setpoint, which is set at 105.5% Rated Thermal Power (RTP). The second is the Flux/Flow/Imbalance trip function, which is a dynamic setpoint based on the measured power and measured RCS flow rate. Since SSLB is an overcooling event, as the RCS gets colder the coolant becomes more dense, the measured RCS flow rate increases. This overcooling causes two responses to the Oconee RPS. First, the colder reactor vessel downcomer fluid attenuates neutrons and masks the excore detectors from measuring the true core power. This causes the true power to potentially increase much higher than what the excore detectors would indicate and hence, delay and or avoid either a high flux trip or a flux/flow/imbalance trip, both of which use indicated (i.e., excore detectors) core power as an input. The SSLB event in UFSAR Chapter 15.17 conservatively models downcomer attenuation and its impact on the excore detector signal. The second response is that the colder, more dense coolant, causes measured RCS flow to increase which causes the flux/flow/imbalance trip to increase. This also delays and/or avoids reactor trip on flux/flow/imbalance. This is a physical phenomenon and no special modeling techniques are required to account for this effect. With four RCPs operating, the high flux trip is more effective at tripping the reactor than the flux/flow/imbalance trip, even before the flux/flow/imbalance trip setpoint increases due to increasing flow. With three RCPs operating, the flux/flow/imbalance trip is the main trip function and, with the dynamic setpoint increasing as the coolant becomes more dense, a much larger increase in true core power occurs relative to the power increase calculated with four RCPs in operation. Therefore, the current limiting SSLB accident documented in UFSAR 15.17 for the DNBR acceptance criterion is the SSLB initiated from three RCP operation.

The NRC-approved analysis (documented in DPC-NE-3005-PA) of the SSLB transient uses the NRC approved code RETRAN-3D to determine a limiting combination of steam line break size and moderator temperature coefficient (MTC) to produce the largest true core power excursion thereby challenging DNBR and centerline fuel melt (CFM), both of which are acceptance criteria

for the UFSAR Chapter 15.17 event. A larger break size increases the primary system overcooling while a more negative moderator temperature coefficient (MTC) maximizes the power excursion as a result of that overcooling. Too large a break will result either in a low RCS pressure or variable low pressure-temperature reactor trip or a faster power increase resulting in a high flux or flux/flow/imbalance trip. Too negative an MTC will result in a faster power increase resulting in a high flux or flux/flow/imbalance trip. The most conservative combination of break size and MTC either avoids a RPS trip altogether or delays it long enough to maximize the true core power.

Centerline fuel melt is only a concern for 4 RCP operation and will not be addressed further in this LAR. Departure from nucleate boiling ratio calculations are performed with the NRC approved VIPRE-01 code using the RETRAN-3D forcing functions as input. Departure from nucleate boiling ratio is more limiting for three RCP operation (vs. four RCP operation) due to the combination of lower RCS flow and higher relative power increase. The type of steam line breaks analyzed in UFSAR 15.17 can only occur if there were an actual pipe break (vs. valve failures), which is classified as an infrequent fault and therefore, DNB fuel failures are allowed. However, Duke Energy treats the SSLB as a fault of moderate frequency with respect to the DNB acceptance criteria and consequently, no DNB related fuel failures are allowed. The analysis of the three RCP SSLB with the proposed high flux trip setpoint for when three RCPs are operating demonstrates that true core power is significantly reduced before reactor trip occurs. In fact, with the proposed high flux trip setpoint for three RCP operation, the limiting SSLB transient with respect to both CFM and DNB becomes the SSLB initiated from four RCPs.

NRC Information Request 4

Provide a sample calculation that shows the uncertainty determination in the elements of the setpoint calculations for the high flux trip.

Duke Energy Response

As stated in the LAR, the 80.5% RTP setpoint was chosen to maintain the delta between nominal 100% RTP and the current TS allowable value of 105.5% RTP. The 5.5% RTP delta is simply added to the maximum power level allowed for three RCP operation, which is 75% RTP. Adding 5.5% RTP to 75% RTP results in the proposed high flux trip setpoint of 80.5%RTP. This value is verified acceptable in the SSLB analysis initiated from three RCP operation.

The method described in the NRC-approved DPC-NE-3005-PA (Chapter 4), for performing Chapter 15 analyses specifies that the trip setpoint assumed in the analyses is the TS trip setpoint plus (or minus) an uncertainty to account for the trip setpoint uncertainty itself. Any uncertainty or adjustments in the signal that is used to compare to the setpoint is accounted for in the specific analysis, if applicable. For the SSLB DNB analyses, the Statistical Core Design (SCD) method is employed (NRC approved DPC-NE-2005-PA) which accounts for the various uncertainties in core power and RCS flow in the DNB limit itself. What is not accounted for in the SCD method is transient effects such as downcomer attenuation, which the SSLB RETRAN-3D analysis specifically accounts for as described in DPC-NE-3005-PA. As mentioned previously, reactor vessel downcomer attenuation affects the excore detector signal

response and acts to mask the true power increase. Basically, if this were put in mathematical terms, it would be:

$\Phi_m \geq \Phi_{sp}$ + trip setpoint uncertainty allowance

Where Φ_m = flux measured at excore detectors adjusted for transient effects (e.g., downcomer attenuation) and excore detector calibration tolerances

Φ_{sp} = Technical Specification allowable value trip setpoint

Trip setpoint uncertainty = current analysis assumes 1.0% RTP for convenience since that is the old analog RPS trip bistable uncertainty and it bounds the uncertainty on the setpoint in the digital RPS. There is no uncertainty on the trip setpoint in the digital RPS.

NRC Information Request 5

Identify and describe the procedure that will be used by control room operators to manually insert the high flux trip setpoint when going from 4 RCP operation to 3 RCP operation. Please also describe how this procedure accomplishes the setpoint changes to avoid overpower operation or spurious trips.

Duke Energy Response

If a condition arises which requires Operations to reduce reactor power on an operating unit so that a reactor coolant pump can be shutdown, Operations procedural guidance (OP/1,2,3/A/1102/004 - Operation at Power) triggers a notification to maintenance personnel to change the RPS high flux trip set point from the four RCP value to the three RCP value. This is done following power reduction and shutdown of the problematic RCP. A maintenance procedure (AM/1,2,3/A/0315/017 - TXS RPS Channels A, B, C, and D Parameter Changes For Abnormal/Normal Operating Conditions) is utilized to perform the following action one RPS channel at a time. The RPS is a digital system. From the RPS service unit, a graphical service monitor screen which has design features specific to changing the high flux trip set point is used to lower the high flux set point to the required three RCP value.

When conditions permit returning to four RCP operation, the fourth RCP is placed in service, the high flux trip set point for each RPS channel is changed to the four RCP value via Operations notification to Maintenance who use the same Maintenance procedure to change the set point, and then escalation to full power operation is allowed.

NRC Information Request 6

Provide an explanation of how the 80.5% RTP high flux trip setpoint will be verified to be applicable to each new reactor core loading.

Duke Energy Response

Maximum allowed peaking limit curves are generated with the VIPRE-01 computer code for the SSLB transient, and will continue to be generated for the three RCP SSLB transient once the proposed high flux trip setpoint is approved and implemented. These peaking limit curves are performed once for the bounding analysis then verified acceptable for each reload core. The peaking limit curves for SSLB restrict peaking to preclude the occurrence of DNB. Duke Energy verifies that the DNB acceptance criteria is met for each reload by comparing potential pin powers from the SIMULATE neutronics code to the peaking limit curves generated by VIPRE. Duke Energy intends to continue this practice for the SSLB transient initiated from three RCP operation unless and until it is demonstrated that the four RCP SSLB transient is more limiting and bounding than the three RCP SSLB transient. If such a situation were to occur, Duke Energy would perform reload checks to the four RCP SSLB peaking limit curves and only verify the three RCP SSLB peaking limits remain bounded for any future fuel design change, DNB correlation change, or any plant modification that would be unbounded by the existing UFSAR Chapter 15.17 analysis assumptions.