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TS 6.9.1.9

LR-N09-0115
May 14, 2009

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

Hope Creek Generating Station
Facility Operating License No. NPF-57
NRC Docket No. 50-354

Subject: Core Operating Limits Report, Reload 15, Cycle 16, Revision 3

In accordance with section 6.9.1.9 of the Hope Creek Technical Specifications, PSEG Nuclear LLC (PSEG) submits the Core Operating Limits Report (COLR) for Hope Creek Generating Station (HCGS) Reload 15, Cycle 16, Revision 3. Revision 3 of this report incorporates the revised cycle specific parameters resulting from the new core configuration implemented during HCGS refueling outage RF15.

There are no commitments contained in this letter.

Should you have any questions, please contact Paul Duke at (856) 339-1466.

Sincerely,

Jeffrie J. Keenan
Manager - Licensing

Attachment

cc: S. Collins, Regional Administrator – NRC Region I
R. Ennis, Project Manager - USNRC
NRC Senior Resident Inspector - Hope Creek
P. Mulligan, Manager IV, NJBNE
L. Marabella, Corporate Commitment Tracking Coordinator
T. Devik, HC Commitment Tracking Coordinator

A001
NRR

**Attachment 1**

**Hope Creek Generating Station**
**Facility Operating License No. NPF-57**
**NRC Docket No. 50-354**

**Core Operating Limits Report**
**Reload 15, Cycle 16**
**Revision 3**

# CORE OPERATING LIMITS REPORT

## FOR

## Hope Creek Generating Station Unit 1

## RELOAD 15, CYCLE 16

## Effective Date: 4/28/2009

Prepared By: Kelly A Wichman Date: 4/27/2009

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Prepared By: Francis J Safin Date: 4/27/2009

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Approved By: Date: 4/27/09

Donald V Notigan

Manager - BWR Design & Analysis

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## List of Tables

## 1.0 Terms and Definitions

| | |
|---|---|
| APLHGR | Average Planar Linear Heat Generation Rate |
| ARTS | APRM and RBM Technical Specification Analysis |
| BSP | Backup Stability Protection |
| COLR | Core Operating Limits Report |
| EOC | End of Cycle |
| ECCS | Emergency Core Cooling Systems |
| EOC-RPT | End-Of-Cycle Recirculation Pump Trip |
| GNF-A | Global Nuclear Fuel – Americas, LLC |
| LCO | Limiting Condition for Operation |
| LHGR | Linear Heat Generation Rate |
| $LHGRFAC_f$ | ARTS LHGR thermal limit flow dependent adjustments and multipliers |
| $LHGRFAC_p$ | ARTS LHGR thermal limit power dependent adjustments and multipliers |
| MCPR | Minimum Critical Power Ratio |
| $MCPR_p$ | ARTS MCPR thermal limit power dependent adjustments and multipliers |
| $MCPR_f$ | ARTS MCPR thermal limit flow dependent adjustments and multipliers |
| OPRM | Oscillation Power Range Monitor |
| SLMCPR | Safety Limit Minimum Critical Power Ratio |
| SLO | Single recirculation Loop Operation |
| TLO | Two recirculation Loop Operation |

## 2.0 References

1. "General Electric Standard Application for Reactor Fuel", NEDE-24011-P-A-16, and the Supplement NEDE-24011-P-A-16-US, October 2007.

2. "Supplemental Reload Licensing Report for Hope Creek Unit 1 Reload 15 Cycle 16", Global Nuclear Fuel Document No. 0000-0088-3934-SRLR, Revision 0, March 2009.

3. HCG.5-0094, "Fuel Bundle Information Report for Hope Creek Unit 1 Reload 15, Cycle 16", Global Nuclear Fuel Document No. 0000-0088-3934-FBIR, Revision 1, April 2009.

4. "Technical Specifications and Bases for Hope Creek Generating Station Unit", Docket No. 50-354, License No. NPF-57.

5. "Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications", Global Nuclear Fuel Document NEDO-32465-A, August, 1996.

6. Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Amendment 174 to Facility Operating License No NPF-57, PSEG Nuclear LLC, Hope Creek Generating Station, Docket No. 50-354, May 14, 2008.

7. Licensing Topical Report NEDC-33173P, Applicability of GE Methods to Expanded Operating Domains, January 2008.

8. GE14 Compliance with Amendment 22 of NEDE-24011-P-A (GESTAR II), NEDC-32868P, Revision 3, April 2009.

9. "Supplemental Reload Licensing Report for Hope Creek Unit 1 Reload 14 Cycle 15 EPU", Global Nuclear Fuel Document No. 0000-0078-1947-SRLR, Revision 3, August 2008.

## 3.0 General Information

The purpose of this revision is to provide the Core Operating Limits for Hope Creek Generation Station Unit 1 Cycle 16 / Reload 15 operation. This report will provide information relative to OPRM setpoints and Backup Stability Regions, single recirculation loop operation, and core average scram speed. The power distribution limits presented here correspond to the core thermal limits for Average Planar Linear Heat Generation Rate (APLHGR), Minimum Critical Power Ratio (MCPR), and Linear Heat Generation Rate (LHGR). Finally, this report also provides references to the most recent revision of the implemented approved methodology.

These operating limit values have been determined using NRC approved methods contained in GESTAR-II (Reference 1) and NEDO-32465-A Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications (Reference 5). These operating limit values also include limitations as required by the NRC Safety Evaluation Report for Hope Creek License Amendment Number 174, Extended Power Uprate (Reference 6) for the use of GE Licensing Topical Report NEDC-33173P, Applicability of GE Methods to Expanded Operating Domains (Reference 7). In addition, the LHGR limits developed for this COLR are based upon GE Report, GE14 Compliance with Amendment 22 of NEDE-24011-P-A (GESTAR II), NEDC-32868P, Revision 3, April 2009 (Reference 8). Revision 3 of NEDC-32868P updates the report to include LHGR limit curves to be used by plants referencing NEDC-33173P. The LHGR limit curves address a limitation on the use of NEDC-33173P to incorporate a 350 psi penalty on the fuel rod critical pressure in the development of LHGR limits. The evaluation in Revision 3 of NEDC-32868P demonstrates compliance with fuel licensing criteria while incorporating the 350 psi penalty.

These operating limits are established such that all applicable fuel thermal-mechanical, core thermal-hydraulic, ECCS, and nuclear limits such as shutdown margin, and transient and accident analysis limits are met.

Various sections of the Hope Creek Technical Specifications reference this COLR. Those sections are listed in section 4 of this document. Hope Creek Technical Specification 6.9.1.9 also requires that this report, including any mid cycle revisions, shall be provided, upon issuance, to the NRC.

This document is specific to Hope Creek Generating Station Unit 1 Cycle 16 / Reload 15 and shall not be applicable to any other core or cycle design. This report is applicable for Cycle 16 operation from the date of issuance through the end of cycle including consideration of a power coastdown to a core thermal power that shall not go below 40% rated core thermal power. End of full power capability is reached when 100% rated power can no longer be maintained by increasing core flow (up to 105% of rated core flow), at allowable rated feedwater temperatures, in the all-rods-out configuration. Operation beyond the end of full power capability is defined as power coastdown operation which includes an operating assumption that vessel dome pressure will decrease during the power coastdown period as steam flow decreases (maintaining constant vessel dome pressure during the power coastdown period was not generically considered by GESTAR-II for determining the operating limit LCO values described above).

## 4.0 Technical Specifications that Reference the COLR

The following Hope Creek Technical Specifications reference this COLR:

| Tech. Spec. | Title |
|---|---|
| 2.1 | Safety Limit Bases |
| 3/4.2b | Power Distribution Bases |
| 3/4.2.1 | Average Planar Linear Heat Generation Rate |
| 3/4.2.1b | Average Planar Linear Heat Generation Rate |
| 3/4.2.3 | Minimum Critical Power Ratio |
| 3/4.2.4 | Linear Heat Generation Rate |
| 3/4.3.11 | Oscillation Power Range Monitor |
| 3/4.4.1 | Recirculation System Recirculation Loops |
| 6.9.1.9 | Administrative Controls, Core Operating Limits Report |

## 4.1 Average Planar Linear Heat Generation Rate

**LIMITING CONDITION FOR OPERATION:**

All AVERAGE PLANAR LINEAR HEAT GENERATION RATES (APLHGRs) shall be less than or equal to the limits specified in Table 4.1-1 for Two recirculation Loop Operation (TLO).

When the Technical Specification Section 3/4 .4.1 Action statement a.1.d is entered from that section's Limiting Condition for Operation, reduce the APLHGR limits to the values specified in Table 4.1-1 for Single recirculation Loop Operation (SLO).

Linear interpolation shall be used to determine APLHGR limits as a function of exposure for intermediate values in Table 4.1-1.

**TABLE 4.1-1 APLHGR Data for GE14 Fuel**

| Average Planar Exposure | | APLHGR Limit (kW/ft) | |
|---|---|---|---|
| MWd/MTU | MWd/STU | Two recirculation Loop Operation (TLO) | Single recirculation Loop Operation (SLO) |
| 0.00 | 0.00 | 12.82 | 10.26 |
| 16000 | 14510 | 12.82 | 10.26 |
| 21090 | 19130 | 12.82 | 10.26 |
| 63500 | 57610 | 8.00 | 6.40 |
| 70000 | 63500 | 5.00 | 4.00 |

## 4.2 Minimum Critical Power Ratio

**LIMITING CONDITION FOR OPERATION:**

The MINIMUM CRITICAL POWER RATIO (MCPR) shall be equal to or greater than the MCPR limit computed from the following steps:

1. Determine $\tau$ as defined in Appendix A.

| NOTE |
| --- |
| The SLO operating condition MCPR values in Tables 4.2-1, 4.2-2, and 4.2-4 implement the increase in the MCPR Safety Limit to meet the requirements of Technical Specification Section 3/4.4.1.1 ACTION statement a.1.c. |

2. Linearly interpolate a MCPR value as a function of $\tau$ from the MCPR value at $\tau$=0 and MCPR value at $\tau$=1 as specified in Table 4.2-1 and Table 4.2-2 for the appropriate condition.

3. For the power dependent MCPR adjustment, when thermal power is $\geq$ 24% rated core thermal power, determine a $K_p$ value by linearly interpolating a $K_p$ value as a function of core rated thermal power from Table 4.2-3. Multiply the MCPR value obtained from Step 2 by the $K_p$ value to determine the power dependent MCPR limit.

   When core thermal power is < 24% rated thermal power, no thermal limits are required.

4. For the flow dependent MCPR adjustment, determine the appropriate flow dependent MCPR limit by linearly interpolating between the MCPR limits as a function of rated core flow using the information in Table 4.2-4.

5. Choose the most limiting (highest value) of the power and flow dependent MCPR limits determined in Steps 3 and 4 as the value for the MCPR limit for the Limiting Condition For Operation.

Note that the MCPR limit is a function of core average scram speed ($\tau$), cycle exposure, core thermal power, total core flow, EOC-RPT operability, the number of reactor coolant recirculation loops in operation, and main turbine bypass operability.

EOC-RPT system operability is defined by Hope Creek Technical Specification 3.3.4.2.

Reactor coolant recirculation loop operation is defined by Hope Creek Technical Specification 3.4.1.1.

Main Turbine Bypass operability is defined by Hope Creek Technical Specification 3.7.7.

**TABLE 4.2-1 Cycle 16 MCPR Operating Limits:**
**Cycle Exposure ≤ 12629 MWD/MTU (≤ 11456 MWD/STU)**

| Main Turbine Bypass Operable | | |
|---|---|---|
| Operating Condition | Scram Speed Option | GE14 |
| TLO-EOC-RPT Operable | A | 1.49 |
| | B | 1.38 |
| TLO-EOC-RPT Inoperable | A | 1.51 |
| | B | 1.40 |
| SLO-EOC-RPT Operable | A | 1.51 |
| | B | 1.40 |
| SLO-EOC-RPT Inoperable | A | 1.53 |
| | B | 1.42 |

Scram Speed Option A $\tau$ = 1, Scram Speed Option B $\tau$ = 0, TLO = Two recirculation Loop Operation, SLO = Single recirculation Loop Operation.

**TABLE 4.2-2 Cycle 16 MCPR Operating Limits:**
**Cycle Exposure > 12629 MWD/MTU (> 11456 MWD/STU)**

| Main Turbine Bypass Operable | | |
|---|---|---|
| Operating Condition | Scram Speed Option | GE14 |
| TLO-EOC-RPT Operable | A | 1.61 |
| | B | 1.44 |
| TLO-EOC-RPT Inoperable | A | 1.63 |
| | B | 1.46 |
| SLO-EOC-RPT Operable | A | 1.63 |
| | B | 1.46 |
| SLO-EOC-RPT Inoperable | A | 1.65 |
| | B | 1.48 |

Scram Speed Option A $\tau$ = 1, Scram Speed Option B $\tau$ = 0, TLO = Two recirculation Loop Operation, SLO = Single recirculation Loop Operation.

TABLE 4.2-3 Power Dependent MCPR Multiplier ($K_p$) Data

| Operating Condition | Core Thermal Power (% of Rated) | | | |
|---|---|---|---|---|
| | 24 | 45 | 60 | ≥ 100 |
| | MCPR Multiplier Kp | | | |
| TLO | 1.561 | 1.280 | 1.150 | 1.000 |
| SLO | 1.561 | 1.280 | 1.150 | 1.000 |

$K_p$ is Linearly Interpolated between Core Thermal Power entries. TLO = Two recirculation Loop Operation, SLO = Single recirculation Loop Operation.

TABLE 4.2-4 Flow Dependent MCPR Limit ($MCPR_f$)

| Operating Condition | Core Flow (% of Rated) | | | |
|---|---|---|---|---|
| | 30 | 60 | 80.8 | 105 |
| | MCPR Limit | | | |
| TLO | 1.55 | | 1.25 | 1.25 |
| SLO | 1.57 | 1.39 | | |

MCPRf is Linearly Interpolated between Core Flow entries. TLO = Two recirculation Loop Operation, SLO = Single recirculation Loop Operation.

## 4.3 Linear Heat Generation Rate

**LIMITING CONDITION FOR OPERATION:**

The LINEAR HEAT GENERATION RATE (LHGR) shall not exceed the limit computed from the following steps:

**NOTE**

The exposure dependent Gadolinia fuel rod LHGR limits are not reproduced in the COLR but incorporated by reference (Reference 3) due to the GNF-A proprietary nature of the information. Reference 3 provides the most limiting exposure dependent Gadolinia LHGR limit for each bundle type. The process described in steps 1 through 6 is also applicable to Gadolinia bearing fuel rods.

1. Determine the exposure dependent LHGR limit using linear interpolation between the values in Table 4.3-1 for UO2 fuel rods.

**NOTE**

For Two recirculation Loop Operation (TLO) utilize steps 1, 2, 3 and 6 to determine the LCO LHGR limits.

When the Technical Specification Section 3/4.4.1.1 ACTION statement a.1.e is entered from that section's Limiting Condition for Operation (LCO), utilize steps 1, 4, 5 and 6 to determine the LCO LHGR limits for Single recirculation Loop Operation (SLO).

2. For the power dependent LHGR adjustment for TLO, determine a $LHGRFAC_p$ value by linearly interpolating a $LHGRFAC_p$ value as a function of rated core thermal power from the TLO entries in Table 4.3-2. Multiply the LHGR values obtained from Step 1 by the $LHGRFAC_p$ value to determine the power dependent LHGR limit.

3. For the flow dependent LHGR adjustment for TLO, determine a $LHGRFAC_f$ value by linearly interpolating a $LHGRFAC_f$ value as a function of rated core flow from the TLO entries in Table 4.3-3. Multiply the LHGR values obtained from Step 1 by the $LHGRFAC_f$ value to determine the flow dependent LHGR limit.

4. For the power dependent LHGR adjustment for SLO, determine a $LHGRFAC_p$ value by linearly interpolating a $LHGRFAC_p$ value as a function of rated core thermal power from the SLO entries in Table 4.3-2. Multiply the LHGR values obtained from Step 1 by the $LHGRFAC_p$ value to determine the power dependent LHGR limit.

5. For the flow dependent LHGR adjustment for SLO, determine a $LHGRFAC_f$ value by linearly interpolating a $LHGRFAC_f$ value as a function of rated core flow from the SLO entries in Table 4.3-3. Multiply the LHGR values obtained from Step 1 by the $LHGRFAC_f$ value to determine the flow dependent LHGR limit.

6. Choose the most limiting (lowest value) of the power and flow dependent LHGR limits determined in Steps 2 and 3 (TLO) or 4 and 5 (SLO) as the value for the LHGR limit for the Limiting Condition For Operation.

TABLE 4.3-1 LHGR Data for GE14 Fuel

| Peak Pellet Exposure | | LHGR Limit |
|---|---|---|
| MWd/MTU | MWd/STU | KW/ft |
| 0.00 | 0.00 | 13.40 |
| 16000 | 14510 | 13.40 |
| 55500 | 50350 | 8.80 |
| 63500 | 57610 | 7.10 |
| 70000 | 63500 | 5.00 |

TABLE 4.3-2 Power Dependent Linear Heat Generation Rate Multiplier ($LHGRFAC_p$)

| Operating Condition | Core Thermal Power (% of Rated) | | |
|---|---|---|---|
| | 24 | 60.86 | ≥ 100 |
| | $LHGRFAC_p$ Multiplier | | |
| TLO | 0.603 | | 1.000 |
| SLO | 0.603 | 0.796 | |

TABLE 4.3-3 Flow Dependent Linear Heat Generation Rate Multiplier ($LHGRFAC_f$)

| Operating Condition | Core Flow (% of Rated) | | | | | |
|---|---|---|---|---|---|---|
| | 30 | 50 | 52.7 | 60 | 82.2 | 105 |
| | $LHGRFAC_f$ Multiplier | | | | | |
| TLO | 0.500 | 0.782 | | | 1.000 | 1.000 |
| SLO | 0.500 | 0.782 | 0.800 | 0.800 | | |

## 4.4 OPRM Setpoints

### 4.4.1 1.0 Hz Corner Frequency Setpoints

**LIMITING CONDITION FOR OPERATION:**

Four channels of the OPRM instrumentation shall be OPERABLE. Each OPRM channel period based algorithm amplitude trip setpoint (Sp) shall be less than or equal to the Allowable Value of 1.12.

Additional Information.

The NRC Safety Evaluation Report, dated 12/22/04, which was issued for Technical Specification Amendment Number 159 required that the period based algorithm amplitude trip setpoint (Sp) and confirmation counts be documented in the COLR. Confirmation count information applicable to Cycle 16 is documented below.

For Sp $\geq$ 1.10 but < 1.11, the required minimum number of successive confirmation counts for OPRM setpoint ($N_2$) = 13.

For Sp $\geq$ 1.11, the required minimum number of successive confirmation counts for OPRM setpoint ($N_2$) = 14.

# Appendix A: Method of Core Average Scram Speed Calculation

## Method of Core Average Scram Speed, τ , Calculation

$\tau$ is defined as

$$\tau = \frac{(\tau_{ave} - \tau_B)}{\tau_A - \tau_B}$$

where:

$\tau_A$ = 0.86 seconds, control rod average scram insertion time limit to notch 39 per Specification 3.1.3.3

$$\tau_B = 0.672 + 1.65\left[\frac{N_1}{\sum_{i=1}^{n} N_i}\right]^{1/2} (0.016)$$

$$\tau_{ave} = \frac{\sum_{i=1}^{n} N_i \tau_i}{\sum_{i=1}^{n} N_i}$$

n = number of surveillance tests performed to date in cycle,

$N_i$ = number of active control rods measured in the $i^{th}$ surveillance test,

$\tau_i$ = average scram time to notch 39 of all rods measured in the $i^{th}$ surveillance test, and

$N_1$ = total number of active rods measured in Specification 4.1.3.2.a.

If $\tau_{ave} \leq \tau_B$ , set $\tau$ = 0 to apply Option B OLMCPR.

$\tau$ shall be 1.0 ($\tau$ = 1.0) prior to performance of the initial scram time measurements for the cycle in accordance with Specification 4.1.3.2.

# Appendix B: Backup Stability Protection

### Backup Stability Protection Region Intercepts

The BSP region endpoints given in Table B-1 are bounding for Cycle 16. The region boundaries are defined using the Generic Shape Function and the applicable endpoints given in the tables below (Reference 2 and Reference 9).

**Table B-1 BSP Region Intercepts at EOC for Cycle 15**

Region 1 = BSP Scram Region
Region 2 = BSP Controlled Entry Region

| Region Boundary Intercept | % Power | % Flow |
|---|---|---|
| Region 1 High Flow Control Line | 62.8 | 45.5 |
| Region 1 Natural Circulation Line | 44.7 | 35.0 |
| Region 2 High Flow Control Line | 67.2 | 51.1 |
| Region 2 Natural Circulation Line | 32.2 | 36.3 |

The cycle specific calculated BSP region endpoints for Cycle 16 are given in Table B-2.

**Table B-2 BSP Region Intercepts for Cycle 16**

| Region Boundary Intercept | % Power | % Flow |
|---|---|---|
| Region 1 High Flow Control Line | 58.2 | 40.0 |
| Region 1 Natural Circulation Line | 44.7 | 35.0 |
| Region 2 High Flow Control Line | 66.5 | 50.2 |
| Region 2 Natural Circulation Line | 32.2 | 36.3 |