DUANE ARNOLD

December 19, 2017

NG-17-0236

10 CFR 50.90

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

Duane Arnold Energy Center
Docket No. 50-331
Renewed Facility Operating License No. DPR-49

License Amendment Request (TSCR-179)

Application to Add Technical Specification 3.2.3, "Linear Heat Generation Rate"

Pursuant to 10 CFR 50.90, NextEra Energy Duane Arnold, LLC (NextEra) is submitting a request for an amendment to the Technical Specifications (TS) for the Duane Arnold Energy Center (DAEC). The proposed change adds TS 3.2.3, "Linear Heat Generation Rate (LHGR)," and modifies TS 1.1, "Definitions," TS 3.3.4.1, "End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation," TS 3.4.1, "Recirculation Loops Operating," TS 3.7.7, "The Main Turbine Bypass System," and TS 5.6.5, "Core Operating Limits Report (COLR)."

The Enclosure to this letter provides NextEra's evaluation of the proposed change. Attachment 1 to the enclosure provides markups of the TS showing the proposed changes, and Attachment 2 provides the clean TS pages containing the proposed TS changes. The changes to the TS Bases are provided for information in Attachment 3 and will be incorporated in accordance with the TS Bases Control Program upon implementation of the approved amendment.

NextEra requests approval of the proposed license amendment by December 31, 2018, and implementation within 90 days.

In accordance with 10 CFR 50.91, a copy of this application with enclosures is being provided to the designated State of Iowa official.

As discussed in the Enclosure, the proposed change does not involve a significant hazards consideration pursuant to 10 CFR 50.92, and there are no significant environmental impacts associated with the change. The DAEC Onsite Review Group has reviewed the proposed license amendment.

This letter contains no new or revised regulatory commitments.

If you have any questions or require additional information, please contact Michael Davis, Licensing Manager, at 319-851-7032.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on December 19, 2017

Dean Curtland
Site Director
NextEra Energy Duane Arnold, LLC

Enclosure

cc: Regional Administrator, USNRC, Region III,
Project Manager, USNRC, Duane Arnold Energy Center
Resident Inspector, USNRC, Duane Arnold Energy Center
A. Leek (State of Iowa)

# NEXTERA ENERGY DUANE ARNOLD, LLC
# DUANE ARNOLD ENERGY CENTER

## License Amendment Request (TSCR-179)

## Application to Add Technical Specification 3.2.3, "Linear Heat Generation Rate"

## EVALUATION OF PROPOSED CHANGE

## 1.0 SUMMARY DESCRIPTION

NextEra Energy Duane Arnold, LLC (NextEra) requests an amendment to the Duane Arnold Energy Center (DAEC) Technical Specifications (TS). The proposed change would separate the Linear Heat Generation Rate (LHGR) requirements and actions from the Average Planar Linear Heat Generation Rate (APLHGR) requirements and actions contained in TS 3.2.1. The proposed change adds TS 3.2.3, "Linear Heat Generation Rate (LHGR)," and modifies TS 1.1, "Definitions," TS 3.4.1, "Recirculation Loops Operating," and TS 5.6.5, "Core Operating Limits Report (COLR)" to reflect the LHGR change. Modifications associated with TS 3.2.1 and the new TS 3.2.3 are also being added to the actions for TS 3.3.4.1, "End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation," and TS 3.7.7, "The Main Turbine Bypass System."

## 2.0 DETAILED DESCRIPTION

### 2.1 Description of LHGR

The Linear Heat Generation Rate (LHGR) is a measure of the heat generation rate of a fuel rod in a fuel assembly at any axial location. Limits on LHGR are specified to ensure that fuel design limits are not exceeded anywhere in the core during normal operation, including anticipated operational occurrences. An LHGR limit represents a thermal mechanical performance limit for the primary fission product barrier. Exceeding the LHGR limit could potentially result in fuel damage and subsequent release of radioactive materials. Fuel design limits are specified to ensure that fuel system damage, fuel rod failure, or inability to cool the fuel does not occur during the anticipated operating conditions identified in the UFSAR.

### 2.2 Current TS Requirements

The Average Planar Linear Heat Generation Rate (APLHGR) is a measure of the LHGR, expressed in kW/ft, of all the fuel rods in a fuel assembly at any axial location. DAEC TS 3.2.1 places a limit on the APLHGR based on the Core Operating Limits Report (COLR) for the current reload cycle, and provides for required actions if that limit is not met. This limit is also referred to as the Maximum APLHGR (MAPLHGR).

The DAEC TS does not include a distinct TS for the LHGR. However, the requirements of TS 3.2.1 for APLHGR are also used to ensure that the limiting values of the LHGR are maintained or that required actions to return operation to within the LHGR limits are initiated. APLHGR and LHGR limits are both monitored by the core monitoring system at DAEC and included within the daily surveillances, with the actions of TS 3.2.1 applied to either limit.

The TS Bases for Section 3.2.1 describe the fuel design evaluations which take the operating limit LHGR value into consideration, and also the ECCS LOCA analyses performed to ensure the APLHGR limits that have been established are acceptable. The following two excerpts are from TS Bases Section 3.2.1:

*Fuel design evaluations are performed to demonstrate that the 1% limit on the fuel cladding plastic strain and other fuel design limits described in Reference 1 are not exceeded during Abnormal Operational Transients for operation with LHGRs up to the operating limit LHGR. [Reference 1 is NEDE-24011-P-A, "General Electric Standard Application for Reactor Fuel" (latest version)]*

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*LOCA analyses are then performed to ensure that the Maximum Average Planar LHGR (MAPLHGR) limits for the individual fuel type are adequate to meet the PCT* [Peak Cladding Temperature] *and maximum oxidation limits of 10 CFR 50.46.*

The current DAEC approach of addressing both APLHGR and LHGR via the same TS requirement is supported by the BWR/4 Standard Technical Specifications (Reference 1), which notes that inclusion of a distinct LHGR TS is optional.

In accordance with the approved NRC methodology in GESTAR II (Reference 2), different APLHGR and LHGR limits may be applicable under different operating conditions (e.g., all conditions in service, single loop operation, EOC-RPT out of service, or turbine bypass system out of service). The LCO for TS 3.4.1, "Recirculation Loops Operating," contains an action to apply different APLHGR limits when operating with one recirculation loop.

## 2.3 Reason for the Proposed Change

Early versions of core monitoring systems operated with core simulators containing limited models. One of those modeling limitations was the use of composite APLHGR limits, which were conservatively based on the ECCS LOCA APLHGR limits and the thermal mechanical LHGR limits used to protect the primary fission product barrier. This approach allowed the single APLHGR TS to meet the requirements for monitoring the APLHGR LOCA limits as well as the LHGR thermal mechanical limits of the cladding - thus having a combined TS was appropriate. However, modern modeling capabilities of core simulators have made this approach unnecessary.

Following the implementation of the General Electric PANAC11 code for fuel cycle reload analysis (Reference 3) within the industry, the APLHGR limits transitioned to be based solely on the ECCS LOCA analyses. LHGR limits, meanwhile, are determined by thermal mechanical analyses. Since the determination of these two limits (APLHGR, LHGR) is performed via independent analysis methods, and because improvement in modeling capabilities means their monitoring is also performed independently, it would be appropriate that each limit have a unique TS and TS LCO. The proposed change is an improvement from the current approach in that the TS will include separate descriptions, requirements and actions for the APLHGR and the LHGR. Additional TS which refer to the APLHGR TS 3.2.1 will also be modified to refer to both the APLHGR TS 3.2.1 and the (new) LHGR TS 3.2.3.

In addition, consistent with GESTAR II methodology (Reference 2), the LCOs for APLHGR and LHGR will be added to the LCO for 3.3.4.1, "End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation" and the LCO for TS 3.7.7, "Main Turbine Bypass System."

The proposed LHGR TS addition will not require any changes to the core monitoring system or the supporting data, as the limits are currently being monitored separately, but with the actions of TS 3.2.1 applied to either limit. The only alteration resulting from the proposed addition of the LHGR TS is the formatting of the TS to have the two limits and their requirements specified separately. The LCO requirements remain the same for both. The proposed change also requests the addition of the APLHGR and LHGR LCOs to the EOC-RPT Instrumentation and Main Turbine Bypass System LCOs. This action, as well, will not affect the core monitoring system or supporting data.

The proposed change will not require any changes beyond editorial to the cycle-specific COLR, as the APLHGR and LHGR limits are currently noted individually. The addition of the APLHGR and LHGR LCOs to the EOC-RPT Instrumentation and Main Turbine Bypass System LCOs will also not affect the COLR, as it currently includes all APLHGR and LHGR limits for all analyzed conditions, including single loop operation, EOC-RPT Instrumentation and Main Turbine Bypass System out of service.

## 2.4 Description of the Proposed Change

NextEra proposes the following changes to the DAEC TS (new information is shown in italics and deleted information contains a strikeout):

1. Revise TS 1.1, Definitions, to add LHGR.

| | |
|---|---|
| *LINEAR HEAT GENERATION RATE (LHGR)* | *The LHGR shall be the heat generation rate per unit length of fuel rod. It is the integral of the heat flux over the heat transfer area associated with the unit length.* |

2. Insert TS 3.2.3, LINEAR HEAT GENERATION RATE (LHGR).

*3.2.3 LINEAR HEAT GENERATION RATE (LHGR)*

*LCO 3.2.3* — *All LHGRs shall be less than or equal to the limits Specified in the COLR.*

*APPLICABILITY:* *THERMAL POWER ≥ 21.7% RTP.*

[continued]

*ACTIONS*

| *CONDITION* | | *REQUIRED ACTION* | *COMPLETION TIME* |
|---|---|---|---|
| *A.* | *Any LHGR not within limits* | *A.1 Restore LHGR(s) to within limits.* | *2 hours* |
| *B.* | *Required Action and associated Completion Time not met.* | *B.1 Reduce THERMAL POWER to < 21.7% RTP.* | *4 hours* |

*SURVEILLANCE REQUIREMENTS*

| *SURVEILLANCE* | | *FREQUENCY* |
|---|---|---|
| *SR 3.2.3.1* | *Verify all LHGRs are less than or equal to the limits specified in the COLR.* | *Once within 12 hours after ≥ 21.7% RTP*<br><br>*<u>AND</u>*<br><br>*In accordance with the Surveillance Frequency Control Program* |

3. Revise LCO 3.3.4.1, End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation, to add APLHGR and LHGR.

<u>OR</u>

b. *LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION (APLHGR),"* LCO 3.2.2 "MINIMUM CRITICAL POWER RATIO (MCPR)," *and LCO 3.2.3, "LINEAR HEAT GENERATION (LHGR),"* limits for inoperable EOC-RPT as specified in the COLR are made applicable.

[continued]

ACTIONS

| CONDITION | | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|---|
| A. | [Unchanged] | [Unchanged] | [Unchanged] |
| B. | One or more Functions with EOC-RPT trip capability not maintained.<br><br><u>AND</u><br><br>*APLHGR*, MCPR *and* *LHGR* limit*s* for inoperable EOC-RPT not made applicable. | B.1 Restore EOC-RPT Trip Capability<br><br><u>OR</u><br><br>B.2 Apply the *APLHGR*, MCPR and *LHGR* limit*s* as specified in the COLR. | 2 hours<br><br><br><br>2 hours |
| C. | [Unchanged] | [Unchanged] | [Unchanged] |

4. Revise TS 3.4.1, Recirculation Loops Operating to add LHGR.

   <u>OR</u>

   One recirculation loop may be in operation with core flow as a function of THERMAL POWER outside the Exclusion Region specified in the COLR and with the following limits applied when the associated LCO is applicable:

   a. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)," single loop operation limits specified in the COLR;

   b. LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," single loop operation limits specified in the COLR; and

   c. *LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR)," single loop operation limits specified in the COLR; and*

   ~~c~~.*d* LCO 3.3.1.1, "Reactor Protection System (RPS) Instrumentation," Function 2.b (Average Power Range Monitors Flow Biased High Scram), Allowable Value of Table 3.3.1.1-1 is reset for single loop operation.

5. Revise TS 3.7.7, The Main Turbine Bypass System to add APLHGR and LHGR.

<u>OR</u>

*a. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable;*

*b.* LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable, *and*

*c. LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable.*

6. Revise TS 5.6.5, CORE OPERATING LIMITS REPORT (COLR) to add LHGR.

5.6.5 CORE OPERATING LIMITS REPORT (COLR)

a. Core operating limits shall be established prior to each reload cycle, or prior to any remaining portion of a reload cycle, and shall be documented in the COLR for the following:

1. The Average Planar Linear Heat Generation Rate (APLHGR) for Specification 3.2.1;

2. The Minimum Critical Power Ration (MCPR) for Specification 3.2.2; ~~and~~

*3. The Linear Heat Generation Rate (LHGR) for Specification 3.2.3; and*

~~3.~~*4.* Exclusion Region in the Power/Flow Map for Specification 3.4.1

## 3.0 TECHNICAL EVALUATION

The analytical methods and assumptions used in evaluating the fuel design limits, Design Basis Accidents (DBAs), anticipated operational transients, and normal operation are from the GESTAR II methodology (Reference 2).

The fuel design bases for steady-state operation have been established to provide sufficient margin between the steady-state operating condition and any fuel damage condition to accommodate uncertainties and to assure that no fuel damage results even during the worst anticipated transient condition at any time in core life. The three parameters composing the fuel design limits are the minimum critical power ratio (MCPR), average planar linear heat generation rate (APLHGR), and the linear heat generation rate (LHGR). For purposes of maintaining adequate thermal margin during normal steady-state operation, the MCPR shall not be lower than the limiting values, whereas the APLHGR and LHGR shall not be greater than the limiting values.

Fuel design evaluations are performed to demonstrate that the 1% limit on the fuel cladding plastic strain and other fuel design limits described in Reference 2 are not exceeded during abnormal operational transients for operation with LHGRs up to the operating limit LHGR. These limits are developed for each bundle type in the core as a function of exposure and the various operating core flow and power states to ensure adherence to fuel design limits during the limiting abnormal operational transients. The LHGR limits are fuel design dependent and are explicitly modeled by the core monitoring system. The LHGR limits are specified in the COLR.

ECCS LOCA analyses are performed to ensure that the Average Planar LHGR (APLHGR) limits for the individual fuel type are adequate to meet the peak cladding temperature (PCT) and maximum oxidation limits of 10 CFR 50.46. The analyses are performed using calculational models that are consistent with the requirements of 10 CFR 50, Appendix K. The PCT following a postulated LOCA is a function of the average heat generation rate of all the rods of a fuel assembly at any axial location and is not strongly influenced by the rod to rod power distribution within an assembly. The APLHGR limits are assembly-type dependent and are explicitly modeled by the core monitoring system. The APLHGR limits are specified in the COLR.

The MCPR requirements and limitations are contained in TS 3.2.2. The APLHGR requirements and limitations are addressed via TS 3.2.1. TS 3.2.1 is also used to address the LHGR limits. The proposed change would separate the APLHGR and LHGR requirements and actions; TS 3.2.1 would remain for the APLHGR, and new TS 3.2.3 would be for the LHGR. The proposed change is in compliance with Code of Federal Regulations 10 CFR 50.36(c)(2)(ii)(B) Criterion 2.

The following proposed additions are being made based on the proposed change to specify both the APLHGR and LHGR LCOs separately. They are consistent with GESTAR II (Reference 2):

- LCO 3.2.3 (LHGR) to TS 3.4.1, Recirculation Loops Operating
- LHGR limits to TS 5.6.5, Core Operating Limits Report

The following proposed additions add the LCOs for APLHGR and LHGR to the LCO for 3.3.4.1, "End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation" and the LCO for TS 3.7.7, "Main Turbine Bypass System." The basis for these additions is that different APLHGR and LHGR limits may be applicable under different operating conditions. In these cases, it would be for the EOC-RPT instrumentation and the turbine bypass system being out of service, respectively. Placing the recognition of and response to changing APLHGR and LHGR limits within these LCOs is a beneficial practice. The changes reflect actions which are already occurring via the core monitoring processes in place. The additions are consistent with GESTAR II (Reference 2).

The proposed changes do not make any alterations to the fuel design limits or to the monitoring of the fuel design limits. No changes beyond editorial to the cycle-specific COLR will be required as it currently provides all APLHGR and LHGR limits.

Bases sections appropriate to the LHGR have been moved to the new 3.2.3 bases. In addition, the bases for the sections involved have been modified when appropriate to reflect the current state of reactor core analysis and monitoring.

## 4.0 REGULATORY EVALUATION

### 4.1 Applicable Regulatory Requirements/Criteria

- 10 CFR 50.36, Technical Specifications – requires that the TS contain limiting conditions for operation, which are the lowest functional capability or performance levels of equipment required for safe operation of the facility.

- NUREG-1433 Volume 1, Revision 4.0 – Standard Technical Specifications (Reference 1), include the LHGR as optional in Section 3.2.3.

The proposed changes are consistent with the above regulatory guidance and regulation.

### 4.2 Precedent

In July 2015, Nebraska Public Power District received approval to relocate the Linear Heat Generation Rate limits from the Technical Requirements Manual to Technical Specifications (Reference 4). That amendment is similar to the one proposed here in that the outcome is to separate APLHGR and LHGR TS.

### 4.3 No Significant Hazards Consideration

NextEra Energy Duane Arnold, LLC (NextEra) requests an amendment to the Duane Arnold Energy Center (DAEC) Technical Specifications (TS). The proposed change would separate the Linear Heat Generation Rate (LHGR) requirements and actions

from the Average Planar Linear Heat Generation Rate (APLHGR) requirements and actions contained in TS 3.2.1. The proposed change adds TS 3.2.3, "Linear Heat Generation Rate (LHGR)," and modifies TS 1.1, "Definitions," TS 3.4.1, "Recirculation Loops Operating," and TS 5.6.5, "Core Operating Limits Report (COLR)" to reflect the LHGR change. Modifications associated with TS 3.2.1 and the new TS 3.2.3 are also being added to the actions for TS 3.3.4.1, "End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation," and TS 3.7.7, "The Main Turbine Bypass System."

NextEra has evaluated the proposed change against the criteria of 10 CFR 50.92(c) to determine if the proposed change results in any significant hazards. The following is the evaluation of each of the 10 CFR 50.92(c) criteria:

1. Does the proposed change involve a significant increase in the probability or consequences of an accident previously evaluated?

   Response: No

   The separation of the LHGR requirements and actions from the APLHGR TS is an administrative change. No actions within the TS are changed. The addition of the LCO for APLHGR and the proposed LCO for LHGR to the LCO for 3.3.4.1, End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation and the LCO for TS 3.7.7, Main Turbine Bypass System reflect within the TS requirements APLHGR and LHGR actions which are already occurring via the core monitoring processes in place. None of those changes affect any plant systems, structures, or components designed for the prevention or mitigation of previously evaluated accidents. No new equipment is added nor is installed equipment being changed or operated in a different manner.

   LHGR limits have been defined to provide sufficient margin between the steady-state operating condition and any fuel damage condition to accommodate uncertainties and to assure that no fuel damage results even during the worst anticipated transient condition at any time.

   The proposed change does not modify the limits, change assumptions for the accident analysis, or change operation of the station. Therefore, the proposed change does not involve an increase in the probability or consequences of a previously evaluated accident.

2. Does the proposed change create the possibility of a new or different kind of accident from any accident previously evaluated?

   Response: No

   The separation of the LHGR requirements and actions from the APLHGR TS is an administrative change. No actions within the TS are changed. The addition of the

LCO for APLHGR and the proposed LCO for LHGR to the LCO for 3.3.4.1, End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation and the LCO for TS 3.7.7, Main Turbine Bypass System reflect within the TS requirements APLHGR and LHGR actions which are already occurring via the core monitoring processes in place. None of those changes affect any plant systems, structures, or components designed for the prevention or mitigation of previously evaluated accidents. No new equipment is added nor is installed equipment being changed or operated in a different manner.

The proposed change does not modify the limits, change assumptions for the accident analysis, or change operation of the station. Therefore, the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. Does the proposed change involve a significant reduction in a margin of safety?

   Response: No

   The margin of safety is not affected by the separation of the LHGR requirements and actions from the APLHGR TS. Similarly, the margin of safety is not affected by the addition of the LCO for APLHGR and the proposed LCO for LHGR to the LCO for 3.3.4.1, End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation and the LCO for TS 3.7.7, Main Turbine Bypass System.

   Appropriate measures exist to control the values of these limits since it is required by TS that only NRC-approved methods be used to determine the limits. The proposed change continues to require operation within the core thermal limits as obtained from NRC-approved reload design methodologies and the actions to be taken if a limit is exceeded remain unchanged, again, in accordance with existing TS.

   The proposed change does not modify the limits, change assumptions for the accident analysis, or change operation of the station. Therefore, the proposed change has no impact to the margin of safety.

Based on the above, NextEra concludes that the proposed change presents no significant hazards consideration under the standards set forth in 10 CFR 50.92, and, accordingly, a finding of "no significant hazards consideration" is justified.

## 4.4 Conclusions

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

## 5.0 ENVIRONMENTAL CONSIDERATIONS

A review has determined that the proposed amendment would change a requirement with respect to installation or use of a facility component located within the restricted area, as defined in 10 CFR 20, or would change an inspection or surveillance requirement. However, the proposed amendment does not involve (i) a significant hazards consideration, (ii) a significant change in the types or a significant increase in the amounts of any effluents that may be released offsite, or (iii) a significant increase in individual or cumulative occupational radiation exposure. Accordingly, the proposed amendment meets the eligibility criterion for categorical exclusion set forth in 10 CFR 51.22(c)(9). Therefore, pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the proposed amendment.

## 6.0 REFERENCES

1. NUREG-1433 Volume 1, Revision 4.0 – Standard Technical Specifications, General Electric BWR/4 Plants, April 2012.

2. Global Nuclear Fuels Topical Report NEDE-24011-P-A, (GESTAR II), Revision 24, March 2017.

3. Letter from Stuart A. Richards (NRC) to G. A. Watford (GE Nuclear Energy), "Amendment 26 to GE Licensing Topical Report NEDE-24011-P-A, "GESTAR II" - Implementing Improved GE Steady-State Methods (TAC No. MA6481)," November 10, 1999.

4. Letter from Siva P. Lingam (NRC) to Oscar A. Limpias (NPPD), "Cooper Nuclear Station – Issuance of Amendment RE: Move Linear Heat Generation Rate (LHGR) and Single Loop Operation LHGR Limits from Technical Requirements Manual to Technical Specifications (TAC NO. MF4485)," July 14, 2015 (ML15168A171).

## LIST OF ATTACHMENTS

Attachment 1 - Proposed Technical Specification Change (Mark-Up)

Attachment 2 - Revised Technical Specification Page

Attachment 3 - Proposed Technical Specification Bases Change (Mark-Up)

**ATTACHMENT 1**

Proposed Technical Specification Change (Mark-Up)

8 pages follow

(continued)

1.1 Definitions (continued)

| | |
|---|---|
| LEAKAGE | LEAKAGE shall be:<br>a. Identified LEAKAGE<br>1. LEAKAGE into the drywell, such as that from pump seals or valve packing, that is captured and conducted to a sump or collecting tank; or<br>2. LEAKAGE into the drywell atmosphere from sources that are both specifically located and known not to interfere with the operation of leakage detection systems;<br>b. Unidentified LEAKAGE<br>All LEAKAGE into the drywell that is not identified LEAKAGE;<br>c. Total LEAKAGE<br>Sum of the identified and unidentified LEAKAGE. |
| LOGIC SYSTEM FUNCTIONAL TEST | A LOGIC SYSTEM FUNCTIONAL TEST shall be a test of all logic components required for OPERABILITY of a logic circuit, from as close to the sensor as practicable up to, but not including, the actuated device, to verify OPERABILITY. The LOGIC SYSTEM FUNCTIONAL TEST may be performed by means of any series of sequential, overlapping, or total system steps so that the entire logic system is tested. |
| MINIMUM CRITICAL POWER RATIO (MCPR) | The MCPR shall be the smallest critical power ratio (CPR) that exists in the core for each class of fuel. The CPR is that power in the assembly that is calculated by application of the appropriate correlation(s) to cause some point in the assembly to experience transition boiling, divided by the actual assembly operating power. Transition boiling means the boiling regime between nucleate and film boiling. Transition boiling is the regime in which both nucleate and |
| LINEAR HEAT GENERATION RATE (LHGR) | The LHGR shall be the heat generation rate per unit length of fuel rod. It is the integral of the heat flux over the heat transfer area associated with the unit length. |

(continued)

## 3.2 POWER DISTRIBUTION LIMITS

### 3.2.3 LINEAR HEAT GENERATION RATE (LHGR)

LCO 3.2.3 All LHGRs shall be less than or equal to the limits specified in the COLR.

APPLICABILITY: THERMAL POWER $\geq$ 21.7% RTP.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. Any LHGR not within limits. | A.1 Restore LHGR(s) to within limits. | 2 hours |
| B. Required Action and associated Completion Time not met. | B.1 Reduce THERMAL POWER to < 21.7% RTP. | 4 hours |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.2.3.1 | Verify all LHGRs are less than or equal to the limits specified in the COLR. | Once within 12 hours after $\geq$ 21.7% RTP<br><br>AND<br><br>In accordance with the Surveillance Frequency Control Program |

## 3.3 INSTRUMENTATION

### 3.3.4.1 End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation

LCO 3.3.4.1

a. Two channels per trip system for each EOC-RPT instrumentation Function listed below shall be OPERABLE:

1. Turbine Stop Valve (TSV) – Closure; and

2. Turbine Control Valve (TCV) Fast Closure, Trip Oil Pressure-Low.

<u>OR</u>

b. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION (APLHGR)," LCO 3.2.2 "MINIMUM CRITICAL POWER RATIO (MCPR)," and LCO 3.2.3, "LINEAR HEAT GENERATION (LHGR)," limits for inoperable EOC-RPT as specified in the COLR ~~are~~ made applicable.

APPLICABILITY: THERMAL POWER ≥ 26% RTP.

ACTIONS

-----------------------------------------------------NOTE-----------------------------------------------------
Separate Condition entry is allowed for each channel.
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| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. One or more channels inoperable. | A.1 Restore channel to OPERABLE status.<br><br><u>OR</u><br><br>A.2 -----------NOTE------------<br>Not applicable if inoperable channel is the result of an inoperable breaker.<br>--------------------------------<br><br>Place channel in trip. | 72 hours<br><br><br><br><br><br><br>72 hours |

(continued)

ACTIONS (continued)

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| B. One or more Functions with EOC-RPT trip capability not maintained.<br><br>AND<br><br>~~MCPR limit~~ APLHGR, MCPR and LHGR limits for inoperable EOC-RPT not made applicable. | B.1 Restore EOC-RPT trip capability.<br><br>OR<br><br>B.2 Apply the ~~MCPR limit~~ APLHGR, MCPR and LHGR limits for inoperable EOC-RPT as specified in the COLR. | 2 hours<br><br><br><br>2 hours |
| C. Required Action and associated Completion Time not met. | C.1 Remove the associated recircluation pump from service.<br><br>OR<br><br>C.2 Reduce THERMAL POWER to < 26% RTP. | 4 hours<br><br><br><br>4 hours |

SURVEILLANCE REQUIREMENTS

-----------------------------------NOTE-----------------------------------
When a channel is placed in an inoperable status solely for performance of required Surveillances, entry into associated Conditions and Required Actions may be delayed for up to 6 hours provided the associated Function maintains EOC-RPT trip capability.
---------------------------------------------------------------------------

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.3.4.1.1 | Perform CHANNEL FUNCTIONAL TEST. | In accordance with the Surveillance Frequency Control Program |

(continued)

## 3.4 REACTOR COOLANT SYSTEM (RCS)

### 3.4.1 Recirculation Loops Operating

LCO 3.4.1 Two recirculation loops with matched pump speeds shall be in operation with core flow as a function of THERMAL POWER outside the Exclusion Region specified in the COLR.

OR

One recirculation loop may be in operation with core flow as a function of THERMAL POWER outside the Exclusion Region specified in the COLR and with the following limits applied when the associated LCO is applicable:

a. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)," single loop operation limits specified in the COLR;

b. LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," single loop operation limits specified in the COLR; ~~and~~

~~c.~~ d LCO 3.3.1.1, "Reactor Protection System (RPS) Instrumentation," Function 2.b (Average Power Range Monitors Flow Biased High Scram), Allowable Value of Table 3.3.1.1-1 is reset for single loop operation.

APPLICABILITY: MODES 1 and 2.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. No recirculation loops in operation. | A.1 Place the reactor mode switch in the Shutdown position. | Immediately |

(continued)

c. LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR)," single loop operation limits specified in the COLR; and

## 3.7 PLANT SYSTEMS

### 3.7.7 The Main Turbine Bypass System

LCO 3.7.7 The Main Turbine Bypass System shall be OPERABLE.

OR

b. LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable~~.~~; and

a. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable;

c. LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable.

APPLICABILITY: THERMAL POWER ≥ 21.7% RTP.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. Requirements of the LCO not met. | A.1 Satisfy the requirements of the LCO. | 2 hours |
| B. Required Action and associated Completion Time not met. | B.1 Reduce THERMAL POWER to < 21.7% RTP. | 4 hours |

5.6 Reporting Requirements (continued)

5.6.3 Radioactive Material Release Report

The Radioactive Material Release Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year in accordance with 10 CFR 50.36a. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The material provided shall be consistent with the objectives outlined in the ODAM and Process Control Program and in conformance with 10 CFR 50.36a and 10 CFR Part 50, Appendix I, Section IV.B.1.

5.6.4 DELETED

5.6.5 CORE OPERATING LIMITS REPORT (COLR)

a. Core operating limits shall be established prior to each reload cycle, or prior to any remaining portion of a reload cycle, and shall be documented in the COLR for the following:

1. The Average Planar Linear Heat Generation Rate (APLHGR) for Specification 3.2.1;

2. The Minimum Critical Power Ration (MCPR) for Specification 3.2.2; ~~and~~

3. The Linear Heat Generation Rate (LHGR) for Specification 3.2.3; and

4 → ~~3.~~ Exclusion Region in the Power/Flow Map for Specification 3.4.1.

b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC in General Electric Standard Application for Reactor Fuel, NEDE-24011-P-A, (GESTAR II). The revision number is the one approved at the time the reload fuel analyses are performed.

(continued)

# ATTACHMENT 2

Revised Technical Specification Pages

8 pages follow

(continued)

1.1 Definitions (continued)

| | |
|---|---|
| LEAKAGE | LEAKAGE shall be:<br>a. <u>Identified LEAKAGE</u><br>1. LEAKAGE into the drywell, such as that from pump seals or valve packing, that is captured and conducted to a sump or collecting tank; or<br>2. LEAKAGE into the drywell atmosphere from sources that are both specifically located and known not to interfere with the operation of leakage detection systems;<br>b. <u>Unidentified LEAKAGE</u><br>All LEAKAGE into the drywell that is not identified LEAKAGE;<br>c. <u>Total LEAKAGE</u><br>Sum of the identified and unidentified LEAKAGE. |
| LINEAR HEAT GENERATION RATE (LHGR) | The LHGR shall be the heat generation rate per unit length of fuel rod. It is the integral of the heat flux over the heat transfer area associated with the unit length. |
| LOGIC SYSTEM FUNCTIONAL TEST | A LOGIC SYSTEM FUNCTIONAL TEST shall be a test of all logic components required for OPERABILITY of a logic circuit, from as close to the sensor as practicable up to, but not including, the actuated device, to verify OPERABILITY. The LOGIC SYSTEM FUNCTIONAL TEST may be performed by means of any series of sequential, overlapping, or total system steps so that the entire logic system is tested. |
| MINIMUM CRITICAL POWER RATIO (MCPR) | The MCPR shall be the smallest critical power ratio (CPR) that exists in the core for each class of fuel. The CPR is that power in the assembly that is calculated by application of the appropriate correlation(s) to cause some point in the assembly to experience transition boiling, divided by the actual assembly operating power. Transition boiling means the boiling regime between nucleate and film boiling. Transition boiling is the regime in which both nucleate and |

(continued)

## 3.2 POWER DISTRIBUTION LIMITS

### 3.2.3 LINEAR HEAT GENERATION RATE (LHGR)

LCO 3.2.3 All LHGRs shall be less than or equal to the limits specified in the COLR.

APPLICABILITY: THERMAL POWER ≥ 21.7% RTP.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. Any LHGR not within limits. | A.1 Restore LHGR(s) to within limits. | 2 hours |
| B. Required Action and associated Completion Time not met. | B.1 Reduce THERMAL POWER to < 21.7% RTP. | 4 hours |

SURVEILLANCE REQUIREMENTS

| SURVEILLANCE | | FREQUENCY |
|---|---|---|
| SR 3.2.3.1 | Verify all LHGRs are less than or equal to the limits specified in the COLR. | Once within 12 hours after ≥ 21.7% RTP<br><br>AND<br><br>In accordance with the Surveillance Frequency Control Program |

## 3.3 INSTRUMENTATION

### 3.3.4.1 End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation

LCO 3.3.4.1

a. Two channels per trip system for each EOC-RPT instrumentation Function listed below shall be OPERABLE:

1. Turbine Stop Valve (TSV) – Closure; and
2. Turbine Control Valve (TCV) Fast Closure, Trip Oil Pressure-Low.

OR

b. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION (APLHGR)," LCO 3.2.2 "MINIMUM CRITICAL POWER RATIO (MCPR)," and LCO 3.2.3, "LINEAR HEAT GENERATION (LHGR)," limits for inoperable EOC-RPT as specified in the COLR are made applicable.

APPLICABILITY: THERMAL POWER ≥ 26% RTP.

ACTIONS

-----------------------------------------------------NOTE-----------------------------------------------------
Separate Condition entry is allowed for each channel.
----------------------------------------------------------------------------------------------------------------

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. One or more channels inoperable. | A.1 Restore channel to OPERABLE status. | 72 hours |
| | OR | |
| | A.2 -----------NOTE------------ Not applicable if inoperable channel is the result of an inoperable breaker. ------------------------------- Place channel in trip. | 72 hours |

(continued)

ACTIONS (continued)

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| B. One or more Functions with EOC-RPT trip capability not maintained.<br><br>AND<br><br>APLHGR, MCPR and LHGR limits for inoperable EOC-RPT not made applicable. | B.1 Restore EOC-RPT trip capability.<br><br>OR<br><br>B.2 Apply the APLHGR, MCPR and LHGR limits for inoperable EOC-RPT as specified in the COLR. | 2 hours<br><br><br><br>2 hours |
| C. Required Action and associated Completion Time not met. | C.1 Remove the associated recircluation pump from service.<br><br>OR<br><br>C.2 Reduce THERMAL POWER to < 26% RTP. | 4 hours<br><br><br><br>4 hours |

SURVEILLANCE REQUIREMENTS

-----NOTE-----
When a channel is placed in an inoperable status solely for performance of required Surveillances, entry into associated Conditions and Required Actions may be delayed for up to 6 hours provided the associated Function maintains EOC-RPT trip capability.
---------------

| SURVEILLANCE | FREQUENCY |
|---|---|
| SR 3.3.4.1.1 Perform CHANNEL FUNCTIONAL TEST. | In accordance with the Surveillance Frequency Control Program |

(continued)

## 3.4 REACTOR COOLANT SYSTEM (RCS)

### 3.4.1 Recirculation Loops Operating

LCO 3.4.1 Two recirculation loops with matched pump speeds shall be in operation with core flow as a function of THERMAL POWER outside the Exclusion Region specified in the COLR.

OR

One recirculation loop may be in operation with core flow as a function of THERMAL POWER outside the Exclusion Region specified in the COLR and with the following limits applied when the associated LCO is applicable:

a. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)," single loop operation limits specified in the COLR;

b. LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," single loop operation limits specified in the COLR;

c. LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR)," single loop operation limits specified in the COLR; and

d. LCO 3.3.1.1, "Reactor Protection System (RPS) Instrumentation," Function 2.b (Average Power Range Monitors Flow Biased High Scram), Allowable Value of Table 3.3.1.1-1 is reset for single loop operation.

APPLICABILITY: MODES 1 and 2.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. No recirculation loops in operation. | A.1 Place the reactor mode switch in the Shutdown position. | Immediately |

(continued)

## 3.7 PLANT SYSTEMS

### 3.7.7 The Main Turbine Bypass System

LCO 3.7.7 The Main Turbine Bypass System shall be OPERABLE.

OR

a. LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable;

b. LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable; and

c. LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR)," limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are made applicable.

APPLICABILITY: THERMAL POWER $\geq$ 21.7% RTP.

ACTIONS

| CONDITION | REQUIRED ACTION | COMPLETION TIME |
|---|---|---|
| A. Requirements of the LCO not met. | A.1 Satisfy the requirements of the LCO. | 2 hours |
| B. Required Action and associated Completion Time not met. | B.1 Reduce THERMAL POWER to < 21.7% RTP. | 4 hours |

5.6 Reporting Requirements (continued)

5.6.3 Radioactive Material Release Report

The Radioactive Material Release Report covering the operation of the unit during the previous calendar year shall be submitted prior to May 1 of each year in accordance with 10 CFR 50.36a. The report shall include a summary of the quantities of radioactive liquid and gaseous effluents and solid waste released from the unit. The material provided shall be consistent with the objectives outlined in the ODAM and Process Control Program and in conformance with 10 CFR 50.36a and 10 CFR Part 50, Appendix I, Section IV.B.1.

5.6.4 DELETED

5.6.5 CORE OPERATING LIMITS REPORT (COLR)

a. Core operating limits shall be established prior to each reload cycle, or prior to any remaining portion of a reload cycle, and shall be documented in the COLR for the following:

1. The Average Planar Linear Heat Generation Rate (APLHGR) for Specification 3.2.1;

2. The Minimum Critical Power Ration (MCPR) for Specification 3.2.2;

3. The Linear Heat Generation (LHGR) for Specification 3.2.3; and

4. Exclusion Region in the Power/Flow Map for Specification 3.4.1.

b. The analytical methods used to determine the core operating limits shall be those previously reviewed and approved by the NRC in General Electric Standard Application for Reactor Fuel, NEDE-24011-P-A, (GESTAR II). The revision number is the one approved at the time the reload fuel analyses are performed.

(continued)

# ATTACHMENT 3

Proposed Technical Specification Bases Change (Mark-Up)

28 pages follow

TABLE OF CONTENTS



(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

assurance that the assumptions for scram reactivity in the DBA and transient analyses are not violated. Since the SDM ensures the reactor will be subcritical with the highest worth control rod withdrawn (assumed single failure), the additional failure of a second control rod to insert, if required, could invalidate the demonstrated SDM and potentially limit the ability of the CRD System to hold the reactor subcritical. If the control rod is stuck at an inserted position and becomes decoupled from the CRD, a control rod drop accident (CRDA) can possibly occur. Therefore, the requirement that all control rods be OPERABLE ensures the CRD System can perform its intended function.

The control rods also protect the fuel from damage which could result in release of radioactivity. The limits protected are the MCPR Safety Limit (SL) (see Bases for SL 2.1.1, "Reactor Core SLs," and LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)"), and the 1% cladding plastic strain fuel design limit (see Bases for LCO ~~3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR~~)"), and the fuel damage limit (see Bases for LCO 3.1.6, "Rod Pattern Control") during reactivity insertion events.

3.2.3, "LINEAR HEAT GENERATION RATE (LHGR →

The negative reactivity insertion (scram) provided by the CRD System provides the analytical basis for determination of plant thermal limits and provides protection against fuel damage limits during a CRDA. The Bases for LCO 3.1.4, LCO 3.1.5, and LCO 3.1.6 discuss in more detail how the SLs are protected by the CRD System.

Control rod OPERABILITY satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

The OPERABILITY of an individual control rod is based on a combination of factors, primarily, the scram insertion times, the control rod coupling integrity, and the ability to determine the control rod position. Accumulator OPERABILITY is addressed by LCO 3.1.5. The associated scram accumulator status for a control rod only affects the scram insertion times; therefore, an inoperable accumulator does not immediately require declaring

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

The scram function of the CRD System protects the MCPR Safety Limit (SL) (see Bases for SL 2.1.1, "Reactor Core SLs," and LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)") and the 1% cladding plastic strain fuel design limit (see Bases for LCO ~~3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR~~ 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR)"), which ensure that no fuel damage will occur if these limits are not exceeded. Above 800 psig, the scram function is designed to insert negative reactivity at a rate fast enough to prevent the actual MCPR from becoming less than the MCPR SL, during the analyzed limiting power transient. Below 800 psig, the scram function is assumed to perform during the control rod drop accident (Ref. 5) and, therefore, also provides protection against violating fuel damage limits during reactivity insertion accidents (see Bases for LCO 3.1.6, "Rod Pattern Control"). For the reactor vessel overpressure protection analysis (Ref. 3), the scram function, along with the safety/relief valves, ensure that the peak vessel pressure is maintained within the applicable ASME Code limits.

Control rod scram times satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii).

LCO

The scram times specified in Table 3.1.4-1 are required to ensure that the scram reactivity assumed in the DBA and transient analysis is met (Ref. 6). To account for single failures and "slow" scramming control rods, the scram times specified in Table 3.1.4-1 are faster than those assumed in the design basis analysis. The scram times have a margin that allows up to approximately 7% of the control rods (e.g., 89 x 7% ≈ 6) to have scram times exceeding the specified limits (i.e., "slow" control rods) assuming a single stuck control rod (as allowed by LCO 3.1.3, "Control Rod OPERABILITY") and an additional control rod failing to scram per the single failure criterion. The scram times are specified as a function of reactor steam dome pressure to account for the pressure dependence of the scram times. The scram times are specified relative to measurements based on reed switch positions, which provide the control rod position indication. The reed switch closes ("pickup") when the index tube passes a specific location and then opens ("dropout") as the index tube travels upward. Verification of the specified scram times in Table 3.1.4-1 is accomplished through

(continued)

B 3.1 REACTIVITY CONTROL SYSTEMS

B 3.1.5 Control Rod Scram Accumulators

BASES

BACKGROUND

The control rod scram accumulators are part of the Control Rod Drive (CRD) System and are provided to ensure that the control rods scram under varying reactor conditions. The control rod scram accumulators store sufficient energy to fully insert a control rod at any reactor vessel pressure. The accumulator is a hydraulic cylinder with a free floating piston. The piston separates the water used to scram the control rods from the nitrogen, which provides the required energy. The scram accumulators are necessary to scram the control rods within the required insertion times of LCO 3.1.4, "Control Rod Scram Times."

APPLICABLE SAFETY ANALYSES

The analytical methods and assumptions used in evaluating the control rod scram function are presented in References 1, 2, and 3. The Design Basis Accident (DBA) and transient analyses assume that all of the control rods scram at a specified insertion rate. OPERABILITY of each individual control rod scram accumulator, along with LCO 3.1.3, "Control Rod OPERABILITY," and LCO 3.1.4, ensures that the scram reactivity assumed in the DBA and transient analyses can be met. The existence of an inoperable accumulator may invalidate prior scram time measurements for the associated control rod.

3.2.3, "LINEAR HEAT GENERATION RATE →

The scram function of the CRD System, and therefore the OPERABILITY of the accumulators, protects the MCPR Safety Limit (see Bases for SL 2.1.1, "Reactor Core SLs," and LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)") and 1% cladding plastic strain fuel design limit (see Bases for LCO ~~3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR~~)," which ensure that no fuel damage will occur if these limits are not exceeded (see Bases for LCO 3.1.4). In addition, the scram function at low reactor vessel pressure (i.e., startup conditions) provides protection against violating fuel design limits during reactivity insertion accidents (see Bases for LCO 3.1.6, "Rod Pattern Control").

Control Rod Scram Accumulators satisfy Criterion 3 of 10 CFR 50.36(c)(2)(ii).

(continued)

# B 3.2 POWER DISTRIBUTION LIMITS

## B 3.2.1 AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)

BASES

**BACKGROUND**

The APLHGR is a measure of the Linear Heat Generation Rate (LHGR), expressed in kW/ft, of all the fuel rods in a fuel assembly at any axial location. APLHGR ~~has two key components:~~ limits ~~on the APLHGR~~ are specified to ensure that the ~~fuel design limits identified in Reference 1 are not exceeded during Abnormal Operational Transients; and, also to assure that the~~ Peak Cladding Temperature (PCT) during the postulated design basis Loss Of Coolant Accident (LOCA) does not exceed the limits specified in 10 CFR 50.46.

**APPLICABLE SAFETY ANALYSES**

~~The analytical methods and assumptions used in evaluating the fuel design limits are presented in References 1 and 2.~~ The analytical methods and assumptions used in evaluating Design Basis Accidents (DBAs), anticipated operational transients, and normal operation that determine the APLHGR limits are presented in References 1, 2, 3, 4 and 5.

~~Fuel design evaluations are performed to demonstrate that the 1% limit on the fuel cladding plastic strain and other fuel design limits described in Reference 1 are not exceeded during Abnormal Operational Transients for operation with LHGRs up to the operating limit LHGR. The Maximum LHGR (MLHGR) is the highest surface heat flux on the fuel rod at a given nodal plane in the bundle. These limits are developed for each bundle type in the core as a function of exposure and the various operating core flow and power states to ensure adherence to fuel design limits during the limiting Abnormal Operational Transients (Refs. 1, and 5). The actual MLHGR values for the GE fuel design are lattice type dependent and, with the introduction of advanced modeling capabilities (Ref. 9), are explicitly modeled by the plant process computer. The lattice type dependent values can be found in Reference 8.~~

~~Flow dependent MLHGR limits are determined using the three dimensional BWR simulator code (Ref. 6) to analyze slow flow runout transients. The flow dependent multiplier, $LHGRFAC_f$, is dependent on the maximum core flow runout capability.~~

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

~~The maximum runout flow is dependent on the existing setting of the core flow limiter in the Recirculation System.~~

~~Based on analyses of limiting plant transients (other than core flow increases) over a range of power and flow conditions, power dependent multipliers, $LHGRFAC_p$, are also generated. Due to the sensitivity of the transient response to initial core flow levels at power levels below those at which turbine stop valve closure and turbine control valve fast closure scram trips are bypassed (approximately 26% RTP), both high and low core flow $LHGRFAC_p$ limits are provided for operation at power levels between 21.7% RTP and the previously mentioned bypass power level (26% RTP). The exposure dependent MLHGR limits are reduced by $LHGRFAC_p$ and $LHGRFAC_f$ at various operating conditions to ensure that all fuel design criteria are met for normal operation and Abnormal Operational Transients (Ref. 5). A complete discussion of the analysis code is provided in Reference 7.~~

LOCA analyses are ~~then~~ performed to ensure that the Maximum Average Planar LHGR (MAPLHGR) limits for the individual fuel type are adequate to meet the PCT and maximum oxidation limits of 10 CFR 50.46. The analysis is performed using calculational models that are consistent with the requirements of 10 CFR 50, Appendix K. A complete discussion of the analysis is provided in Reference 3. The PCT following a postulated LOCA is a function of the average heat generation rate of all the rods of a fuel assembly at any axial location and is not strongly influenced by the rod to rod power distribution within an assembly. ~~The MAPLHGR limits specified in the COLR are equivalent to the LHGR of the highest powered fuel rod assumed in the LOCA analysis divided by its local peaking factor. A conservative multiplier is applied to the LHGR assumed in the LOCA analysis to account for the uncertainty associated with the measurement of the MAPLHGR.~~

For single recirculation loop operation, a multiplier is applied to ~~both~~ the MAPLHGR ~~and LHGR~~ limits due to the conservative analysis assumption of an earlier departure from nucleate boiling with one recirculation loop available, resulting in a more severe cladding heatup during a LOCA (Ref. 5). For operation at off-rated conditions, power- and flow-dependent multipliers, $MAPFAC_p$ and $MAPFAC_f$ are applied to the MAPLHGR limits to ensure that the rated power/flow MAPLHGR limits

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

are bounding for operation throughout the allowable operating domain.

The APLHGR satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The APLHGR limits specified in the COLR are the result of the fuel design~~,~~ and DBA~~, and transient analyses~~. For two recirculation loops operating, the APLHGR limit for each fuel type is determined by ~~the more limiting value of either: the smaller of the $LHGRFAC_p$ and $LHGRFAC_f$ factors times the exposure-dependent MLHGR limits or,~~ the smaller of the $MAPFAC_p$ and $MAPFAC_f$ factors times the exposure-dependent MAPLHGR value. With only one recirculation loop in operation, in conformance with the requirements of LCO 3.4.1, "Recirculation Loops Operating", the APLGHR limit for each fuel type is determined by the more-limiting value of either: ~~the exposure dependent MLHGR limit times the smaller of either $LHGRFAC_p$ or $LHGRFAC_f$, or,~~ a specific single recirculation loop multiplier, found in the COLR, times the exposure-dependent MAPLHGR value or, the smaller of either $MAPFAC_p$ or $MAPFAC_f$ times the exposure dependent MAPLHGR value (Ref. 5).

APPLICABILITY

The APLHGR limits are primarily derived from fuel design evaluations and LOCA ~~and transient~~ analyses that are assumed to occur at high power levels. Design calculations (Ref. 1) and operating experience have shown that as power is reduced, the margin to the required APLHGR limits increases. This trend continues down to the power range of 5% to 15% RTP when entry into MODE 2 occurs. When in MODE 2, the intermediate range monitor scram function, in addition to the average power range monitor scram in Startup, provides prompt scram initiation during any significant transient, thereby effectively removing any APLHGR limit compliance concern in MODE 2. Therefore, at THERMAL POWER levels ≤ 21.7% RTP, the reactor is operating with substantial margin to the APLHGR limits; thus, this LCO is not required.

(continued)

BASES (continued)

REFERENCES

1. NEDE-24011-P-A "General Electric Standard Application for Reactor Fuel" (latest approved version).
2. UFSAR, Section 15.0.
3. UFSAR, Section 15.2.1.
4. ~~NEDC 32980P, "Safety Analysis Report for Duane Arnold Energy Center Extended Power Uprate," Rev. 1, April 2001.~~ 0000-0133-6901-R0, "Duane Arnold Energy Center GNF2 ECCS-LOCA Evaluation," August 2012.
5. "Supplemental Reload Licensing Report for Duane Arnold Energy Center," (latest version referenced in COLR).
6. ~~NEDO 30130 A, "Steady State Nuclear Methods," May 1985.~~
7. ~~NEDO 24154, "Qualification of the One Dimensional Core Transient Model for Boiling Water Reactors," October 1978.~~
8. ~~NEDE 31152P, "GE Fuel Bundle Designs", (latest version referenced in COLR).~~
9. ~~NEDE 24011 P A, "General Electric Standard Application for Reactor Fuel," Rev. 14 , June 2000.~~

# B 3.2 POWER DISTRIBUTION LIMITS

## B 3.2.3 LINEAR HEAT GENERATION RATE (LHGR)

BASES

**BACKGROUND**

The LHGR is a measure of the heat generation rate, expressed in kW/ft, of a fuel rod in a fuel assembly at any axial location. Limits on LHGR are specified to ensure that fuel design limits are not exceeded anywhere in the core during normal operation, including anticipated operational occurrences (AOOs). Exceeding the LHGR limit could potentially result in fuel damage and subsequent release of radioactive materials. Fuel design limits are specified to ensure that fuel system damage, fuel rod failure, or inability to cool the fuel does not occur during the anticipated operating conditions identified in References 1 and 2.

**APPLICABLE SAFETY ANALYSES**

The analytical methods and assumptions used in evaluating the fuel design limits, AOOs and normal operation that determine the LHGR limits are presented in References 1, 2 and 3.

Fuel design evaluations are performed to demonstrate that the 1% limit on the fuel cladding plastic strain and other fuel design limits described in Reference 1 are not exceeded during AOOs for operation with LHGRs up to the operating limit LHGR. The Maximum LHGR (MLHGR) is the highest surface heat flux on the fuel rod at a given nodal plane in the bundle. These limits are developed for each bundle type in the core as a function of exposure and the various operating core flow and power states to ensure adherence to fuel design limits during the limiting AOOs. The actual MLHGR values for the GE fuel design are lattice-type dependent and are explicitly modeled by the plant process computer.

Flow dependent LHGR limits are determined using the three dimensional BWR simulator code to analyze slow flow runout transients. The flow dependent multiplier, $LHGRFAC_f$, is dependent on the maximum core flow runout capability. The maximum runout flow is dependent on the existing setting of the core flow limiter in the Recirculation System.

(continued)

BASES (continued)

APPLICABLE SAFETY ANALYSES (continued)

Based on analyses of limiting plant transients (other than core flow increases) over a range of power and flow conditions, power dependent multipliers, $LHGRFAC_p$, are also generated. Due to the sensitivity of the transient response to initial core flow levels at power levels below those at which turbine stop valve closure and turbine control valve fast closure scram trips are bypassed (approximately 26% RTP), both high and low core flow $LHGRFAC_p$ limits are provided for operation at power levels between 21.7% RTP and the previously mentioned bypass power level (26% RTP). The exposure dependent LHGR limits are reduced by $LHGRFAC_p$ and $LHGRFAC_f$ at various operating conditions to ensure that all fuel design criteria are met for normal operation and AOOs.

For single recirculation loop operation, a multiplier is applied to the LHGR limits due to the conservative analysis assumption of an earlier departure from nucleate boiling with one recirculation loop available, resulting in a more severe cladding heatup during a LOCA.

The LHGR satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The LHGR is a basic assumption in the fuel design analysis. The fuel has been designed to operate at rated core power with sufficient design margin to the LHGR limit calculated to cause a 1% fuel cladding plastic strain. The LHGR limits specified in the COLR are the result of the fuel design and transient analyses. For two recirculation loops operating, the LHGR limit is determined by multiplying the smaller of the $LHGRFAC_p$ and $LHGRFAC_f$ factors times the exposure dependent LHGR limits. With only one recirculation loop in operation, in conformance with the requirements of LCO 3.4.1, "Recirculation Loops Operating", the LGHR limit is determined by the more-limiting value of either: the exposure dependent MLHGR limit times the smaller of either $LHGRFAC_p$ or $LHGRFAC_f$, or, a specific single recirculation loop multiplier, found in the COLR, times the exposure-dependent LHGR value.

(continued)

BASES (continued)

APPLICABILITY

The LHGR limits are derived from fuel design analyses that are limiting at high power level conditions. At THERMAL POWER levels ≤ 21.7% RTP, the reactor is operating with substantial margin to the LHGR limits; thus, this LCO is not required.

ACTIONS

A.1

If any LHGR exceeds the required limit, an assumption regarding an initial condition of the fuel design analysis is not met. Therefore, prompt action should be taken to restore the LHGRs to within the required limits such that the plant operates within analyzed conditions and within the design limits of the fuel rods. The 2 hour Completion Time is normally sufficient to restore the LHGRs to within its limits and is acceptable based on the low probability of a transient or DBA occurring simultaneously with the LHGR out of specification.

B.1

If the LHGR cannot be restored to within its required limits within the associated Completion Time, the plant must be brought to a MODE or other specified condition in which the LCO does not apply. To achieve this status, THERMAL POWER must be reduced to < 21.7% RTP within 4 hours. The allowed Completion Time is reasonable, based on operating experience, to reduce THERMAL POWER to < 21.7% RTP in an orderly manner and without challenging plant systems because in general, a power reduction from full power would normally have already been initiated as part of Required Action A.1.

SURVEILLANCE REQUIREMENTS

SR 3.2.3.1

The LHGR is required to be initially calculated within 12 hours after THERMAL POWER is ≥ 21.7% RTP and then periodically thereafter. It is compared to the specified limits in the COLR to ensure that the reactor is operating within the assumptions of the safety analysis. The Surveillance Frequency is controlled under the Surveillance Frequency Control Program. The frequency is based on both engineering judgment and recognition of the slowness of changes in power distribution during normal operation. The 12 hour allowance after THERMAL POWER ≥ 21.7% RTP is achieved is acceptable given the large inherent margin to operating limits at low power levels.

(continued)

BASES (continued)

REFERENCES

1. NEDE-24011-P-A "General Electric Standard Application for Reactor Fuel" (latest approved version).

2. UFSAR, Section 15.0.

3. "Supplemental Reload Licensing Report for Duane Arnold Energy Center," (latest version referenced in COLR).

BASES

SURVEILLANCE REQUIREMENTS

SR 3.3.1.1.1 (continued)

during normal operational use of the displays associated with the channels required by the LCO.

SR 3.3.1.1.2

To ensure that the APRMs are accurately indicating the true core average power, the APRMs are calibrated to the reactor power calculated from a heat balance. LCO 3.4.1, "Recirculation Loops Operating," allows the APRMs to be reading greater than actual THERMAL POWER to effectively lower the APRM Flow Biased High setpoints by 6.3% for single recirculation loop operation. When this adjustment is made, the requirement for the APRMs to indicate within 2% RTP of calculated power is modified to require the APRMs to indicate within 2% RTP of calculated power plus 6.3%. The Surveillance Frequency is controlled under the Surveillance Frequency Control Program. The Frequency is based on minor changes in LPRM sensitivity, which could affect the APRM reading between performances of SR 3.3.1.1.8.

A restriction to satisfying this SR when < 21.7% RTP is provided that requires the SR to be met only at ≥ 21.7% RTP because it is difficult to accurately maintain APRM indication of core THERMAL POWER consistent with a heat balance when < 21.7% RTP. At low power levels, a high degree of accuracy is unnecessary because of the large, inherent margin to thermal limits (MCPR, LHGR, and APLHGR). At ≥ 21.7% RTP, the Surveillance is required to have been satisfactorily performed within the previous Frequency, in accordance with SR 3.0.2. A Note is provided which allows an increase in THERMAL POWER above 21.7% if the Frequency is not met per SR 3.0.2. In this event, the SR must be performed within 12 hours after reaching or exceeding 21.7% RTP. Twelve hours is based on operating experience and in consideration of providing a reasonable time in which to complete the SR.

SR 3.3.1.1.3

There are four pairs of RPS automatic scram contactors (i.e., K14 relay contacts) with each pair associated with an automatic scram logic (A1, A2, B1, and B2). The automatic scram contactors can be functionally tested without the necessity of using an automatic scram

(continued)

B 3.3 INSTRUMENTATION

B 3.3.4.1 End of Cycle Recirculation Pump Trip (EOC-RPT) Instrumentation

BASES

and fuel design limits

BACKGROUND

The EOC-RPT instrumentation initiates a Recirculation Pump Trip (RPT) to reduce the peak reactor pressure and power resulting from turbine trip or generator load rejection transients to provide additional margin to core thermal MCPR Safety Limits (SLs).

The need for the additional negative reactivity in excess of that normally inserted on a scram reflects end of cycle reactivity considerations. The scram reactivity depends on the ability of the control rods to be in the high flux regions of the core. The minimum scram reactivity occurs at the end of cycle when control rods are fully withdrawn from the core. In this situation, it takes a longer time for the control rods to travel to a high importance region in the core. For this reason at the end of cycle the control rods may not be able to ensure that thermal limits are maintained by inserting sufficient negative reactivity during the first few feet of rod travel upon a scram caused by Turbine Control Valve (TCV) Fast Closure, Trip Oil Pressure — Low or Turbine Stop Valve (TSV) — Closure. The physical phenomenon involved is that the positive reactivity feedback due to a pressurization transient (i.e., void collapse) can add positive reactivity at a faster rate than the control rods can add negative reactivity.

The EOC-RPT instrumentation, is composed of sensors that detect initiation of closure of the TSVs or fast closure of the TCVs, combined with relays, logic circuits, and fast acting circuit breakers that interrupt power from the recirculation pump Motor Generator (MG) set generators to each of the recirculation pump motors. The channels include electronic equipment (e.g., limit switches or pressure switches) that compares measured input signals with pre-established setpoints. When the setpoint is exceeded, the channel output relay actuates, which then outputs an EOC-RPT signal to the trip logic. When the RPT breakers trip open, the recirculation pumps coast down under their own inertia. The EOC-RPT has two identical trip systems, either of which can actuate an RPT in both recirculation loops.

(continued)

BASES

BACKGROUND (continued)

Each EOC-RPT trip system is a two-out-of-two logic for each Function; thus, either two TSV — Closure or two TCV Fast Closure, Trip Oil Pressure — Low signals are required for a trip system to actuate. If either trip system actuates, both recirculation pumps will trip. There are two EOC-RPT breakers in series per recirculation pump. One trip system trips one of the two EOC-RPT breakers for each recirculation pump, and the second trip system trips the other EOC-RPT breaker for each recirculation pump.

and protect fuel design limits

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY

The TSV — Closure and the TCV Fast Closure, Trip Oil Pressure — Low Functions are designed to trip the recirculation pumps in the event of a turbine trip or generator load rejection to mitigate the neutron flux, heat flux, and pressurization transients, and to increase the margin to the MCPR SL. The analytical methods and assumptions used in evaluating the turbine trip and generator load rejection, as well as other safety analyses that ensure EOC-RPT, are summarized in References 1, 2, and 3.

APLHGR, MCPR and LHGR

and other fuel design limits

To mitigate pressurization transient effects, the EOC-RPT must trip the recirculation pumps after initiation of closure movement of either the TSVs or the TCVs. The combined effects of this trip and a scram reduce fuel bundle power more rapidly than a scram alone, resulting in an increased margin to the MCPR SL. Alternatively, ~~MCPR~~ limits for an inoperable EOC-RPT, as specified in the COLR, are sufficient to mitigate pressurization transient effects. The EOC-RPT function is automatically disabled when turbine first stage pressure is < 26% RTP.

EOC-RPT instrumentation satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

The OPERABILITY of the EOC-RPT is dependent on the OPERABILITY of the individual instrumentation channel Functions. Each Function must have a required number of OPERABLE channels in each trip system, with their setpoints within the specified Allowable Value of SR 3.3.4.1.2. The actual setpoint is calibrated consistent with applicable setpoint methodology assumptions. Channel OPERABILITY also includes the associated EOC-RPT breakers. Each channel (including the

(continued)

BASES

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY (continued)

associated EOC-RPT breakers) must also respond within its assumed response time.

Allowable Values are specified for each EOC-RPT Function specified in the LCO. Nominal trip setpoints are specified in the setpoint calculations. A channel is inoperable if its actual trip setpoint is not within its required Allowable Value. The nominal setpoints are selected to ensure that the setpoints do not exceed the Allowable Value between successive CHANNEL CALIBRATIONS. Operation with a trip setpoint less conservative than the nominal trip setpoint, but within its Allowable Value, is acceptable. Each Allowable Value specified is more conservative than the Analytical Limit assumed in the transient and accident analysis in order to account for instrument uncertainties appropriate to the Function. Trip setpoints are those predetermined values of output at which an action should take place. The setpoints are compared to the actual process parameter (e.g., TSV position), and when the measured output value of the process parameter exceeds the setpoint, the associated device (e.g., limit switch) changes state. Analytical Limits, where established, are the limiting values of the process parameters used in safety analysis to define the margin to unacceptable consequences. Margin is provided between the Allowable Value and the Analytical Limits to allow for process, calibration (i.e., M&TE) and some instrument uncertainties. Additional margin is provided between the Allowable Value and the trip setpoint to allow for the remaining instrument uncertainties (e.g., drift). The trip setpoints derived in this manner provide adequate protection because instrumentation uncertainties, process effects, calibration tolerances, instrument drift, and severe environment errors (for channels that must function in harsh environments as defined by 10 CFR 50.49) are accounted for.

The specific Applicable Safety Analysis, LCO, and Applicability discussions are listed below on a Function by Function basis.

as well as other fuel design limits

Alternatively, since this instrumentation protects against a MCPR SL violation, with the instrumentation inoperable, modifications to the ~~MCPR~~ limits ~~(LCO 3.2.2)~~ may be applied to allow ~~this LCO~~ to be met. The ~~MCPR penalty~~ for the EOC-RPT inoperable condition ~~is~~ specified in the COLR.

APLHGR, MCPR and LHGR

APLHGR, MCPR, and LHGR limits

are

these LCOs

LCOs 3.2.1, 3.2.2 and 3.2.3, respectively

(continued)

BASES

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY (continued)

Turbine Stop Valve — Closure

Closure of the TSVs and a main turbine trip result in the loss of a heat sink that produces reactor pressure, neutron flux, and heat flux transients that must be limited. Therefore, an RPT is initiated on TSV — Closure in anticipation of the transients that would result from closure of these valves. EOC-RPT decreases reactor power and aids the reactor scram in ensuring that the MCPR SL ~~is~~ and other fuel design limits are not exceeded during the worst case transient.

Closure of the TSVs is determined by measuring the position of each valve. There is one position switch associated with each stop valve. The signals from two of the four valves are assigned to one trip system, while the signals from the other two valves are assigned to the other trip system. The logic for the TSV — Closure Function is such that either TSV 1 and TSV 2 must be less than fully open or TSV 3 and TSV 4 must be less than fully open to produce an EOC-RPT. This Function must be enabled whenever THERMAL POWER ≥ 26% RTP. This is normally accomplished automatically by pressure switches sensing turbine first stage pressure. Because an increase in the main turbine bypass flow can affect this Function nonconservatively (THERMAL POWER is derived from the turbine first stage pressure), the main turbine bypass valves must not cause the trip Functions to be bypassed in order to maintain this Function OPERABLE whenever THERMAL POWER ≥ 26% RTP (e.g., during TBV surveillance testing per SR 3.7.7.1). In addition, other steam loads, such as second stage reheaters in operation below 26% RTP, must be accounted for in establishing this setpoint. Otherwise, turbine first stage pressure would be non-conservative with respect to the 26% RTP RPS bypass. Four channels of TSV — Closure, with two channels in each trip system, are available and required to be OPERABLE to ensure that no single instrument failure will preclude an EOC-RPT from this Function on a valid signal. The TSV — Closure Allowable Value is selected to detect imminent TSV closure.

This protection is required, consistent with the safety analysis assumptions, whenever THERMAL POWER is ≥ 26% RTP. Below 26% RTP, the Reactor Vessel Steam Dome Pressure — High and the Average Power Range Monitor (APRM) Fixed Neutron Flux — High Functions of the Reactor Protection System (RPS) are adequate to maintain the necessary safety margins.

(continued)

BASES

APPLICABLE SAFETY ANALYSES, LOC and APPLICABILITY (continued)

Turbine Control Valve Fast Closure, Trip Oil Pressure — Low

Fast closure of the TCVs during a generator load rejection results in the loss of a heat sink that produces reactor pressure, neutron flux, and heat flux transients that must be limited. Therefore, an RPT is initiated on TCV Fast Closure, Trip Oil Pressure — Low in anticipation of the transients that would result from the closure of these valves. The EOC-RPT decreases reactor power and aids the reactor scram in ensuring that the MCPR ~~SL is~~ not exceeded during the worst case transient.

and other fuel design limits are

Fast closure of the TCVs is determined by measuring the electrohydraulic control fluid pressure at each control valve. There is one pressure switch associated with each control valve. The signal from two of the four valves are assigned one trip system, while the signals from the other two valves are assigned to the other trip system. The logic for the TCV Fast Closure, Trip Oil Pressure — Low Function is such that either TCV 1 and TCV 2 must be closed (pressure switch trips) or TCV 3 and TCV 4 must be closed to produce an EOC-RPT. This Function must be enabled whenever THERMAL POWER ≥ 26% RTP. This is normally accomplished automatically by pressure switches sensing turbine first stage pressure. Because an increase in the main turbine bypass flow can affect this Function nonconservatively (THERMAL POWER is derived from turbine first stage pressure), the main turbine bypass valves must not cause the trip Functions to be bypassed in order to maintain this Function OPERABLE whenever THERMAL POWER is ≥ 26% RTP. In addition, other steam loads, such as second stage reheaters in operation below 26% RTP, must be accounted for in establishing this setpoint. Otherwise, turbine first stage pressure would be non-conservative with respect to the 26% RTP RPS bypass. Four channels of TCV Fast Closure, Trip Oil Pressure — Low, with two channels in each trip system, are available and required to be OPERABLE to ensure that no single instrument failure will preclude an EOC-RPT from this Function on a valid signal. The TCV Fast Closure, Trip Oil Pressure — Low Allowable Value is selected high enough to detect imminent TCV fast closure. The transient analysis assumes a response time of 30 msec (i.e., start of TCV closure from full open to switch actuation). The switch setting is selected to support this response time.

(continued)

BASES

APPLICABLE SAFETY ANALYSES, LCO, and APPLICABILITY

Turbine Control Valve Fast Closure, Trip Oil Pressure — Low (continued)

This protection is required consistent with the safety analysis whenever THERMAL POWER is ≥ 26% RTP. Below 26% RTP, the Reactor Vessel Steam Dome Pressure — High and the APRM Fixed Neutron Flux — High Functions of the RPS are adequate to maintain the necessary safety margins.

ACTIONS

A Note has been provided to modify the ACTIONS related to EOC-RPT instrumentation channels. Section 1.3, Completion Times, specifies that once a Condition has been entered, subsequent divisions, subsystems, components, or variables expressed in the Condition, discovered to be inoperable or not within limits, will not result in separate entry into the Condition. Section 1.3 also specifies that Required Actions of the Condition continue to apply for each additional failure, with Completion Times based on initial entry into the Condition. However, the Required Actions for inoperable EOC-RPT instrumentation channels provide appropriate compensatory measures for separate inoperable channels. As such, a Note has been provided that allows separate Condition entry for each inoperable EOC-RPT instrumentation channel.

A.1 and A.2

With one or more channels inoperable, but with EOC-RPT trip capability maintained (refer to Required Actions B.1 and B.2 Bases), the EOC-RPT System is capable of performing the intended function. However, the reliability and redundancy of the EOC-RPT instrumentation is reduced such that a single failure in the remaining trip system could result in the inability of the EOC-RPT System to perform the intended function. Therefore, only a limited time is allowed to restore compliance with the LCO. Because of the diversity of sensors available to provide trip signals, the low probability of extensive numbers of inoperabilities affecting all diverse Functions, and the low probability of an event requiring the initiation of an EOC-RPT, 72 hours is provided to restore the inoperable channels (Required Action A.1). Additionally, applying the EOC-RPT inoperable ~~MCPR limit~~ APLHGR, MCPR, and LHGR limits satisfies the ~~LCO~~ LCOs and is thus acceptable.

(continued)

BASES

ACTIONS

A.1 and A.2 (continued)

Alternately, the inoperable channels may be placed in trip (Required Action A.2) since this would conservatively compensate for the inoperability, restore capability to accommodate a single failure, and allow operation to continue. As noted, placing the channel in trip with no further restrictions is not allowed if the inoperable channel is the result of an inoperable breaker, since this may not adequately compensate for the inoperable breaker (e.g., the breaker may be inoperable such that it will not open). If it is not desired to place the channel in trip (e.g., as in the case where placing the inoperable channel in trip would result in an RPT, or if the inoperable channel is the result of an inoperable breaker), Condition C must be entered and its Required Actions taken.

B.1 and B.2

Required Actions B.1 and B.2 are intended to ensure that appropriate actions are taken if multiple, inoperable, untripped channels within the same Function result in the Function not maintaining EOC-RPT trip capability. A Function is considered to be maintaining EOC-RPT trip capability when sufficient channels are OPERABLE or in trip, such that the EOC-RPT System will generate a trip signal from the given Function on a valid signal and both recirculation pumps can be tripped. This requires two channels of the Function in the same trip system, to each be OPERABLE or in trip, and the associated EOC-RPT breakers to be OPERABLE or in trip. Alternately, Required Action B.2 requires the ~~MCPR limit~~ [APLHGR, MCPR, and LHGR limits] for inoperable EOC-RPT, as specified in the COLR, to be applied. This also restores the margin to ~~MCPR~~ [APLHGR, MCPR, and LHGR] assumed in the safety analysis.

The 2 hour Completion Time is sufficient time for the operator to restore EOC-RPT trip capability or apply the ~~MCPR penalty~~ [APLHGR, MCPR, and LHGR limits], and takes into account the likelihood of an event requiring actuation of the EOC-RPT instrumentation during this period. It is also consistent with the 2 hour Completion Time provided in ~~LCO 3.2.2~~ [LCOs 3.2.1, 3.2.2 and 3.2.3] for Required Action A.1, since this instrumentation's purpose is to preclude a ~~MCPR~~ [APLHGR, MCPR, or LHGR] violation. Once the ~~MCPR penalty is~~ [APLHGR, MCPR, and LHGR limits are] applied, Required Action A.1 of ~~LCO 3.2.2~~ [LCOs 3.2.1, 3.2.2 and 3.2.3] allows 2 hours for ~~MCPR~~ [APLHGR, MCPR, and LHGR] to be restored within limits, if necessary.

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

the loop with the higher flow. While the flow coastdown and core response are potentially more severe in this assumed case (since the intact loop starts at a lower flow rate and the core response is the same as if both loops were operating at a lower flow rate), a small mismatch has been determined to be acceptable based on engineering judgement. Since recirculation loop flow is controlled by varying recirculation pump speed, a limit on the speed mismatch between operating recirculation pumps has been imposed. For some limited low probability accidents (e.g., intermediate break size LOCAs) with the recirculation loop operating with large speed differences, it is possible for the LPCI Loop Select Logic to select the wrong loop for injection. For these limited conditions the Core Spray itself is adequate to prevent fuel temperatures from exceeding allowable limits. However, to limit the probability even further, operating procedures have been put into place limiting the allowable mismatch in speed between the recirculation pumps.

Analyses indicate that above 69.4% RTP the Loop Select Logic could be expected to function at a speed differential up to 14% of their average speed. Below 69.4% RTP the Loop Select Logic would be expected to function at a speed differential up to 20% of their average speed. The recirculation loop speed mismatch limits imposed to prevent the LPCI Loop Select Logic from selecting the wrong loop for injection bound the recirculation flow mismatch limits for LOCA analyses. If the reactor is operating on one recirculation pump, the Loop Select Logic trips that pump before making the loop selection.

occurrences (AOOs)

The recirculation system is also assumed to have sufficient flow coastdown characteristics to maintain fuel thermal margins during abnormal operational ~~transients~~ (Ref. 2), which are analyzed in Chapter 15 of the UFSAR.

A plant specific LOCA analysis has been performed assuming only Single Loop Operation (SLO). This analysis has demonstrated that, in the event of a LOCA caused by a pipe break in the operating recirculation loop, the Emergency Core Cooling System response will provide adequate core cooling, provided the APLHGR requirements are modified accordingly (Ref. 3).

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

The transient analyses of Chapter 15 of the UFSAR have also been performed for SLO (Ref. 3) and demonstrate sufficient flow coastdown characteristics to maintain fuel thermal margins during the abnormal operational transients analyzed provided the MCPR requirements are modified. During SLO, modification to the Reactor Protection System (RPS) Average Power Range Monitor (APRM) instrument setpoints is also required to account for the different relationships between recirculation drive flow and reactor core flow. The APLHGR, ~~and~~ MCPR, and LHGR limits adjusted for SLO are specified in the COLR. The APRM Flow Biased High Scram allowable value is in LCO 3.3.1.1, "Reactor Protection System (RPS) Instrumentation."

Recirculation loops operating satisfies Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

Two recirculation loops are normally required to be in operation with the recirculation pump speeds matched within the limits specified in SR 3.4.1.1 to ensure that during a LOCA caused by a break of the piping of one recirculation loop the assumptions of the LOCA analysis are satisfied. Alternately, with only one recirculation loop in operation, modifications to the required APLHGR limits (LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)"), MCPR limits (LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)"), LHGR limits (LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR)"), and APRM Flow Biased High Scram allowable value (LCO 3.3.1.1) must be applied to allow continued operation consistent with the assumptions of Reference 3. The idle loop is isolated electrically by disconnecting the breaker to the recirculation pump motor generator (M/G) set drive motor prior to reactor startup or, if disabled during reactor operation, within 24 hours of entering SLO. With either one or two recirculation pumps in operation, core flow as a function of THERMAL POWER must be outside the Exclusion Region specified in the COLR to avoid the potential for thermal hydraulic instability.

(continued)

BASES

ACTIONS

B.1 (continued)

Though each operator action can prevent the occurrence and protect the reactor from an instability, the APRM flow-biased scram function is designed to suppress global oscillations, the most likely mode of oscillation, prior to exceeding the fuel safety limit (Ref. 4). While global oscillations are the most likely mode, protection from out-of-phase oscillations are provided through avoidance of the Exclusion Region and administrative controls on reactor conditions which are primary factors affecting reactor stability.

C.1

If recirculation pump speed mismatch is not within limits, the pump speed mismatch must be restored or one recirculation pump must be tripped within two hours. For some limited low probability accidents with the recirculation loops operating with large speed differences, it is possible for the LPCI Loop Select Logic to select the wrong loop for injection. For these limited conditions, Core Spray itself is adequate to prevent fuel temperature from exceeding allowable limits. However, to limit the probability even further, a two hour Completion Time has been established. The two hour Completion Time provides a reasonable time for the operator to restore the pump speed mismatch to within limits.

D.1

LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR),"

With the requirements of the LCO not met for reasons other than Conditions A, B, or C, the Single Loop Operation (SLO) limits must be applied for LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR), "LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," and LCO 3.3.1.1, "Reactor Protection System (RPS) Instrumentation." Should a LOCA occur with one recirculation loop not in operation when the limits specified for SLO have not been applied, the core flow coastdown and resultant core response may not be bounded by the LOCA analyses. Therefore, only a limited time is allowed to apply the limits specified for SLO or restore the inoperable loop to operating status.

(continued)

B 3.4 REACTOR COOLANT SYSTEM (RCS)

B 3.4.10 Reactor Steam Dome Pressure

BASES

BACKGROUND

The reactor steam dome pressure is an assumed initial condition of design basis accidents and transients and is conservative to the value used in the determination of compliance with reactor pressure vessel overpressure protection criteria.

APPLICABLE SAFETY ANALYSES

The reactor steam dome pressure of ≤ 1025 psig is an initial condition for the analysis of design basis accidents and transients used to determine the limits for fuel cladding integrity (see Bases for LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)") and 1% fuel cladding plastic strain (see Bases for LCO ~~3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR~~)") (Reference 1).

3.2.3, "LINEAR HEAT GENERATION RATE (LHGR

Reference 2 vessel overpressure protection analysis evaluates the response of the pressure relief system, primarily the safety/relief valves, during the limiting pressurization transient. The determination of compliance with the overpressure criteria is dependent on the initial reactor steam dome pressure; therefore, the LCO limit on dome pressure ensures that the assumptions of the overpressure protection analysis are conservative.

Reactor steam dome pressure satisfies the requirements of Criterion 2 of 10 CFR 50.36(c)(2)(ii).

LCO

The specified reactor steam dome pressure limit of ≤ 1025 psig ensures the plant is operated within the assumptions of the accident and transient analyses. Operation above the limit may result in a plant response more severe than analyzed.

APPLICABILITY

In MODES 1 and 2, the reactor steam dome pressure is required to be less than or equal to the limit. In these MODES, the reactor may be generating significant steam and the events that may challenge the fuel thermal limits are possible.

In MODE 3, the limit is not applicable because the reactor is shut down and the stored energy in the primary system is less than that assumed in the accident analyses.

(continued)

B 3.7 PLANT SYSTEMS

B 3.7.7 Main Turbine Bypass System

BASES

BACKGROUND

The Main Turbine Bypass System is designed to control steam pressure when reactor steam generation exceeds turbine requirements during unit startup, sudden load reduction, and cooldown. It allows excess steam flow from the reactor to the condenser without going through the turbine. The bypass capacity of the system is slightly less than 21% of the Nuclear Steam Supply System rated steam flow. Sudden load reductions within the capacity of the steam bypass can be accommodated without reactor scram. The Main Turbine Bypass System consists of two valves connected to the main steam lines at the bypass valve chest, which is between the main steam isolation valves and the turbine stop valve chest. Each of these two valves is operated by hydraulic cylinders. The bypass valves are controlled by the pressure regulation function of the Turbine Electro-Hydraulic Control System, as discussed in the UFSAR, Sections 7.7.2.3.1, 10.2.2 and 10.4.4 (Refs. 1, 3 and 4, respectively). The bypass valves are normally closed, and the pressure regulator controls the turbine control valves that direct all steam flow to the turbine. If the speed governor or the load limiter restricts steam flow to the turbine, the pressure regulator controls the system pressure by opening the bypass valves. When the bypass valves open, the steam flows from the bypass chest, through connecting piping, to the pressure breakdown assemblies, where a series of orifices are used to further reduce the steam pressure before the steam enters the condenser. However, because turbine first stage pressure is used to enable the RPS and EOC-RPT trips on TSV and TCV closure, bypass valve opening can impact the OPERABILITY of those trips.

APPLICABLE SAFETY ANALYSES

The APLHGR and LHGR are also impacted.

The Main Turbine Bypass System is assumed to function during the Feedwater Controller Failure - Maximum Demand transient, as discussed in the UFSAR, Section 15.1.1.1 (Ref. 2). Opening the bypass valves during the pressurization event mitigates the increase in reactor vessel pressure, which affects the MCPR during the event. An inoperable Main Turbine Bypass System may result in a ~~MCPR~~ APLHGR, MCPR, and/or LHGR penalty. The Main Turbine Bypass System satisfies Criterion 3 of 10 CFR 50.36(c)(2)(ii).

(continued)

Additionally, modifications to the APLHGR limits (LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION (APLHGR)") and LHGR limits (LCO 3.2.3, "LINEAR HEAT GENERATION (LHGR)") may also be applied.



APLHGR, MCPR, and LHGR

BASES (continued)

LCO

The Main Turbine Bypass System is required to be OPERABLE to limit peak pressure in the main steam lines and maintain reactor pressure within acceptable limits during certain events that cause rapid pressurization, so that the Safety Limit MCPR is not exceeded. With the Main Turbine Bypass System inoperable, modifications to the MCPR limits (LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)") may be applied to allow this LCO to be met. The ~~MCPR~~ limits for the inoperable Main Turbine Bypass System are specified in the COLR. An OPERABLE Main Turbine Bypass valve requires the bypass valves to open in response to increasing main steam line pressure. This response is within the assumptions of the applicable analysis (Ref. 2).

design limits are

APPLICABILITY

The Main Turbine Bypass System is required to be OPERABLE at ≥ 21.7% RTP to ensure that ~~the~~ fuel ~~cladding integrity Safety Limit~~ ~~is~~ not violated during the Feedwater Controller Failure - Maximum Demand transient. As discussed in the Bases for LCO 3.2.2, sufficient margin to these limits exists at < 21.7% RTP. Therefore, these requirements are only necessary when operating at or above this power level.

LCO 3.2.1, and LCO 3.2.3,

ACTIONS

A.1 and A.2

APLHGR, MCPR and LHGR

If the Main Turbine Bypass System is inoperable (one or both bypass valves inoperable), and the ~~MCPR~~ limits for an inoperable Main Turbine Bypass System, as specified in the COLR, are not applied, the assumptions of the design basis transient analysis may not be met. Under such circumstances, prompt action should be taken to restore the Main Turbine Bypass System to OPERABLE status or adjust the ~~MCPR~~ limits accordingly. The 2 hour Completion Time is reasonable, based on the time to complete the Required Action and the low probability of an event occurring during this period requiring the Main Turbine Bypass System.

APLHGR, MCPR and LHGR

(continued)

BASES

ACTIONS (continued)

B.1

APLHGR, MCPR and LHGR

If the Main Turbine Bypass System cannot be restored to OPERABLE status and the ~~MCPR~~ limits for an inoperable Main Turbine Bypass System are not applied, THERMAL POWER must be reduced to < 21.7% RTP. As discussed in the Applicability section, operation at < 21.7% RTP results in sufficient margin to the required limits, and the Main Turbine Bypass System is not required to protect fuel integrity during the Feedwater Controller Failure Maximum Demand transient. The 4 hour Completion Time is reasonable, based on operating experience, to reach the required unit conditions from full power conditions in an orderly manner and without challenging unit systems.

SURVEILLANCE REQUIREMENTS

SR 3.7.7.1

Cycling each main turbine bypass valve through one complete cycle of full travel demonstrates that the valves are mechanically OPERABLE and will function when required. The Surveillance Frequency is controlled under the Surveillance Frequency Control Program. The Frequency is based on operating experience, is consistent with the procedural controls governing valve operation, and ensures correct valve positions. Operating experience has shown that these components usually pass the SR when performed at this Frequency. Therefore, the Frequency is acceptable from a reliability standpoint. In addition, because this SR makes the RPS and EOC-RPT trips on TSV and TCV closure inoperable when performed above 26% RTP (Ref. SRs 3.3.1.1.16 and 3.3.4.1.4), the Frequency also considers the impact on those functions as well.

SR 3.7.7.2

The Main Turbine Bypass System is required to actuate automatically to perform its design function. This SR demonstrates that, with the required system initiation signals, the valves will actuate to their required position. The Surveillance Frequency is controlled under the Surveillance Frequency Control Program. The Frequency is based on the need to perform this Surveillance under the conditions that apply during a plant startup and because of the potential for an unplanned transient if the Surveillance were performed with the reactor at power. In addition, as noted above, cycling the valves also impacts the RPS and EOC-RPT trips on TSV and TCV closure. Thus, it is preferable to perform this Surveillance when those trips are not required to be OPERABLE.

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

As described in LCO 3.0.7, compliance with Special Operations LCOs is optional, and therefore, no criteria of 10 CFR 50.36(c)(2)(ii) apply. Special Operations LCOs provide flexibility to perform certain operations by appropriately modifying requirements of other LCOs. A discussion of the criteria satisfied for the other LCOs is provided in their respective Bases.

LCO

As described in LCO 3.0.7, compliance with this Special Operations LCO is optional. Control rod testing may be performed in compliance with the prescribed sequences of LCO 3.1.6, and during these tests, no exceptions to the requirements of LCO 3.1.6 are necessary. For testing performed with a sequence not in compliance with LCO 3.1.6, the requirements of LCO 3.1.6 may be suspended, provided additional administrative controls are placed on the test to ensure that the assumptions of the special safety analysis for the test sequence are satisfied. Assurances that the test sequence is followed can be provided by either programming the test sequence into the RWM, with conformance verified as specified in SR 3.3.2.1.7 and allowing the RWM to monitor control rod withdrawal and provide appropriate control rod blocks if necessary, or by verifying conformance to the approved test sequence by a second licensed operator or other qualified member of the technical staff. These controls are consistent with those normally applied to operation in the startup range as defined in the SRs and ACTIONS of LCO 3.3.2.1, "Control Rod Block Instrumentation."

APPLICABILITY

Control rod testing, while in MODES 1 and 2, with THERMAL POWER greater than the LPSP of the RWM, is adequately controlled by the existing LCOs on power distribution limits and control rod block instrumentation. Control rod movement during these conditions is not restricted to prescribed sequences and can be performed within the constraints of LCO 3.2.1, "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)," LCO 3.2.2, "MINIMUM CRITICAL POWER RATIO (MCPR)," and LCO 3.3.2.1. With THERMAL POWER less than or equal to the LPSP of the RWM, the provisions of this Special Operations LCO are necessary to perform special tests that are not in conformance with the prescribed sequences of LCO 3.1.6.

" LCO 3.2.3, "LINEAR HEAT GENERATION RATE (LHGR),"

(continued)