FENOC
FirstEnergy Nuclear Operating Company

76 South Main Street
Akron, Ohio 44308

Lew W. Myers
Chief Operating Officer

330-384-3733
Fax: 330-384-3799

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United States Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Perry Nuclear Power Plant
Docket No. 50-440
License Amendment Request Pursuant to 10CFR50.90: Revision of Technical Specification 3.4.1, "Recirculation Loops Operating" Associated with Single Recirculation Loop Operation

Ladies and Gentlemen:

Nuclear Regulatory Commission (NRC) review and approval of a license amendment for the Perry Nuclear Power Plant (PNPP) is requested. The proposed amendment would modify the existing Technical Specification (TS) 3.4.1, "Recirculation Loops Operating" associated with single recirculation loop operation by incorporating limits for the Linear Heat Generation Rate (LHGR) fuel thermal limit into the Limiting Condition of Operation (LCO). Currently, TS 3.4.1 only contains thermal limits for the Minimum Critical Power Ratio and the Average Planar Linear Heat Generation Rate. Thermal limits associated with the two recirculation operations are contained in TS 3.2.1, "Average Planar Linear Heat Generation Rate (APLHGR)," TS 3.2.2, "Minimum Critical Power Ratio (MCPR)," and TS 3.2.3 "Linear Heat Generation Rate (LHGR)." The proposed TS change will reflect a consistency with the existing two recirculation loop LCOs by including the same three thermal limits into the single recirculation loop LCO.

A similar change to include the single recirculation loop operation LHGR limits into TS 3.4.1 was submitted for the Dresden Nuclear Power Station, the LaSalle County Station, and the Quad Cities Nuclear Power Station (ADAMS Accession Number ML033180448) in November 2003.

Approval of the license amendment is requested prior to June 1, 2005, with the amendment being implemented within 90 days following its effective date. If the PNPP would need to operate in single recirculation loop prior to the implementation of this amendment, administrative controls for LHGR will be implemented to ensure fuel thermal limits will be maintained (reference NRC Administrative Letter 98-10, "Dispositioning of Technical Specifications That Are Insufficient to Assure Plant Safety").

A001

There are no regulatory commitments included in this letter or its attachments. If you have questions or require additional information, please contact Mr. Jeffrey J. Lausberg, Manager - Regulatory Compliance, at (440) 280-5940.

Very truly yours,

Lew W Myers

Attachments:

1. Notarized FirstEnergy Nuclear Operating Company Affidavit
2. Description, Background, Technical Analysis, Regulatory Analysis, and Environmental Consideration for the Proposed Technical Specification Change
3. Significant Hazards Consideration
4. Technical Specification Pages Annotated with the Proposed Amendment
5. Marked-Up Technical Specification Bases Pages (For Information Only)

cc: NRC Project Manager
NRC Resident Inspector
NRC Region III
State of Ohio

I, Lew W. Myers, hereby affirm that (1) I am Chief Operating Officer, of the FirstEnergy Nuclear Operating Company, (2) I am duly authorized to execute and file this certification as the duly authorized agent for The Cleveland Electric Illuminating Company, Toledo Edison Company, Ohio Edison Company, and Pennsylvania Power Company, and (3) the statements set forth herein are true and correct to the best of my knowledge, information and belief.

Lew W Myers

Lew W. Myers

Subscribed to and affirmed before me, the 31st day of August, 2004

Jane E Mott

JANE E. MOTT
Notary Public, State of Ohio
My Commission Expires Feb. 20, 2006
(Recorded in Lake County)

1.0 DESCRIPTION

The proposed License Amendment Request, submitted for Nuclear Regulatory Commission (NRC) review and approval, modifies Technical Specification (TS) 3.4.1, "Recirculation Loops Operating" associated with single recirculation loop operation by incorporating limits for the Linear Heat Generation Rate (LHGR) fuel thermal limit into the Limiting Condition of Operation (LCO). Currently, TS 3.4.1 only contains thermal limits for the Minimum Critical Power Ratio and the Average Planar Linear Heat Generation Rate. Thermal limits associated with two recirculation loop operation are contained in TS 3.2.1, "Average Planar Linear Heat Generation Rate (APLHGR)", TS 3.2.2, "Minimum Critical Power Ratio (MCPR)", and TS 3.2.3 "Linear Heat Generation Rate (LHGR)." The proposed TS changes will reflect a consistency with the two recirculation loop LCOs by including the same three thermal limits into the single recirculation loop LCO.

A similar change to include the single recirculation loop operation LHGR limits into TS 3.4.1 was submitted for the Dresden Nuclear Power Station, the LaSalle County Station, and the Quad Cities Nuclear Power Station (ADAMS Accession Number ML033180448) in November 2003.

2.0 PROPOSED TECHNICAL SPECIFICATION CHANGE

Technical Specification 3.4.1, "Recirculation Loops Operating", will be changed by adding the following condition to the Limiting Condition of Operation (LCO):

> "4. LCO 3.2.3, "Linear Heat Generation Rate (LHGR)" limits modified for single loop operation as specified in the COLR; and"

Additionally, an editorial change to revise the numbering of the conditions within the LCO and the inclusion of the condition into the ACTION statements will result from the proposed change.

3.0 BACKGROUND

THERMAL LIMITS

Thermal limits are established for the nuclear fuel in order to maintain fuel cladding integrity during normal and off-normal plant conditions. The three thermal limits associated with the Perry Nuclear Power Plant (PNPP) fuel design are the Linear Heat Generation Rate (LHGR), the Average Planar Linear Heat Generation Rate (APLHGR), and the Critical Power Ratio (CPR).

The LHGR is a measure of the heat generation rate of a fuel rod in a fuel assembly at any axial location. Limits on the 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.

The mechanisms that could cause fuel damage during the AOOs are:

- rupture of the fuel rod cladding caused by strain from the relative expansion of the UO_2 pellet, and

- severe overheating of the fuel rod cladding caused by inadequate cooling.

A value of 1% plastic strain of the fuel cladding has been defined as the limit below which fuel damage caused by overstraining of the fuel cladding is not expected to occur.

For operation with LHGR up to the LHGR limit, evaluations demonstrate that the 1% fuel cladding plastic strain design limit will not be exceeded during operational transients.

The APLHGR is a measure of the average LHGR of all the fuel rods in a fuel assembly at any axial location. Limits on the APLHGR are specified to ensure 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. Operation up to the maximum APLHGR limit ensures compliance with the 10 CFR 50.46 limits. APLHGR limits are a function of exposure and the various operating core flow and power states. The APLHGR limits are modified by the application of either a flow-dependent multiplier or a power-dependent multiplier. These multipliers ensure that all fuel design criteria are met for normal operation and AOOs. The multipliers are used within the LOCA analysis.

The LOCA analysis is performed to ensure that the above modified APLHGR limits are adequate to meet the PCT and maximum oxidation limits of 10 CFR 50.46. 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 specified are equivalent to the LHGR of the highest powered fuel rod assumed in the LOCA analysis divided by its local peaking factor.

Since plant operations are associated with ensuring the fuel remains below the Maximum APLHGR (or MAPLHGR) limits, for the remainder of this submittal MAPLGHR will be used in place of APLHGR.

The Critical Power Ratio (CPR) is a ratio of the fuel assembly power that would result in the onset of boiling transition to the actual fuel assembly power. Although fuel damage does not necessarily occur if a fuel rod actually experiences boiling transition, the critical power at which boiling transition is calculated to occur has been adopted as a fuel design criterion.

The onset of transition boiling is a phenomenon that is readily detected during the testing of various fuel bundle designs. Based on these experimental data, correlations have been developed to predict critical bundle power (i.e., the bundle power level at the onset of transition boiling) for a given set of plant parameters (e.g., reactor vessel pressure,

flow, and subcooling). Because plant operating conditions and bundle power levels are monitored and determined relatively easily, monitoring the CPR is a convenient way of ensuring that fuel failures due to inadequate cooling do not occur.

LOCA ANALYSIS

PNPP uses the General Electric "SAFER/GESTR" methodology for the LOCA analysis.

The LOCA analysis sets both the MAPLHGR and LHGR limits. The local peaking assumed in the LOCA analysis is flatter than the actual local peaking. Therefore, a fuel assembly operating at the LOCA MAPLHGR limit will have an actual LHGR value above the LOCA analysis value. To ensure that the MAPLHGR and LHGR limits generated by the LOCA analysis are not exceeded during operation, the difference between the assumed local peaking factor and the actual peaking factor must be accommodated. To accomplish this, one of two approaches may be followed. First, the actual local peaking can be incorporated into the MAPLHGR limits through the use of "composite" LOCA/Thermal-Mechanical MAPLHGR limits. Second, the actual peaking can be included as part of the LHGR limit monitoring when exposure-dependent Thermal-Mechanical LHGR limits are used.

The LOCA analysis also defines a MAPLHGR multiplier for Single Recirculation Loop Operation (SLO) in order to limit the Peak Cladding Temperature (PCT) increase during SLO. To develop the SLO multiplier, both the MAPLHGR and LHGR values are reduced within the LOCA analysis until the PCT passes the acceptance criterion. Current versions of core monitoring software contain a provision for a SLO MAPLHGR multiplier, but contain no provision for a SLO LHGR multiplier. The SLO MAPLHGR multiplier is sufficient when the "composite" MAPLGHR limits are used since the "composite" limits address the effects of the actual local peaking.

Compliance with TS 3.4.1 is based upon use of the "composite" LOCA/Thermal-Mechanical MAPLHGR limits. Hence, the LHGR limit is adjusted for SLO by use of the SLO MAPLHGR multiplier being applied to the "composite" MAPLHGR limits. However, if the "composite" MAPLHGR limits are not used, then a SLO multiplier must be added to the LHGR limits when in SLO to ensure plant operations remains within the bounds of the LOCA analysis.

CORE MONITOR

The core monitor is a system of computer programs designed to monitor and predict core parameters under various reactor operation states (i.e., startup, steady state, and maneuvering). The core monitor calculates the thermal limits for actual core conditions, which is used for Technical Specification compliance.

The 3D Monicore (core monitor used at PNPP) uses the 3-dimensional core simulator software, PANACEA for calculating reactor power, and moderator void and flow distributions. From these parameters, other parameters such as thermal limits can be determined.

Prior to Refueling Outage 9, PNPP used PANACEA, Version 10. PANACEA, Version 10 monitored the LHGR and MAPLHGR criteria using the "composite" LOCA/Thermal Mechanical MAPLHGR limits. The end result is if PNPP were to operate up to the "composite" LOCA/Thermal-Mechanical MAPLHGR limits, the MAPLHGR and the LHGR would be less than the MAPLHGR and LHGR assumed in the LOCA analysis.

For SLO, PANACEA applies a SLO multiplier to the "composite" MAPLHGR limits. By use of the SLO multiplier, the reactor cannot be operated beyond the values of MAPLHGR and LHGR assumed in the SLO analysis.

4.0 TECHNICAL ANALYSIS

During Refueling Outage 9 PNPP upgraded the core monitor to use the PANACEA, Version 11 software.

The PANACEA, Version 11 software eliminated the "composite" ECCS-LOCA/Thermal-Mechanical MAPLHGR limits that was used in PANACEA, Version 10. The "composite" MAPLHGR limit was replaced by the LOCA MAPLHGR limits and the Thermal-Mechanical LHGR limits. Use of either the "composite" MAPLHGR limits or the LOCA MAPLHGR limits and the Thermal-Mechanical LHGR limits is consistent with the SAFER-GESTR LOCA methodology. By eliminating the "composite" MAPLHGR limits, the fuel is now monitored against its true LOCA limit or its true Thermal-Mechanical limit. Resulting in better and more efficient core designs, as well as achieving better core operations.

When in SLO, PANACEA, Version 11 will automatically apply the SLO multiplier to the LOCA MAPLHGR limit. However, PANACEA, Version 11 does not automatically apply the SLO multiplier to the LHGR limit. Therefore, the SLO multiplier for the Thermal-Mechanical LHGR limit is required to be manually inputted during SLO. Currently, administrative controls are in place to ensure that this function occurs.

The proposed changes to Technical Specification 3.4.1, "Recirculation Loops Operating", will incorporate the requirement for the LHGR limit to be modified by the SLO multiplier as used in the LOCA analysis when the plant enters SLO. This will provide assurance that the appropriate fuel thermal limits will be used during SLO.

5.0 REGULATORY ANALYSIS

SIGNIFICANT HAZARDS CONSIDERATION

The Significant Hazards Consideration for the proposed Technical Specification change is contained in Attachment 3.

6.0 ENVIRONMENTAL CONSIDERATION

The proposed Technical Specification change request was evaluated against the criteria of 10 CFR 51.22 for environmental considerations. The proposed change does not significantly increase individual or cumulative occupational radiation exposures, does not significantly change the types or significantly increase the amounts of effluents that may

be released offsite, and as discussed in Attachment 3, does not involve a significant hazards consideration. Based on the foregoing, it has been concluded that the proposed Technical Specification change meets the criteria given in 10 CFR 51.22(c)(9) for a categorical exclusion from the requirement for an Environmental Impact Statement.

7.0 REFERENCES

1. PNPP Technical Specifications

2. Letter from L.R. Conner (General Electric) to J. Rinckel (FirstEnergy), "Single Loop Operation (SLO) LHGR Limits for Perry Cycle 10", dated June 4, 2003. (Proprietary Document)

3. NRC Administrative Letter 98-10, "Dispositioning of Technical Specifications That Are Insufficient to Assure Plant Safety", dated December 29, 1998

SIGNIFICANT HAZARDS CONSIDERATION

The proposed amendment is requesting Nuclear Regulatory Commission review and approval of changes to the Perry Nuclear Power Plant (PNPP) Technical Specifications which would modify the existing Technical Specification (TS) 3.4.1, "Recirculation Loops Operating" associated with single recirculation loop operation by incorporating limits for the Linear Heat Generation Rate (LHGR) fuel thermal limit into the Limiting Condition of Operation (LCO). Currently, TS 3.4.1 only contains thermal limits for the Minimum Critical Power Ratio and the Average Planar Linear Heat Generation Rate. Thermal limits associated with two recirculation loop operation are contained in TS 3.2.1, "Average Planar Linear Heat Generation Rate (APLHGR)", 3.2.2, "Minimum Critical Power Ratio (MCPR)", and 3.2.3 "Liner Heat Generation Rate (LHGR)." The proposed TS change will reflect a consistency with the existing two recirculation loop LCOs by ensuring the same three thermal limits are contained within the single recirculation loop LCO.

The standards used to arrive at a determination that a request for amendment involves no significant hazards considerations are included in the Nuclear Regulatory Commission's regulation, 10 CFR 50.92, which states that the operation of the facility in accordance with the proposed amendment would not: (1) involve a significant increase in the probability or consequences of an accident previously evaluated; or (2) create the possibility of a new or different kind of accident from any previously evaluated; or (3) involve a significant reduction in a margin of safety.

The proposed amendment has been reviewed with respect to these three factors, and it has been determined that the proposed change does not involve a significant hazard because:

1. The proposed change does not involve a significant increase in the probability or consequences of an accident previously evaluated.

   The LHGR is a measure of the heat generation rate of a fuel rod in a fuel assembly at any axial location. Limits on the LHGR are specified to ensure that fuel design limits are not exceeded anywhere in the core during normal operation, including Anticipated Operational Occurrences (AOOs). Additionally, the LHGR limits provide assurance the fuel Peak Cladding Temperature (PCT) during a Loss Of Coolant Accident (LOCA) will not exceed the requirements of 10 CFR 50.46.

   The PNPP Core Monitor previously automatically modified the "composite" LOCA/Thermal-Mechanical MAPLHGR limits for single recirculation loop operation. As a result, the LHGR limit was adjusted for single recirculation loop operation by application of the single recirculation loop operation MAPLHGR multiplier to the "composite" MAPLHGR limits. The proposed TS change establishes a TS requirement for LHGR limits to be modified, as specified in the Core Operating Limits Report, during single recirculation loop operation. This TS requirement provides assurance that the fuel design limits will remain satisfied during the time the plant may be in single recirculation loop operation.

There are no physical modifications being made to any plant system or component, including the fuel.

The manual versus automatic adjustment of the LHGR limits when in single reactor loop operation is considered a change in the implementation of a core monitoring function. However, since the LHGR limits that will be applied to the core are consistent with the NRC-approved fuel design and LOCA methodologies in use at PNPP, this change in monitoring implementation is not considered significant.

Therefore, since no significant changes are being made to the plant or its operation, the probability or the consequences of an accident have not increased over those previously evaluated.

2. The proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

   There are no physical modifications being made to any plant system or component, including the fuel. The manual versus automatic adjustment of the LHGR limits when in single reactor loop operation is considered a change in the implementation of a core monitoring function. However, since the LHGR limits that will be applied to the core are consistent with the NRC-approved fuel design and LOCA methodologies in use at PNPP, this change in monitoring implementation is not considered significant. The proposed TS change provides assurance that the LHGR limits will be adjusted if the plant enters a condition of single recirculation loop operation, thereby ensuring the fuel design limits remain satisfied.

   Therefore, the proposed change does not create the possibility of a new or different kind of accident from any accident previously evaluated.

3. The proposed change does not involve a significant reduction in a margin of safety.

   There are no physical modifications being made to any plant system or component, including the fuel. The manual versus automatic adjustment of the LHGR limits when in single reactor loop operation is considered a change in the implementation of a core monitoring function. However, since the LHGR limits that will be applied to the core are consistent with the NRC-approved fuel design and LOCA methodologies in use at PNPP, this change in monitoring implementation is not considered significant. The proposed TS change provides assurance that the LHGR limits will be adjusted if the plant enters a condition of single recirculation loop operation, thereby ensuring the fuel design limits remain satisfied.

   Therefore, the proposed change does not involve a significant reduction in a margin of safety.

Based upon the reasoning presented above, the requested change does not involve a significant hazards consideration.

TECHNICAL SPECIFICATION PAGES

ANNOTATED WITH THE PROPOSED AMENDMENT

3.4 REACTOR COOLANT SYSTEM (RCS)

3.4.1 Recirculation Loops Operating

LCO 3.4.1 Either:

a. Two recirculation loops shall be in operation with matched flows;

OR

b. One recirculation loop shall be in operation with:

1. Thermal power ≤ 2500 MWt;

2. LCO 3.2.1 "AVERAGE PLANAR LINEAR HEAT GENERATION RATE (APLHGR)" limits modified for single recirculation loop operation as specified in the COLR;

3. LCO 3.2.2 "Minimum Critical Power Ratio (MCPR)" limits modified for single recirculation loop operation as specified in the COLR; ~~and~~

INSERT 1

~~4.~~ 5. LCO 3.3.1.1, "Reactor Protection System (RPS) Instrumentation," Function 2.b (Average Power Range Monitors Flow Biased Simulated Thermal Power-High) Allowable Value of Table 3.3.1.1-1 reset for single loop operation.

APPLICABILITY: MODES 1 and 2.

ACTIONS

CONDITION	REQUIRED ACTION	COMPLETION TIME
A. Recirculation loop jet pump flow mismatch not within limits.	A.1 Declare the recirculation loop with lower flow to be "not in operation."	2 hours

(continued)

INSERT 1

4. LCO 3.2.3, "Linear Heat Generation Rate (LHGR)" limits modified for single recirculation loop operation as specified in the COLR; and

ACTIONS (continued)

CONDITION	REQUIRED ACTION	COMPLETION TIME
B. Thermal power > 2500 MWt during single recirculation loop operation.	B.1 Reduce thermal power to ≤ 2500 MWt.	1 hour
C. Requirements b.2., b.3, or b.~~4~~ 5 of the LCO not met.	C.1 Satisfy the requirements of the LCO.	24 hours
D. Required Action and associated completion time of Condition A, B, or C not met. OR No recirculation loops in operation.	D.1 Be in MODE 3.	12 hours

b.4,

MARKED-UP

TECHNICAL SPECIFICATION BASES PAGES

(For Information Only)

These pages reflect not only the proposed amendment but additional changes that provide clarification and consistency within the Bases of the Thermal Limit Technical Specifications. The additional changes are being included for they are relevant to the changes being made by the proposed amendment and will provide a clearer understanding of the proposed amendment.

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 average LHGR of all the fuel rods in a fuel assembly at any axial location. Limits on the APLHGR are specified to ensure 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 the~~ USAR, ~~Chapters 4, 6, and 15;~~ and in References 1 and 2. The analytical methods and assumptions used in evaluating ~~Design Basis Accidents (DBAs), anticipated operational transients,~~ LOCA and normal operations that determine APLHGR limits are ~~presented in USAR, Chapters 4, 6, and 15, and~~ in References 1, 2, 3, and 4.

APLHGR limits are developed as a function of exposure and the various operating core flow and power states. Flow dependent APLHGR limits are determined using the three dimensional BWR simulator code (Ref. 5) to analyze slow flow runout transients. The flow dependent multiplier, $MAPFAC_f$, is dependent on the maximum core flow runout capability. $MAPFAC_f$ curves are provided based on the maximum credible flow runout transient for Loop Manual and Non Loop Manual operation. The result of a single failure or single operator error during Loop Manual operation is the runout of only one loop because both recirculation loops are under independent control. Non Loop Manual operational modes allow simultaneous runout of both loops because a single controller regulates core flow.

(continued)

TO ENSURE ADHERENCE TO 10 CFR 50.46 DURING THE LIMITING LOCA.

BASES

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, $MAPFAC_p$, 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 signals are bypassed, both high and low core flow $MAPFAC_p$ limits are provided for operation at power levels between 23.8% RTP and the previously mentioned bypass power level. The exposure dependent APLHGR limits are reduced by $MAPFAC_p$ and $MAPFAC_f$ at various operating conditions to ensure that all fuel design criteria are met for normal operation and ~~AOOs.~~ A complete discussion of the analysis code is provided in Reference 6. The ECCS/LOCA analysis assumes the existence of MAPFAC.

LOCA.

~~LOCA~~ analyses are ~~then~~ performed to ensure that the above determined APLHGR limits 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 discussion of the analysis code is provided in Reference 7. 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 specified 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 APLHGR.~~

For single recirculation loop operation, the MAPFAC multiplier is limited to a maximum value which is specified in the COLR. This multiplier is 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 APLHGR satisfies Criterion 2 of the NRC Policy Statement.

(continued)

BASES (continued)

LCO

The APLHGR limits specified in the COLR are a function of exposure and are a result of DBA analyses. For two recirculation loops operating, the limit is determined by multiplying the smaller of the MAPFACf and MAPFACp factors times the exposure dependent APLHGR limits. With only one recirculation loop in operation, in conformance with the requirements of LCO 3.4.1, "Recirculation Loops Operating," the limit is determined by multiplying the exposure dependent APLHGR limit by the smallest of $MAPFAC_f$, $MAPFAC_p$, and the limiting value specified for single recirculation loop operation in the COLR, which has been determined by a specific single recirculation loop analysis (Ref. 2).

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 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 4.7% to 14.2% RTP when entry into MODE 2 occurs. When in MODE 2, the intermediate range monitor (IRM) scram function provides rapid scram initiation during any significant transient, thereby effectively removing any APLHGR limit compliance concern in MODE 2. Therefore, at THERMAL POWER levels < 23.8% RTP, the reactor operates with substantial margin to the APLHGR limits; thus, this LCO is not required.

ACTIONS

A.1

ANALYSIS

If any APLHGR exceeds the required limit, an assumption regarding an initial condition of the DBA ~~and transient analyses~~ may not be met. Therefore, prompt action is taken to restore the APLHGR(s) ~~to within the required limit(s) such that the plant~~ will be operating within analyzed conditions and within the design limits of the fuel rods. The 2 hour Completion Time is sufficient to restore the APLHGR(s) to within its limit and is acceptable based on the low probability of a ~~transient or DBA~~ LOCA occurring simultaneously with the APLHGR out of specification.

(continued)

BASES

ACTIONS (continued)

B.1

If the APLHGR cannot be restored to within its required limit 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 < 23.8% RTP within 4 hours. The allowed Completion Time is reasonable, based on operating experience, to reduce THERMAL POWER to < 23.8% RTP in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.2.1.1

APLHGRs are required to be initially calculated within 12 hours after THERMAL POWER is ≥ 23.8% RTP and then every 24 hours thereafter. They are compared to the specified limits in the COLR to ensure that the reactor is operating within the assumptions of the safety analysis. The 24 hour Frequency is based on both engineering judgment and recognition of the slowness of changes in power distribution under normal conditions. The 12 hour allowance after THERMAL POWER ≥ 23.8% RTP is achieved, is acceptable given the large inherent margin to operating limits at low power levels.

REFERENCES

1. NEDE-24011-P-A, "General Electric Standard Application for Reactor Fuel, GESTAR-II" (latest approved revision).

2. USAR, Chapter 15, Appendix 15B.

3. USAR, Chapter 15, Appendix 15F.

4. USAR, Chapter 15, Appendix 15E.

5. NEDO-30130-P-A, "Steady State Nuclear Methods," April 1985.

(continued)

INFORMATION ONLY

NO CHANGES ON THIS PAGE

BASES

REFERENCES (continued)	6.	NEDO-24154, "Qualification of the One-Dimensional Core Transient Model for Boiling Water Reactors," October 1978.
	7.	USAR, Section 6.3

INFORMATION ONLY

NO CHANGES ON THIS PAGE

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 of a fuel rod in a fuel assembly at any axial location. Limits on the LHGR are specified to ensure that fuel design limits are not exceeded anywhere in the core during normal operation, including anticipated operational occurrences (AOOs). INSERT 1 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 USAR Chapters 6 and 15.

APPLICABLE SAFETY ANALYSES

The analytical methods and assumptions used in evaluating the fuel design limits are presented in the USAR, Chapters 4, 6, and 15, and in References 1 and 2. INSERT 2 The fuel assembly is designed to ensure (in conjunction with the core nuclear and thermal hydraulic design, plant equipment, instrumentation, and protection system) that fuel damage will not result in the release of radioactive materials in excess of the guidelines of 10 CFR, Parts 20, 50, and 100. The mechanisms that could cause fuel damage during operational transients and that are considered in fuel evaluations are:

a. Rupture of the fuel rod cladding caused by strain from the relative expansion of the UO_2 pellet; and

b. Severe overheating of the fuel rod cladding caused by inadequate cooling.

A value of 1% plastic strain of the fuel cladding has been defined as the limit below which fuel damage caused by overstraining of the fuel cladding is not expected to occur (Ref. 1).

Fuel design evaluations have been performed and demonstrate that the 1% fuel cladding plastic strain design limit is not exceeded during ~~AOOs for~~ operation with LHGR up to the operating limit LHGR specified in the COLR.

(continued)

CONTINUOUS

INSERT 1

, and to ensure that the peak clad temperature (PCT) during postulated Design Basis Loss of Coolant Accident (LOCA) does not exceed the limits specified in 10 CFR 50.46.

INSERT 2

The analytical methods and assumptions used in evaluating AOOs and normal operation that determine the LHGR limits are presented in USAR Chapters 4 and 15, and in References 1 and 2.

BASES

APPLICABLE SAFETY ANALYSES (continued)

The analysis also includes allowances for short term transient operation above the operating limit to account for AOOs, plus an allowance for densification power spiking.

The LHGR limits are developed 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(Refs. 3 and 4). Flow dependent Thermal-Mechanical LHGR Limits are determined using the three dimensional BWR simulator code (Ref. 5) to analyze slow flow runout transients. The flow dependent multiplier for the Thermal-Mechanical LHGR Limits is dependent on the maximum core flow runout capability. Thermal-Mechanical LHGR Limit curves are provided based on the maximum credible flow runout transient for Loop Manual and Non Loop Manual operation. The result of a single failure or single operator error during Loop Manual operation is the runout of only one loop because both recirculation loops are under independent control. Non Loop Manual operational modes allow simultaneous runout of both loops because a single controller regulates core flow.

The LHGR limits are primarily derived from fuel design evaluations and transient analyses that are assumed to occur at high power levels. Design calculations and operating experience have shown that as power is reduced, the margin to the required LHGR limits increases. This trend continues down to the power range of 4.7% to 14.2% RTP when entry into MODE 2 occurs. When in MODE 2, the intermediate range monitor (IRM) scram function provides rapid scram initiation during any significant transient, thereby effectively removing any LHGR limit compliance concern in MODE 2. Therefore, at THERMAL POWER levels < 23.8% RTP, the reactor operates with substantial margin to the LHGR limits; thus, this LCO is not required

The LHGR satisfies Criterion 2 of the NRC Policy Statement.

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 calculated to cause a 1% fuel cladding plastic strain. The operating limit to accomplish this objective is specified in the COLR.

(continued)

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BASES (continued)

APPLICABILITY

The LHGR limits are derived from fuel design analysis that is limiting at high power level conditions. At THERMAL POWER levels < 23.8% RTP, the reactor is operating with substantial margin to the LHGR limits and 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 is taken to restore the LHGR(s) to within required limit(s) such that the plant will be operating within analyzed conditions and within the design limits of the fuel rods. The 2 hour Completion Time is sufficient to restore the LHGR(s) to within its limit and is acceptable based on the low probability of a transient or Design Basis ~~Accident~~ LOCA occurring simultaneously with the LHGR out of specification.

B.1

If the LHGR cannot be restored to within its required limit 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 < 23.8% RTP within 4 hours. The allowed

(continued)

BASES

ACTIONS

B.1 (continued)

Completion Time is reasonable, based on operating experience, to reduce THERMAL POWER to < 23.8% RTP in an orderly manner and without challenging plant systems.

SURVEILLANCE REQUIREMENTS

SR 3.2.3.1

The LHGRs are required to be initially calculated within 12 hours after THERMAL POWER is ≥ 23.8% RTP and then every 24 hours thereafter. They are compared to the specified limits in the COLR to ensure that the reactor is operating within the assumptions of the safety analysis. The 24 hour Frequency is based on both engineering judgment and recognition of the slowness of changes in power distribution under normal conditions. The 12 hour allowance after THERMAL POWER ≥ 23.8% RTP is achieved, is acceptable given the large inherent margin to operating limits at lower power levels.

REFERENCES

1. NUREG-0800, "Standard Review Plan," Section 4.2, II.A.2(g), Revision 2, July 1981.
2. USAR, Chapter 15, Appendix 15B.
3. USAR, Chapter 15, Appendix 15F.
4. USAR, Chapter 15, Appendix 15E.
5. NEDO-30130-P-A, "Steady State Nuclear Methods," April 1985.

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B 3.4 REACTOR COOLANT SYSTEM (RCS)

B 3.4.1 Recirculation Loops Operating

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BASES

BACKGROUND

The Reactor Coolant Recirculation System is designed to provide a forced coolant flow through the core to remove heat from the fuel. The forced coolant flow removes more heat from the fuel than would be possible with just natural circulation. The forced flow, therefore, allows operation at significantly higher power than would otherwise be possible. The recirculation system also controls reactivity over a wide span of reactor power by varying the recirculation flow rate to control the void content of the moderator. The Reactor Coolant Recirculation System consists of two recirculation pump loops external to the reactor vessel. These loops provide the piping path for the driving flow of water to the reactor vessel jet pumps. Each external loop contains a two speed motor driven recirculation pump, a flow control valve and associated piping, jet pumps, valves, and instrumentation. The recirculation loops are part of the reactor coolant pressure boundary and are located inside the drywell structure. The jet pumps are reactor vessel internals.

The recirculated coolant consists of saturated water from the steam separators and dryers that has been subcooled by incoming feedwater. This water passes down the annulus between the reactor vessel wall and the core shroud. A portion of the coolant flows from the vessel, through the two external recirculation loops, and becomes the driving flow for the jet pumps. Each of the two external recirculation loops discharges high pressure flow into an external manifold, from which individual recirculation inlet lines are routed to the jet pump risers within the reactor vessel. The remaining portion of the coolant mixture in the annulus becomes the suction flow for the jet pumps. This flow enters the jet pump at suction inlets and is accelerated by the driving flow. The drive flow and suction flow are mixed in the jet pump throat section. The total flow then passes through the jet pump diffuser section into the area below the core (lower plenum), gaining sufficient head in the process to drive the required flow upward through the core.

(continued)

BASES

BACKGROUND (continued)

The subcooled water enters the bottom of the fuel channels and contacts the fuel cladding, where heat is transferred to the coolant. As it rises, the coolant begins to boil, creating steam voids within the fuel channel that continue until the coolant exits the core. Because of reduced moderation, the steam voiding introduces negative reactivity that must be compensated for to maintain or to increase reactor power. The recirculation flow control allows operators to increase recirculation flow and sweep some of the voids from the fuel channel, overcoming the negative reactivity void effect. Thus, the reason for having variable recirculation flow is to compensate for reactivity effects of boiling over a wide range of power generation (i.e., 55 to 100% RTP) without having to move control rods and disturb desirable flux patterns.

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Each recirculation loop is manually started from the control room. The recirculation flow control valves provide regulation of individual recirculation loop drive flows. The flow in each loop can be manually or automatically controlled. During single recirculation loop operation, the recirculation flow control system is maintained in the Loop Manual mode. If the recirculation flow control system is not in the Loop Manual mode while in single recirculation loop operation, immediately initiate action to place the recirculation flow control system in the Loop Manual mode within one hour.

During single recirculation loop operation, with the volumetric recirculation loop drive flow greater than 48,500 gpm, immediately initiate action to reduce flow to less than or equal to 48,500 gpm within one hour.

APPLICABLE SAFETY ANALYSES

The operation of the Reactor Coolant Recirculation System is an initial condition assumed in the design basis loss of coolant accident (LOCA) (Ref. 1). During a LOCA caused by a recirculation loop pipe break, the intact loop is assumed to provide coolant flow during the first few seconds of the accident. The initial core flow decrease is rapid because the recirculation pump in the broken loop ceases to pump reactor coolant to the vessel almost immediately. The pump in the intact loop coasts down relatively slowly. This pump coastdown governs the core flow response for the next

(continued)

BASES

APPLICABLE SAFETY ANALYSES (continued)

several seconds until the jet pump suction is uncovered (Ref. 1). The analyses assume that both loops are operating at the same flow prior to the accident. However, the LOCA analysis was reviewed for the case with a flow mismatch between the two loops, with the pipe break assumed to be in 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.

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

ANTICIPATED

A plant specific LOCA analysis has been performed assuming only one operating recirculation loop. 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 THERMAL POWER is reduced to ≤ 2500 MWt, and the APLHGR AND LHGR requirements are modified accordingly (Ref. 3).

The transient analyses of Chapter 15 of the USAR have also been performed for single recirculation loop operation (Ref. 3) and demonstrate sufficient flow coastdown characteristics to maintain fuel thermal margins during the abnormal operational transients analyzed provided THERMAL POWER is reduced to ≤ 2500 MWt, and the MCPR requirements are modified. During single recirculation loop operation, modification to the Reactor Protection System 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, LHGR and MCPR limits for single loop operation are specified in the COLR. The APRM flow biased simulated thermal power setpoint is in LCO 3.3.1.1, "Reactor Protection System (RPS) Instrumentation."

Recirculation loops operating satisfies Criterion 2 of the NRC Policy Statement.

(continued)

BASES (continued)

LCO

Two recirculation loops are normally required to be in operation with their flows 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. Alternatively, with the limits specified in SR 3.4.1.1 not met, the recirculation loop with the lower flow must be considered to be not in operation. With only one recirculation loop in operation, THERMAL POWER must be ≤ 2500 MWt, and 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)"), and APRM Flow Biased Simulated Thermal Power —High setpoint (LCO 3.3.1.1) must be applied to allow continued operation consistent with the assumptions of Reference 3.

APPLICABILITY

In MODES 1 and 2, requirements for operation of the Reactor Coolant Recirculation System are necessary since there is considerable energy in the reactor core and the limiting design basis transients and accidents are assumed to occur.

(continued)

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

BASES

APPLICABILITY (continued)

In MODES 3, 4, and 5, the consequences of an accident are reduced and the coastdown characteristics of the recirculation loops are not important.

ACTIONS

A.1

With both recirculation loops operating but the recirculation loop flows not matched, Required Action A.1 requires that the recirculation loops must be restored to operation with matched flows within 2 hours. If the flow mismatch can not be restored to within limits within 2 hours, one recirculation loop must be declared to be "not in operation".

A recirculation loop is considered to be not in operation when the pump in that loop is idle or when the mismatch between total jet pump flows of the two loops is greater than required limits. The loop with the lower flow must be considered not in operation. Should a LOCA occur with one recirculation loop not in operation, the core flow coastdown and resultant core response may not be bounded by the LOCA analyses. Therefore, only a limited time is allowed to restore the inoperable loop to operating status.

OR AOO

Alternatively, if the single loop requirements of the LCO are applied to operating limits and RPS setpoints, operation with only one recirculation loop would satisfy the requirements of the LCO and the initial conditions of the accident sequence.

The 2 hour Completion Time is based on the low probability of an accident occurring during this time period, on a reasonable time to complete the Required Action, and on frequent core monitoring by operators allowing abrupt changes in core flow conditions to be quickly detected.

This Required Action does not require tripping the recirculation pump in the lowest flow loop when the mismatch between total jet pump flows of the two loops is greater than the required limits. However, in cases where large flow mismatches occur, low flow or reverse flow can occur in the low flow loop jet pumps, causing vibration of the jet pumps. If large mismatches are detected, the condition should be alleviated by changing flow control valve position to re-establish forward flow or by tripping the pump, per plant procedures.

(continued)

BASES

ACTIONS (continued)

B.1

AOO

Should a LOCA or ~~transient~~ occur with THERMAL POWER > 2500 MWt during single loop operation, the core response may not be bounded by the safety analyses. Therefore, only a limited time is allowed to reduce THERMAL POWER to ≤ 2500 MWt.

The 1 hour Completion Time is based on the low probability of an accident occurring during this time period, on a reasonable time to complete the Required Action, and on frequent core monitoring by operators allowing changes in THERMAL POWER to be quickly detected.

OR AOO

(continued)

BASES

ACTIONS (continued)

C.1

If the required limit and setpoint modifications for single recirculation loop operation are not performed within 24 hours after transition from two recirculation loop operation to single recirculation loop operation, or requirements b.2, b.3, or b.4 of the LCO are not met for some other reason, the unit must be brought to a MODE in which the LCO does not apply (see Condition D). The 24 hour Completion Time of the Condition provides time before the required modifications to required limits and setpoints have to be in effect after a change in the reactor operating conditions from two recirculation loops operating to single recirculation loop operation. This time is provided due to the need to stabilize operation with one recirculation loop, including the procedural steps necessary to limit flow and adjust the flow control mode (to only Loop Manual mode) in the operating loop, and the complexity and detail required to fully implement and confirm the required limit and setpoint modifications. The 24 hour Completion Time is also based on the low probability of an accident or AOO occurring during this period, on a reasonable time to complete the Required Action, and on frequent monitoring by operators allowing abrupt changes in core flow conditions to be quickly detected.

D.1

With no recirculation loops in operation, or the Required Action and associated Completion Time of Conditions A, B, or C not met, the unit is required to be brought to a MODE in which the LCO does not apply. The plant is required to be placed in MODE 3 within 12 hours. In this condition, the recirculation loops are not required to be operating because of the reduced severity of DBAs and minimal dependence on the recirculation loop coastdown characteristics. The allowed Completion Time of 12 hours is reasonable, based on operating experience, to reach MODE 3 from full power conditions in an orderly manner and without challenging plant systems.

(continued)

BASES (continued)

SURVEILLANCE REQUIREMENTS

SR 3.4.1.1

This SR ensures the recirculation loop flows are within the allowable limits for mismatch. At low core flow (i.e., < 70% of rated core flow), the MCPR requirements provide larger margins to the fuel cladding integrity Safety Limit such that the potential adverse effect of early boiling transition during a LOCA is reduced. A larger flow mismatch can therefore be allowed when core flow is < 70% of rated core flow. The recirculation loop jet pump flow, as used in this Surveillance, is the summation of the flows from all of the jet pumps associated with a single recirculation loop.

The mismatch is measured in terms of percent of rated core flow. This SR is not required when both loops are not in operation since the mismatch limits are meaningless during single loop or natural circulation operation. The Surveillance must be performed within 24 hours after both loops are in operation. The 24 hour Frequency is consistent with the Frequency for jet pump OPERABILITY verification and has been shown by operating experience to be adequate to detect off normal jet pump loop flows in a timely manner.

(continued)

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BASES (continued)

REFERENCES

1. USAR, Section 6.3.3.7.2.
2. USAR, Section 5.4.1.1.
3. USAR, Chapter 15, Appendix 15F.
4. NRC Bulletin 88-07, Supplement 1, "Power Oscillations in Boiling Water Reactors," December 1988.
5. GE Letter, "Interim Recommendations for Stability Actions," November 1988.

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