Tanya M. Hamilton
Vice President
Harris Nuclear Plant
5413 Shearon Harris Road
New Hill, NC 27562-9300

919.362.2502

10 CFR 50.90

October 30, 2017
Serial: HNP-17-082

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

Shearon Harris Nuclear Power Plant, Unit 1
Docket No. 50-400 / Renewed License No. NPF-63

Subject: Response to Request for Additional Information Regarding License Amendment Request Proposing a New Set of Fission Gas Gap Release Fractions for High Burnup Fuel Rods That Exceed the Linear Heat Generation Rate Limit Detailed in Regulatory Guide 1.183, Table 3 (CAC No. MF9740)

Ladies and Gentlemen:

By application dated May 22, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17142A411), Duke Energy Progress, LLC (Duke Energy), submitted a license amendment request (LAR) for Shearon Harris Nuclear Power Plant, Unit 1 (HNP). The proposed license amendment requested to revise the facility as described in the HNP Final Safety Analysis Report (FSAR) to provide gas gap release fractions for high-burnup fuel rods (i.e., greater than 54 gigawatt days per metric ton of uranium (GWD/MTU)) that exceed the 6.3 kilowatt per foot (kW/ft) linear heat generation rate (LHGR) limit detailed in Table 3, “Non-LOCA Fraction of Fission Product Inventory in Gap,” of Regulatory Guide (RG) 1.183, “Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors,” July 2000.

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the LAR and determined that additional information is needed to complete their review. Duke Energy received the request for additional information (RAI) from the NRC by letter dated September 18, 2017 (ADAMS Accession No. ML17250B017). Response to this request is required by October 30, 2017.

The attachment to this letter provides Duke Energy’s responses to the RAI questions.

This additional information does not change the No Significant Hazards Determination provided in the original submittal. No regulatory commitments are contained in this letter.

In accordance with 10 CFR 50.91(b), HNP is providing the state of North Carolina with a copy of this response.

Should you have any questions regarding this submittal, please contact Jeffery Robertson, Manager – Regulatory Affairs, at (919) 362-3137.

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 30, 2017.

Sincerely,

Tanya M. Hamilton

Attachment: Response to Request for Additional Information

cc: J. Zeiler, NRC Senior Resident Inspector, HNP
W. L. Cox, III, Section Chief, N.C. DHSR
M. Barillas, NRC Project Manager, HNP
C. Haney, NRC Regional Administrator, Region II

I declare under penalty of perjury that the foregoing is true and correct. Executed on October 30, 2017.

Sincerely,

Tanya M. Hamilton

Attachment: Response to Request for Additional Information

cc: J. Zeiler, NRC Senior Resident Inspector, HNP
W. L. Cox, III, Section Chief, N.C. DHSR
M. Barillas, NRC Project Manager, HNP
C. Haney, NRC Regional Administrator, Region II

SERIAL HNP-17-082

ATTACHMENT

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

SHEARON HARRIS NUCLEAR POWER PLANT, UNIT 1

DOCKET NO. 50-400

RENEWED LICENSE NUMBER NPF-63

By application dated May 22, 2017 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML17142A411), Duke Energy Progress, LLC (Duke Energy), submitted a license amendment request (LAR) for Shearon Harris Nuclear Power Plant, Unit 1 (HNP). The proposed license amendment requested to revise the facility as described in the HNP Final Safety Analysis Report (FSAR) to provide gas gap release fractions for high-burnup fuel rods (i.e., greater than 54 gigawatt days per metric ton of uranium (GWD/MTU)) that exceed the 6.3 kilowatt per foot (kW/ft) linear heat generation rate (LHGR) limit detailed in Table 3, "Non-LOCA Fraction of Fission Product Inventory in Gap," of Regulatory Guide (RG) 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," July 2000.

The U.S. Nuclear Regulatory Commission (NRC) staff reviewed the LAR and determined that additional information is needed to complete their review. Duke Energy received the request for additional information (RAI) from the NRC by letter dated September 18, 2017 (ADAMS Accession No. ML17250B017). Response to this request is required by October 30, 2017. Duke Energy's response is provided below.

RAI #1

Duke Energy's LAR proposes gap release fractions for high-burnup fuel rods (i.e., greater than 54 GWD/MTU) that exceed the 6.3 kW/ft LHGR limit in footnote 11 of Table 3 in RG 1.183. The non-loss-of-coolant (LOCA) accident gap fractions stated in Table 3 of RG 1.183 are applied to the non-LOCA accidents if fuel failure occurs during the accident. The following accidents at Shearon Harris assume fuel failure: fuel handling accident, locked rotor accident, and control rod ejection accident. In the LAR, the licensee states that no non-LOCA accidents that may result in departure from nucleate boiling are considered (e.g., locked rotor accident, control rod ejection accident) because the fuel cycles for Shearon Harris will be designed so that no fuel rod predicted to enter departure from nucleate boiling will have been operated beyond the current limit in RG 1.183, footnote 11, for maximum LHGR. However, the LAR does not incorporate this new design requirement into the licensing basis as reflected in the FSAR, nor does it place a requirement in the Shearon Harris TSs such as Section 5.0, "Design Features," or any other document controlled under 10 CFR 50.59 such as the core operating limits report.

Describe how Duke Energy will incorporate the new design requirement into the Shearon Harris licensing basis as reflected in the FSAR, TSs, or any other document controlled under 10 CFR 50.59 (such as the core operating limits report) or provide the revised radiological consequence analyses for the other design-basis accidents that assume fuel failure (such as locked rotor accident, control rod ejection accident, etc.), which demonstrate that the regulatory limits will be met with the new proposed gap fractions for high-burnup fuel rods.

HNP Response to RAI #1:

The markups to the HNP FSAR Tables 15.7.4-1 and 15.7.4-3, as provided in the LAR, show an allowance for exceeding the fuel rod power/burnup criteria of RG 1.183 Table 3, Footnote 11 for fuel handling accidents in the Fuel Handling Building and in Containment, along with the resulting increase in the gap fractions for pertinent isotopes in these rods. The HNP fuel cycle designs will ensure that no fuel rod predicted to experience clad failure in any other non-LOCA accidents will have operated beyond the limits of Footnote 11.

To address this new fuel cycle design requirement in the HNP licensing basis, Duke Energy plans to add the following paragraph in HNP FSAR Section 15.0.9.1:

> Inventory in the gap between the fuel pellet and fuel rod cladding
> For some design basis accidents, fuel damage as predicted in bounding analyses is limited to fuel cladding failure. For these design basis accidents, the radioactive source term is limited to the activity initially in the gap between the fuel pellets and the fuel rod cladding. The percentage of the core fission product inventory in this gap -- the gap fraction -- for these non-LOCA accidents is consistent with the values from Table 3 in Regulatory Guide 1.183, except for the fuel handling accidents in the Fuel Handling Building and in Containment. For the fuel handling accidents, gap fractions for Kr-85, Cs-134, and Cs-137 are increased by a factor of 3 from the Regulatory Guide 1.183, Table 3 values (Reference 15.7.4.11). The fuel cycle design ensures that no fuel rod predicted to experience DNB [departure from nucleate boiling] in any other non-LOCA accidents will have operated beyond the power/burnup criteria of Footnote 11 in Regulatory Guide 1.183.

RAI #2

The Shearon Harris FSAR, Section 15.7.4.2.3, "Postulated Fuel Handling Accident in Containment," states:

> ...The activity released from the damaged fuel assembly is released to the outside atmosphere through the containment openings (such as the personnel airlock door or equipment hatch)...No credit is taken for isolation of containment for the [fuel handling accident] FHA in containment.

Shearon Harris TS 3.9.4 allows at least three different configurations during core alterations and during movement of irradiated fuel within containment. Three possible configurations are: (1) equipment door is open and is capable of being closed and held in place by a minimum of four bolts, and each airlock with a minimum of one door closed; (2) equipment door closed and held in place by a minimum of four bolts, and each airlock open with a minimum of one door in the airlock capable of being closed; and (3) equipment door is open and is capable of being closed and held in place by a minimum of four bolts and each airlock open with a minimum of one door in airlock capable of being closed.

Duke Energy submitted a revised fuel handling accident (FHA) in containment analysis that does not specify the configuration of the equipment door and each airlock to demonstrate the most bounding condition. The NRC staff did not find a discussion or analysis provided that explains that the resultant radiological doses provided in the LAR for the FHA in containment bounds all the possible configurations. It appears, depending on the plant building configuration, that the open airlocks could allow a pathway for activity to migrate from the open containment airlocks into the adjacent building and eventually into the control room.

a. Specify all the possible configurations of the equipment door and each airlock. Provide the rate of release for the equipment door and each airlock that support a 2-hour release to the environment and demonstrate 10 CFR 50.67 radiation dose limit (or exposure to personnel) is met and describe how this analysis bounds all possible configurations of the equipment door and each airlock for the FHA in containment.

b. Explain if a pathway for activity to migrate from the open containment airlock into the adjacent building and eventually into the control room during ingress/egress of personnel is possible at Shearon Harris following an FHA event in containment. If this pathway is possible, provide additional information describing how this potential dose contribution pathway to the control room is accounted for or bounded by the analysis provided in the LAR.

HNP Response to RAI #2a:

The possible configurations of the personnel airlock, emergency airlock and equipment hatch during refueling activities and the resultant releases of activity following a fuel handling accident (FHA) in containment are as follows:

1) One or both airlocks may be open while the equipment hatch is closed during refueling activities. Should a FHA occur with the containment in this configuration, all activity could be released into the Reactor Auxiliary Building (RAB). In such a case, the activity would be routed to the plant vent stack and released from there to the environment as described in the response to RAI #2b (see below).

2) The equipment hatch may be open while both airlocks are closed during refueling activities. Should a FHA occur with the containment in this configuration, activity would be released across the open equipment hatchway into the environment, at least until personnel closed the equipment hatch within one hour into the event (not credited in the FHA dose analysis).

3) The equipment hatch and one or both airlocks could be open during refueling activities. If a FHA were to occur with the containment in this configuration, all activity would be released to the environment. Some of the activity would be released past the open equipment hatchway directly into the environment as noted above. The remainder of the activity would be released into the RAB and from there to the environment through the plant vent stack, also noted above.

The locations of releases of activity to the environment following a design basis accident are important to the calculations of control room atmospheric dispersion factors (χ/Qs) and with them the calculations of control room doses for these accidents. Control room χ/Qs were calculated for these release locations and show that the values taken for the control room χ/Q currently used in the alternative source term (AST) analysis of the FHA in containment, as provided in the LAR, produce the bounding control room dose for this scenario and continue to meet the 10 CFR 50.67 radiation dose limit.

The release rate of activity to the environment from the airlocks and the equipment hatch is assumed to occur linearly over the 2-hour period specified in RG 1.183, Appendix B, 5.3. This assumption is conservative since no credit is taken for mixing or filtration prior to being released to the environment.

HNP Response to RAI #2b:

The potential for activity released from an open containment airlock to the RAB and subsequently to the control room after a fuel handling accident in containment has been evaluated. The RAB heating, ventilating, and air conditioning (HVAC) system and RAB

Emergency Exhaust System (RABEES) are designed to exhaust activity released to the RAB to the plant vent stack where it is monitored prior to release to the environment. In addition, the control room is separated from the remainder of the RAB by a wall whose only penetration is a sealed pipe chase. As such, there is no potential for activity released from an open containment airlock to the RAB to migrate to the control room.

During normal plant operation, the RAB HVAC system maintains the RAB at a slight negative pressure below atmospheric. The RAB HVAC system operates continuously except during system maintenance and testing as to fulfill a primary function of maintaining RAB airborne radioactivity levels as low as reasonably achievable. Filtration of the exhaust air from potentially contaminated areas in the RAB reduces offsite airborne radioactivity in accordance with 10 CFR 50, Appendix A, General Design Criteria (GDC) 60, and allows for monitoring of airborne radioactivity releases in accordance with 10 CFR 50, Appendix A, GDC 64, during normal plant operation prior to release from the plant vent stack. For the periods that the RAB HVAC system is out of service for maintenance or testing, the RABEES is procedurally placed in service.

<u>RAI #3</u>

Section 15.7.4.2.2, “Postulated Fuel Handling Accident in the FHB,” of the Shearon Harris FSAR contains the radiological consequence analysis of a postulated FHA in the fuel handling building (FHB). In this analysis, credit is taken for removal of iodine by filters during the operation of the spent fuel pool ventilation system. The spent fuel pool area ventilation system is a part of the FHB heating ventilating and air conditioning system. FSAR 6.5.1.2.1, “FHB Emergency Exhaust System,” states:

…Following a fuel handling accident radioactivity released from fuel rods will be detected by the radiation monitors located around the fuel pools. These radiation monitors will then signal the switchover from the normal to the emergency ventilation and filtration system. The switchover time is 30 seconds for the emergency ventilation and filtration system to become fully operational. The isolation of the normal ventilation system is accomplished in ≤ 10 seconds. Either train may then be manually de-energized from the Control Room and placed on standby. Negative pressure is established at 1/8 in. wg. by continuously exhausting air from the operating floor…Assuming the maximum distance traveled by the FHA radioactive gas is half the total distance to the exhaust register, the resulting travel time is 13.65 seconds. This is the longest time considered possible before the radiation detectors initiate an alarm signal to isolate…

Shearon Harris TS Limiting Condition for Operation (LCO) 3/4.9.12, “Fuel Handling Building Emergency Exhaust System,” requires two independent FHB emergency exhaust system trains to be operable. TS LCO 3.9.12 has a footnote that states, “The Fuel Handling Building Emergency Exhaust System boundary may be opened intermittently under administrative controls.” Section 50.36 of 10 CFR requires that the TSs be derived from the analyses and evaluation included in the safety analysis report.

The footnote to TS LCO 3/4.9.12 is not consistent with the licensing basis radiological consequence analysis of the postulated FHA in the FHB for Shearon Harris, which assumes the FHB emergency exhaust system is established with a negative internal pressure within 1 minute after occurrence of a FHA in the FHB. The footnote allows the FHB emergency exhaust system boundary to be open for an indefinite length of time, in addition to its unlimited use.

The NRC staff requests one of the following:

a. Provide a revised radiological consequence analysis of the FHA in the FHB that supports the FHB emergency exhaust system boundary being open for the duration of the event and has radiological dose results that meet the limits in 10 CFR 50.67 and General Design Criteria 19 of 10 CFR 50, Appendix A. In addition, provide the inputs, assumptions, methodology, and technical basis for the revised analysis.

b. Provide a proposed change to TS 3.9.12 that is consistent with the design basis as reflected in the Shearon Harris FSAR, Sections 15.7.4.2.2 and 6.5.1.2.1.

HNP Response to RAI #3:

In order to maintain operational flexibility as stated in TS LCO 3.9.12, including its footnote, a revised radiological consequence analysis of the FHA in the FHB has been performed that conservatively removes all filtration credit for the FHB emergency exhaust system. Tables 6 and 7, as provided in the original LAR, have been updated to reflect the revised radiological consequence analysis and are provided below. The methodology and technical basis for the revised analysis remain the same as discussed in Section 3.2 of the original LAR. The revised doses continue to satisfy the limits in 10 CFR 50.67 and 10 CFR 50, Appendix A, GDC 19. Control room parameters used in the FHA radiological analysis are provided below.

Control Room Parameters Used For FHA Radiological Analysis

Volume (ft^3)	71000
Normal Ventilation Flow Rates (cfm)	
Filtered Makeup Flow Rate	0
Filtered Recirculation Flow Rate	0
Unfiltered Makeup Flow Rate	1050
Unfiltered Inleakage	300
Post-Accident Recirculation Flow Rates (cfm)	
Filtered Makeup Flow Rate	0
Filtered Recirculation Flow Rate	4000
Unfiltered Inleakage	300
Pressurization Mode Flow Rates (cfm)	
Filtered Makeup Air Flow Rate	400
Filtered Recirculation Flow Rate	3600
Unfiltered Inleakage	300
Iodine Filter Efficiencies (%)	
Elemental	99
Organic	99
Particulate	99
CR Radiation Monitor Sensitivity (μCi/ml for Xe-133)	3.0E-6

CR Radiation Monitor Location	Emergency & Normal Air Intakes
Delay to Initiate Switchover to Post-Accident Recirculation HVAC mode after radiation signal (seconds)	15
Operator Action Time to Switch to Pressurization Mode (hours)	2
Breathing Rate for Duration of the Event (m^3/sec)	3.50E-4
Control Room Atmospheric Dispersion Factors (sec/m^3)	
0 - 8 hours	4.08E-3
8 - 24 hours	1.16E-3
1 - 4 days	3.25E-4
4 - 30 days	1.23E-5
Occupancy Factors	
0 - 24 hours	1.0
1 - 4 days	0.60
4 - 30 days	0.40

Table 6. HNP Fuel Handling Accident - Dose Consequence Analysis Inputs

Input or Assumption Description	Current Licensing Basis Value	Updated Value
Reactor power with uncertainty (MW)	2958	No change
Source Term (Ci)	**FSAR Tables 15.7.4-1 and 15.7.4-3**	**See Changes in Markups provided in Enclosure 2**
Number of fuel rods damaged	264 (Containment) or 314 + 52 BWR assemblies (Fuel Handling Bldg)	No change
Peaking factor	1.73 (PWR assemblies) and 1.50 (BWR assemblies)	No change
Decay time (hr)	100 hours (PWR assemblies) and 4 years (BWR assemblies)	No change
Number of high-burnup (> 54 GWD/MTU) rods that can exceed 6.3 kW/ft	**0**	**264 (Containment) or 314 (Fuel Handling Bldg)**
Kr-85 release fraction for high-burnup rods above 6.3 kW/ft	**Not permitted**	**0.30**
Control room volume (ft^3)	71,000	No change
Control room ventilation Iodine removal efficiencies (elemental, particulate, organic %)	(99, 99, 99)	No change
Control room ventilation unfiltered inleakage (cfm)	**500**	**300**
Fuel Pool Decontamination Factor - Iodine	200	No change
Fuel Pool Decontamination Factor - Noble Gases	1	No change
Depth of water above fuel inside Containment (ft)	22	No change
Depth of water above fuel inside Fuel Handling Building (ft)	21	No change
Duration of Release (hours)	2	No change
Fuel Handling Building Iodine filter efficiencies % (elemental, organic, particulate)	(95, 95, 95)	**No Filtration Assumed**
Containment Iodine filter efficiencies % (elemental, organic, particulate)	No Filtration Assumed	No change

Table 7. HNP Fuel Handling Accident Dose Consequences

Accident	Dose Results (Rem TEDE)		
	Current FSAR	**Updated Analysis**	Dose Acceptance Criteria (Rem TEDE)
Fuel Handling Accident -- Containment			
Exclusion Area Boundary (EAB)	2.03	**2.02**	6.3
Low Population Zone (LPZ)	0.46	**0.46**	6.3
Control Room	1.39	**0.88**	5.0
Fuel Handling Accident -- Fuel Handling Building			
Exclusion Area Boundary (EAB)	0.34	**2.42**	6.3
Low Population Zone (LPZ)	0.077	**0.55**	6.3
Control Room	0.12	**1.05**	5.0