Attachment 2

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NEDO-33172
SAFER/GESTR-LOCA Loss of Coolant Analysis for Hope Creek Generating Station at Power Uprate

GE Energy, Nuclear

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SAFER/GESTR-LOCA
Loss of Coolant Accident Analysis
for
Hope Creek Generating Station
at Power Uprate

Approved by: Jeff Tuttle

Jeff Tuttle
Project Manager

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SUMMARY

A design requirement for nuclear power plants is the capability to withstand Design Basis Accidents. One of the postulated accidents is a guillotine break in the largest size pipe connected to the reactor vessel. Historically, the analysis of the large break loss-of-coolant accident (LOCA) had been performed on a very conservative basis with margin added at every step of the calculation. This was done partly as a result of the restrictions imposed by the requirements of 10CFR50.46 and Appendix K, and partly to compensate for uncertainties inherent in the simplified models. However, after years of research with large-scale experiments and the development of the best-estimate codes, improved and more realistic boiling water reactor (BWR) licensing models (i.e., SAFER/GESTR-LOCA) have been approved by the U.S. Nuclear Regulatory Commission (NRC). These new models calculate more realistic (yet conservative) peak cladding temperatures (PCT) to relieve unnecessary plant operating and licensing restrictions. More realistic analyses also predict actual plant response during postulated accidents and can be used as a basis for more appropriate operator actions. The LOCA analysis for Hope Creek uses these models and this licensing methodology.

The SAFER and GESTR-LOCA models are coupled, mechanistic, reactor system thermal hydraulic and fuel rod thermal-mechanical evaluation models. These models are based on realistic correlations and inputs. The SAFER/GESTR-LOCA methodology approved by the NRC allows the plant-specific break spectrum to be defined using nominal input assumptions. However, the calculation of the limiting PCT to demonstrate conformance with the requirements of 10CFR50.46 must include specific inputs documented in Appendix K. The SAFER/GESTR-LOCA Application Methodology requires:

(1) The Licensing Basis PCT must be less than 2200°F. This Licensing Basis PCT is derived by adding appropriate margin for specific conservatism required by Appendix K of 10CFR50 to the limiting PCT value calculated using nominal values.

(2) The Licensing Basis PCT is required to be greater than the Upper Bound PCT.

(3) The NRC placed a restriction of 1600°F on the Upper Bound PCT in the Safety Evaluation Report (SER) approving the SAFER/GESTR-LOCA application methodology. This restriction is based on the range of test data and analyses used to generically qualify the SAFER code and application methodology. Therefore, it is required that the Upper Bound PCT be below 1600°F, otherwise additional plant

specific analyses must be performed.

The Upper Bound PCT limit of 1600°F was removed in a Supplemental Licensing Topical Report, Reference 8. Reference 8 shows that GE has performed the plant specific Upper Bound PCT calculations for its entire product line and unless there are significant changes to the plant's configuration, plant specific evaluation of Upper Bound PCT is not required.

The SAFER/GESTR-LOCA analysis for Hope Creek was performed in accordance with NRC requirements and demonstrates conformance with the Emergency Core Cooling System (ECCS) acceptance criteria of 10CFR50.46 Appendix K. A sufficient number of plant-specific break sizes were evaluated to establish the behavior of both the nominal and Appendix K PCTs as a function of break size. Different single failures were also investigated in order to clearly identify the worst cases. The Hope Creek specific ECCS analysis was performed with conservative values for the Peak Linear Heat Generation Rate (PLHGR) and initial Minimum Critical Power Ratio. This analysis is applicable to the rated thermal power of 3840 MWt (nominal assumptions) and the following operating conditions: Maximum Extended Operating Domain (MEOD) [includes Maximum Extended Load Line Limit (MELLL) and Increased Core Flow (ICF)], and Single Loop Operation (SLO). The analysis results demonstrated that the five acceptance criteria specified in 10CFR50.46 for ECCS performance analyses are satisfied. The Licensing Basis PCTs for Hope Creek are 1380°F for GE14 and 1540°F for SVEA-96+, which are below the 2200°F limit. Therefore, the Hope Creek specific analysis meets the NRC SAFER/GESTR-LOCA licensing analysis requirements.

1.0 INTRODUCTION

This document provides the results of the Loss-of-Coolant Accident (LOCA) analysis performed by GE Nuclear Energy (GE-NE) for Hope Creek Generating Station. The analysis was performed using the SAFER/GESTR-LOCA Application Methodology approved by the Nuclear Regulatory Commission (NRC) (Reference 1). This analysis was performed assuming a rated thermal power level of 3840 MWt. The analysis addresses a core flow range from 94.8% to 105% of rated core flow and a single loop operation assuming a nominal power level of 2337 MWt at 60% of the rated core flow. Additional analysis performed at core thermal power levels at 3506 MWt and 3673 MWt and rated core flow. Calculated results are also included in the report for comparison.

The LOCA analysis was performed in accordance with NRC requirements to demonstrate conformance with the ECCS acceptance criteria of 10CFR50.46. A key objective of the LOCA analysis is to provide assurance that the most limiting break size, break location, and single failure combination has been considered. Reference 2 documents the requirements and the approved methodology to satisfy these requirements.

The SAFER/GESTR-LOCA application methodology is based on the generic studies presented in the Reference 2 documentation. The approved application methodology consists of three essential parts. First, potentially limiting LOCA cases are determined by applying realistic (nominal) analytical models across the entire break spectrum. Second, limiting LOCA cases are analyzed with an Appendix K model (inputs and assumptions), which incorporates all the required features of 10CFR50 Appendix K. For the most limiting cases, a Licensing Basis Peak Cladding Temperature (PCT) is calculated based on the nominal PCT with an adder to account statistically for the differences between the nominal and Appendix K assumptions. The application methodology required a statistically derived Upper Bound PCT to be calculated to demonstrate the conservatism of the Licensing Basis PCT. The resulting Licensing Basis PCT would then conform to all the requirements of 10CFR50.46 and Appendix K.

As discussed in Section 3.2, further plant specific evaluation of Upper Bound PCT is no longer required to meet the SAFER/GESTR-LOCA application methodology requirements, unless there are significant changes in the plant's configuration.

2.0 DESCRIPTION OF MODELS

Four GE-NE computer models were used in the LOCA analysis to determine the LOCA response for Hope Creek. These models are LAMB, SCAT/TASC, GESTR-LOCA, and SAFER. Together, these models evaluate the short-term and long-term reactor vessel blowdown response to a pipe rupture, the subsequent core flooding by ECCS, and the final rod heatup. Figure 2-1 is a flow diagram of these computer models, including the major code functions and the transfer of major parameters. The purpose of each model is described in the following subsections.

2.1 LAMB

This model (Reference 3) analyzes the short-term blowdown phenomena for postulated large pipe breaks in which nucleate boiling is lost before the water level drops sufficiently to uncover the active fuel. The LAMB output (primarily core flow as a function of time) is used in the SCAT model for calculating blowdown heat transfer and fuel dryout time.

2.2 SCAT/TASC

This model (Reference 3) completes the transient short-term thermal-hydraulic calculation for large recirculation line breaks. Developed for GE11 and later fuels with partial-length rods, an improved SCAT model (designated "TASC") is used to predict the time and location of boiling transition and dryout. The time and location of boiling transition is predicted during the period of recirculation pump coastdown. When the core inlet flow is low, TASC also predicts the resulting bundle dryout time and location. The calculated fuel dryout time is an input to the long-term thermal-hydraulic transient model, SAFER.

2.3 GESTR-LOCA

This model (Reference 4) provides the parameters to initialize the fuel stored energy and fuel rod fission gas inventory at the onset of a postulated LOCA for input to SAFER. GESTR-LOCA also establishes the transient pellet-cladding gap conductance for input to both SAFER and SCAT/TASC.

2.4 SAFER

This model (References 5 and 6) calculates the long-term system response of the reactor over a complete spectrum of hypothetical break sizes and locations. SAFER is compatible with the

GESTR-LOCA fuel rod model for gap conductance and fission gas release. SAFER calculates the core and vessel water levels, system pressure response, ECCS performance, and other primary thermal-hydraulic phenomena occurring in the reactor as a function of time. SAFER realistically models all regimes of heat transfer that occur inside the core, and provides the heat transfer coefficients (which determine the severity of the temperature change) and the resulting PCT as functions of time. For GE11 and later fuel analysis with the SAFER code, the part length fuel rods are treated as full-length rods, which conservatively overestimate the hot bundle power.

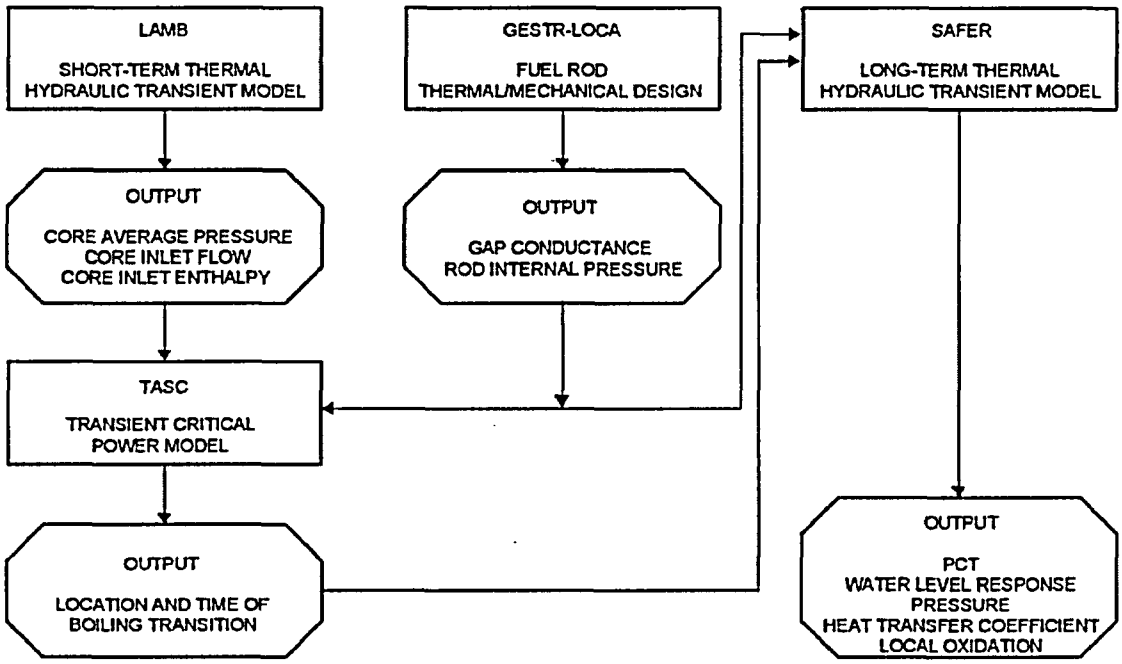


Figure 2-1. Flow Diagram of LOCA Analysis Using SAFER/GESTR

3.0 ANALYSIS PROCEDURE

3.1 LICENSING CRITERIA

The Code of Federal Regulations (10CFR50.46) outlines the acceptance criteria for ECCS performance analyses. A summary of the acceptance criteria is provided below.

Criterion 1 - Peak Cladding Temperature - The calculated maximum fuel element cladding temperature shall not exceed 2200°F.

Criterion 2 - Maximum Cladding Oxidation - The calculated local oxidation shall not exceed 0.17 times the cladding thickness before oxidation.

Criterion 3 - Maximum Hydrogen Generation - The calculated total amount of hydrogen generated from the chemical reaction of the cladding with water or steam shall not exceed 0.01 times the hypothetical amount that would be generated if all the metal in the cladding cylinder surrounding the fuel, excluding the cladding surrounding the plenum volume, were to react.

Criterion 4 - Coolable Geometry - Calculated changes in core geometry shall be such that the core remains amenable to cooling.

Criterion 5 - Long-Term Cooling - After any calculated successful initial operation of the ECCS, the calculated core temperature shall be maintained at an acceptably low value and decay heat shall be removed for the extended period of time required by the long-lived radioactivity remaining in the core.

Conformance with Criteria 1 through 3 for Hope Creek is presented in this report. As discussed in Reference 3, conformance with Criterion 4 is demonstrated by conformance to Criteria 1 and 2. The bases and demonstration of compliance with Criterion 5 are documented in References 3 and 6, and remain unchanged by application of SAFER/GESTR-LOCA.

3.2 SAFER/GESTR-LOCA LICENSING METHODOLOGY

The SAFER/GESTR-LOCA licensing methodology approved by the NRC in Reference 1 allows the plant-specific break spectrum to be defined using nominal input assumptions. However, the calculation of the limiting PCT to demonstrate conformance with the requirements of 10CFR50.46 must include specific inputs and models required by Appendix K.

The Licensing Basis PCT is based on the most limiting LOCA (highest PCT) and is defined as:

$$PCT_{Licensing} = PCT_{Nominal} + ADDER$$

The value of ADDER is calculated as follows:

$$ADDER^2 = [PCT_{App.K} - PCT_{Nominal}]^2 + \Sigma(\delta PCT_i)^2$$

where:

$PCT_{App.K}$ = Peak cladding temperature from calculation using Appendix K specified models and inputs.

$PCT_{Nominal}$ = Peak cladding temperature from nominal case.

$\Sigma(\delta PCT_i)^2$ = Plant variable uncertainty term.

The plant variable uncertainty term accounts statistically for the uncertainty in parameters that are not specifically addressed by 10CFR50 Appendix K.

To conform to 10CFR50.46 and the SAFER/GESTR-LOCA licensing methodology, the Licensing Basis PCT must be less than 2200°F.

Demonstration that the Licensing Basis PCT calculated above is sufficiently conservative is also required through the use of a statistical Upper Bound PCT as defined in Reference 2. The Upper Bound PCT is required to be less than the Licensing Basis PCT. This ensures that the Licensing Basis PCT bounds the expected PCT for at least 95% of all postulated limiting break LOCAs, which occur from limiting initial conditions. As part of the development of SAFER/GESTR-LOCA licensing methodology, GE-NE demonstrated that this criterion was satisfied generically for the BWR-3 through BWR-6 classes of plants. As shown in Reference 8, further plant specific Upper Bound PCT calculations are no longer required. In Reference 2, the application methodology was accepted on a generic basis for an Upper Bound PCT up to 1600°F. This 1600°F restriction was removed in Reference 8. Section 5.2.2 demonstrates that the Licensing Basis PCTs for the fuels and conditions analyzed bound the estimated Upper Bound PCTs based on a plant-specific Upper Bound PCT calculation previously performed.

3.3 Generic Analysis

Hope Creek was designed as one of the GE BWR/4 product line plants; however, the ECCS includes features that are used in the BWR-5/6 plants. The LPCI injection is into the bypass region of the core and part of the HPCI flow is used for high pressure core spray. As such, the Hope Creek response to a LOCA event is closer to that of a BWR-5/6 than a BWR-4. GE-NE performed a generic conformance calculation on the limiting hypothetical LOCA (Reference 2) for GE BWR plants which have LPCI injection into the bypass region (BWR-5/6 and some BWR/4 such as Hope Creek). The SAFER analysis of a typical BWR/6 was performed for this purpose. The limiting LOCA was determined from the nominal break spectrum as the break size and single ECCS component failure combination yielding the highest nominal PCT. The Appendix K calculation was then performed for this limiting LOCA event to establish the basis for the licensing evaluation.

The DBA suction break with failure of the High Pressure Core Spray (HPCS) was generically found to be the limiting break in the nominal break spectrum for BWR/6 plants. In Hope Creek, there is no HPCS; the high-pressure make-up system is not available due to the limiting failure of Channel A DC failure. The Hope Creek High Pressure Coolant Injection (HPCI) system injects part of its makeup flow through the core spray. As a result, these cases were used to perform the Appendix K calculations. The Licensing Basis PCTs were then calculated by combining the nominal PCTs with the adders described in Section 3.2.

3.4 Hope Creek Plant-Specific Analysis

As discussed in the SER (Reference 2) the determination of the limiting case LOCA is based on:

1. The generic Appendix K PCT versus break size curve exhibits the same trends as the generic Nominal PCT versus break size curve for a given class of plants;

2. The limiting LOCA determined from Nominal calculations is the same as that determined from Appendix K calculations for a given class of plants; and

3. Both generic and Nominal PCT versus break size curve and Appendix K PCT versus break size curve for a given class of plants are shown to be applicable on a plant specific basis. Necessary conditions for demonstrating applicability include:

    a. Calculation of a sufficient number of plant specific PCT points to verify the shape of the curve;

b. Confirmation that plant specific Appendix K PCT calculations match the trend of the generic curve for that plant class;
c. Confirmation that plant specific operating parameters have been conservatively bounded by the models and inputs used in the generic calculations;
d. Confirmation that the plant specific ECCS is consistent with the referenced plant class ECCS configuration.

Conformance to conditions 1 and 2 has been demonstrated in Reference 2. In order to show that conditions 3a and 3b have been satisfied, plant specific analyses for break sizes ranging from 0.05 ft^2 to the maximum DBA recirculation suction line break (4.085 ft^2) were performed. Compliance with conditions 3c and 3d are demonstrated with a plant specific Upper Bound PCT calculation.

Different single failures were also investigated to identify the worst cases. The break spectrum was first evaluated using nominal analysis assumptions (Table 3-1). The potentially limiting cases were then analyzed again with the analysis assumptions specified for the Appendix K calculations (Table 3-2). The normalized decay heat fractions used are shown in Figure 3-1. The Hope Creek nominal and Appendix K results were compared to assure that the PCT trends as a function of the break size were consistent with one another and with those of the generic BWR/6 break spectrum curve documented in Reference 2.

The Hope Creek SAFER/GESTR-LOCA analysis was performed using conservative values for Peak Linear Heat Generation Rate (PLHGR) and Initial Minimum Critical Power Ratio (MCPR) for the fuel types analyzed. Inputs used in the analysis are given in Section 4.

3.5 Analysis of Mixed Cores

The SAFER/GESTR-LOCA analysis assumes an equilibrium core loading. This approach is acceptable because of the channeled configuration of BWR fuel assemblies. There is no channel-to-channel cross flow inside the core and the only issue of hydraulic compatibility of the various bundle types in a core is the bundle inlet flow rate variation. In order to provide an acceptable response during normal operation and transients, the overall bundle design is constrained such that the hydraulic response is similar between different fuel product lines. As a result, there is no significant difference in the hydraulic response for a mixed core as compared to an equilibrium core.

The SAFER analysis is insensitive to mixed cores. The PCT is determined by hot channel response. The hot bundle hydraulics are driven by the overall core pressure drop. This basic premise is valid because no channel-to-channel interaction occurs during a LOCA. In addition, the SAFER single channel modeling is conservative when compared to a multiple channel model (such as TRACG). TRACG models several core regions with multiple channels in each region. The conservatism in the SAFER modeling is shown in the Upper Bound PCT evaluation in Appendix A of NEDC-23785-1-PA, Volume III (Reference 4). This conservatism is on the order of 175°F, which is much greater than the PCT variation resulting from mixed cores.

The first peak PCT is primarily influenced by the timing of boiling transition at the various elevations in the bundle. The boiling transition in the bundle is governed by the core flow coastdown characteristics and the bundle power level. The core flow coastdown is a core-wide phenomenon determined by the initial core flow and the recirculation pump coastdown, neither of which are dependent on the fuel type. The bundle power also affects the boiling transition time; a higher power bundle will experience an earlier and potentially deeper boiling transition. Because of the channeled configuration of BWR fuel assemblies, there is no channel-to-channel cross flow inside the core. The boiling transition in one bundle will not affect the other bundles in the core. The second peak PCT is primarily influenced by bundle flooding from the bottom. This is a low flow rate process that is governed by the ECCS system capacity. There is no channel-to-channel interaction during this time. Therefore, the transition from a mixed core to an equilibrium core is not expected to affect the second peak PCT response.

Fuels from other vendors are analyzed in GE's thermal-hydraulic methodologies, including SAFER/GESTR-LOCA, as if they were GE fuel. The inputs to the thermal-hydraulic codes are flexible and can be adapted to a large variety of bundle designs. Sufficient information is

obtained from the other vendor to allow modeling the thermal-hydraulic behavior of the other vendor's fuel using GE's codes. Most inputs can be used directly (e.g., dimensions, weights, material properties). A controlled benchmarking approach is used to model critical fuel performance correlations (e.g., boiling transition, bundle pressure drop) in a format compatible with GE's methods.

Table 3-1

ANALYSIS ASSUMPTIONS FOR NOMINAL CALCULATIONS
(Reference 2)

1.	Decay Heat	1979 American Nuclear Society (ANS) (Figure 3-1)
2.	Transition Boiling Temperature	Iloeje correlation
3.	Break Flow	1.25 HEM[1] (subcooled) 1.0 HEM[1] (saturated)
4.	Metal-Water Reaction	EPRI coefficients
5.	Core Power	3840 MWt
6.	Peak Linear Heat Generation Rate	See Table 4-2
7.	Bypass Leakage Coefficients	Nominal values
8.	Initial Operating Minimum Critical Power Ratio (MCPR)	See Table 4-2
9.	ECCS Water Enthalpy (Temperature)	88 Btu/lbm (120 °F)
10.	ECCS Initiation Signals	(See Table 4-3)
11.	Automatic Depressurization System	120-second delay time (Table 4-3)
12.	ECCS Available	Systems remaining after worst case single failure.
13.	Stored Energy	Best Estimate GESTR-LOCA
14.	Fuel Rod Internal Pressure	Best Estimate GESTR-LOCA
15.	Fuel Exposure	Limiting fuel exposure which maximizes PCT

(1) HEM: Homogeneous Equilibrium Model.

Table 3-2

ANALYSIS ASSUMPTIONS FOR APPENDIX K CALCULATIONS
(Reference 2)

1.	Decay Heat	1971 ANS + 20% Decay Heat (Figure 3-1)
2.	Transition Boiling Temperature	Transition boiling allowed during blowdown only until cladding superheat exceeds 300°F.
3.	Break Flow	Moody Slip Flow Model with discharge coefficients of 1.0, 0.8, and 0.6.
4.	Metal-Water Reaction	Baker–Just
5.	Core Power	3917 MWt [1]
6.	Peak Linear Heat Generation Rate	See Table 4-2
7.	Bypass Leakage Coefficients	Same as Table 3–1
8.	Initial Operating Minimum Critical Power Ratio (MCPR)	See Table 4-2
9.	ECCS Water Enthalpy (Temperature)	Same as Table 3–1
10.	ECCS Initiation Signals	Same as Table 3–1
11.	Automatic Depressurization System	Same as Table 3–1
12.	ECCS Available	Same as Table 3–1
13.	Stored Energy	Same as Table 3–1
14.	Fuel Rod Internal Pressure	Same as Table 3–1
15.	Fuel Exposure	Same as Table 3–1

(1) 102% of nominal core power (1.02 x 3840 MWt) and 102% of bundle power were used in the Appendix K analysis.

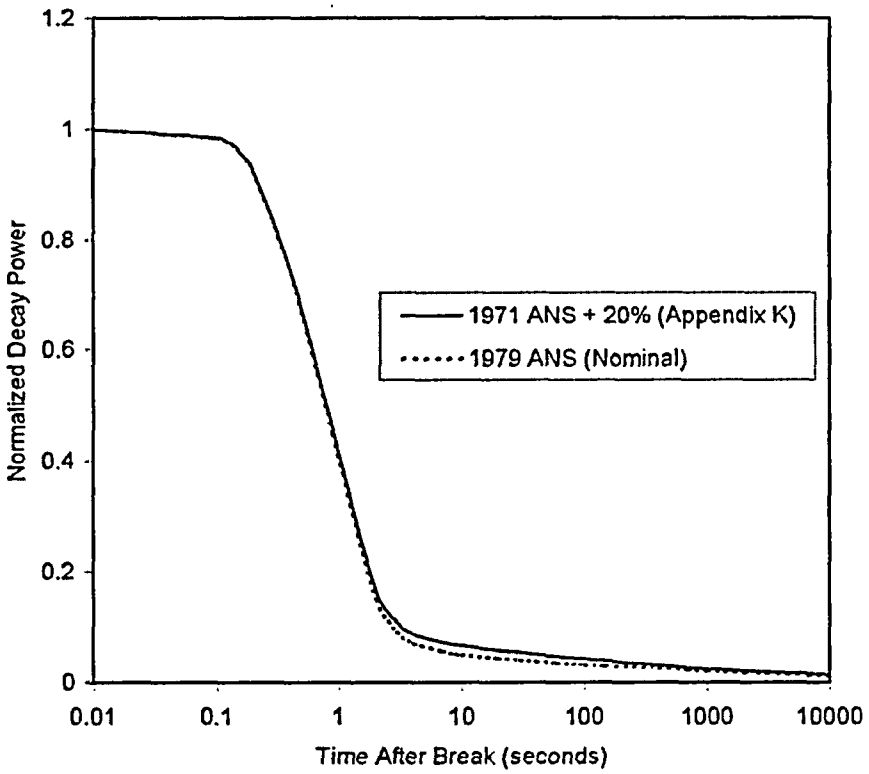


Figure 3-1. Hope Creek Decay Heat Used for Nominal and Appendix K Calculations

4.0 INPUT TO ANALYSIS

4.1 PLANT INPUTS

The plant input parameters to Hope Creek LOCA analysis are presented in Tables 4-1, 4-2 and 4-3. Table 4-1 shows the plant operating conditions, Table 4-2 shows the fuel parameters, and Table 4-3 identifies the key ECCS parameters used in the analysis. Table 4-4 identifies the combinations of single failures and available systems specifically analyzed for the Hope Creek ECCS configuration, illustrated in Figure 4-1.

4.2 FUEL PARAMETERS

All SAFER/GESTR-LOCA analyses were performed with a conservative Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) at the most limiting combination of power and exposure (Table 4-2). These values were carefully selected in order to meet the 10CFR50.46 acceptance criteria. The values shown in Table 4-2 for MAPLHGR and PLHGR are used for the Nominal and Appendix K analyses. The axial power shape is varied for each analyzed power / flow condition to place the hot bundle on the PLHGR limit while the bundle power is on the MCPR limit.

4.3 ECCS PARAMETERS

The Hope Creek SAFER/GESTR-LOCA analysis incorporates values for the ECCS performance parameters that are consistent with those documented in Reference 11 and the current Technical Specifications. Table 4-3 shows a summary of specific performance input parameters used in the analysis (and in the Reference 11 analysis). Table 4-3 is applied to all fuel types and initial conditions. Note that the analysis is performed with a LPCI flow rate that assumes the minimum flow bypass valve remains open.

Table 4-1

PLANT PARAMETERS USED IN
HOPE CREEK SAFER/GESTR-LOCA ANALYSIS

Plant Parameters	Nominal	Appendix K
Core Thermal Power (MWt)	3840	3917
Corresponding Power (% of 3840 MWt)	100	102
Vessel Steam Output (lbm/hr)	16.773×10^6	17.198×10^6
Rated Core Flow (lbm/hr)[1]	100×10^6	100×10^6
Vessel Steam Dome Pressure (psia)	1020	1055
Maximum Recirculation Suction Line Break Area (ft^2)	4.085[2]	4.085[2]

(1) The break spectrum determination of worst single failure was performed at rated core flow of 100 Mlb/hr. The limiting LOCA cases were analyzed for a core flow range of 94.8 Mlb/hr to 105 Mlb/hr (94.8% to 105%) of rated core flow at 3840 and 3917 MWt core power.

(2) Includes area of bottom head drain.

Table 4-2
FUEL PARAMETERS USED IN HOPE CREEK
SAFER/GESTR-LOCA ANALYSIS

Fuel Parameter	Analysis Value	
	GE14	SVEA-96+
PLHGR (kW/ft) - Appendix K - Nominal	[[ ]]	See Note 3
MAPLHGR (kW/ft) - Appendix K - Nominal	12.82x1.02 12.24	See Note 3
Worst Case Pellet Exposure (1) (MWd/MTU)	[[ ]]	See Note 3
Initial Operating MCPR – Analysis Limit – Appendix K – Nominal	 1.25 1.25 ÷ 1.02 1.25 + 0.02	 1.25 1.25 ÷ 1.02 1.25 + 0.02
Number of Fuel Rods per Bundle (2)	92	96

Notes:
(1) This is the exposure at the knee in the PLHGR curve for each fuel. It represents the limiting operating condition resulting in the maximum calculated PCT at anytime during the fuel bundle life.
(2) GE14 (10x10) has 2 water rods occupying a 8-rod space. SVEA-96+ (10x10) has no water rods, but has a water channel occupying a 4-rod space.
(3) The PLHGR curve for SVEA-96+ fuel is Westinghouse Proprietary and cannot be included. The SVEA-96+ analysis was performed at the exposure with the highest PLHGR.

Table 4-3

HOPE CREEK SAFER/GESTR-LOCA ANALYSIS ECCS PARAMETERS

1. Low Pressure Coolant Injection (LPCI) System

Variable	Units	Analysis Value
a. Maximum vessel pressure at which pumps can inject flow	psid (vessel to drywell)	286
b. Minimum flow to reactor vessel with minimum flow bypass valve open		
• Vessel pressure at which below listed flow rates are quoted	psid (vessel to drywell)	20
• 1 LPCI pump	gpm	9000[1]
• 2 LPCI pumps	gpm	18000[1]
• 3 LPCI pumps	gpm	27000[1]
• 4 LPCI pumps	gpm	36000[1]
c. Minimum flow to reactor vessel at 0 psid with minimum flow bypass valve open		
• 1 LPCI pump	gpm	10600[1]
• 2 LPCI pumps	gpm	21200[1]
• 3 LPCI pumps	gpm	31800[1]
• 4 LPCI pumps	gpm	42400[1]
d. Initiating Signals		
• Low water level (L1)	inches (above vessel zero)	378.5
Or		
• High drywell pressure	psig	2.0
e. Vessel pressure at which injection valve may open	psig	360
f. Time from initiating signal (Item 1.d) to system capable of delivering full flow (power available, pump at rated speed, and injection valve fully open)	sec	40[2]
g. Injection valve stroke time–opening	sec	24[2]

(1) These flow rates assume the minimum flow bypass valve does not close. Flow rates are increased by 1000 gpm per pump when the bypass valve closes. These flow rates to the vessel are reduced by 80 gpm to account for leakage.

(2) This does not include signal processing delay time (1 sec).

Table 4-3 (cont.)
HOPE CREEK SAFER/GESTR-LOCA ANALYSIS ECCS PARAMETERS

2. Core Spray (CS) System

Variable	Units	Analysis Value
a. Maximum vessel pressure at which pumps can inject flow	psid (vessel to drywell)	289
b. Minimum flow to reactor vessel		
• Vessel pressure at which below listed flow rate is quoted	psid (vessel to drywell)	105
• Minimum flow of one core spray loop	gpm	5650[2]
c. Minimum flow of one core spray loop at 0 psid	gpm	7000[2]
d. Initiating Signals		
• Low water level (L1)	inches (above vessel zero)	378.5
or		
• High dry well pressure	psig	2.0
e. Vessel pressure at which injection valve may open	psig	425
f. Injection valve stroke time–opening	sec	12[1]
g. Time from initiating signal (Item 2.d) to system capable of delivering full flow (power available, pump at rated speed and injection valve fully open)	sec	27[1]

[1] This does not include signal processing delay time (1 sec).
[2] The flow rate to vessel is reduced by 100 gpm to account for leakage.

Table 4-3 (cont,)
HOPE CREEK SAFER/GESTR-LOCA ANALYSIS ECCS PARAMETERS

3. High Pressure Coolant Injection (HPCI) System

Variable	Units	Analysis Value
a. Operating Vessel Pressure Range	psid (vessel to drywell)	200 to 1141
b. Minimum flow required over the entire above pressure range	gpm	5600
c. Minimum rated HPCI flow injected through the core spray sparger	gpm	2000
d. Initiating Signals		
• Low water level (L2)	inches (above vessel zero)	469.5
or		
• High drywell pressure	psig	2.0
e. Maximum allowable time delay from initiating signal (Item 3.d) to system capable of delivering full flow (pump at rated speed and injection valve fully open)	sec	35[1]

[1] This does not include signal processing delay time (1 sec).

Table 4-3 (cont,)

HOPE CREEK SAFER/GESTR-LOCA ANALYSIS ECCS PARAMETERS

4. Automatic Depressurization System (ADS)

Variable	Units	Analysis Value
a. Number of ADS valves		
• Total number of relief valves with ADS function	-	5
• Total number of relief valves with ADS function assumed available in the analysis	-	5[3]
b. Pressure at which below listed capacity is quoted	psig	1125
c. Minimum flow capacity for one ADS valve	lbm/hr	800000
d. Initiating Signals		
• Low water level (L1)	inches (above vessel zero)	378.5
and		
• High drywell pressure	psig	2.0
or		
High drywell pressure bypass timer timed out	sec	360
and		
• Confirming signal that 1 LPCI or LPCS is running		
e. Delay time from initiating signal completed to time valves start to open	sec	120[4]

[3] The small break analyses assume five ADS valves to be functioning, but the ADS sensitivity studies were analyzed assuming four ADS valves are functioning.

[4] This does not include signal processing delay time (1 sec).

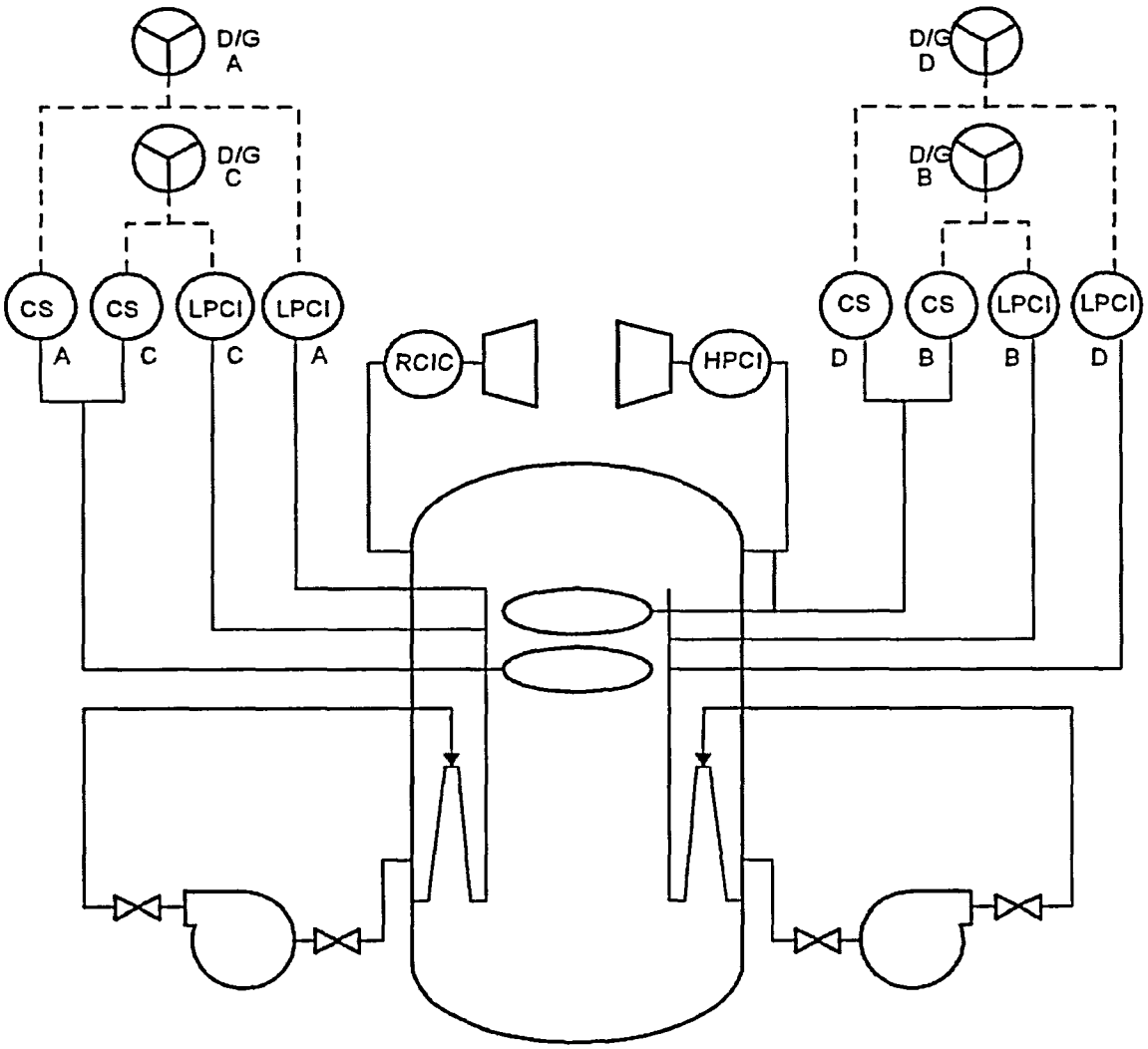
Table 4-4
HOPE CREEK SINGLE FAILURE EVALUATION

Assumed Failure[1]	Systems Remaining[2]
Channel A DC Source (Battery)	1 LPCS, 3 LPCI, ADS[3]
LPCI Injection Valve (LPCI IV)	2 LPCS, 3 LPCI, HPCI, ADS[3]
Diesel Generator (D/G)	1 LPCS, 3 LPCI, HPCI, ADS[3]
HPCI	2 LPCS, 4 LPCI, ADS[3]

(1) Other postulated failures are not specifically considered because they all result in at least as much ECCS capacity as one of the assumed failures.

(2) Systems remaining, as identified in this table, are applicable to all non-ECCS line breaks. For a LOCA from an ECCS line break, the systems remaining are those listed, less the ECCS system in which the break is assumed.

(3) Five ADS valves are assumed for the small break analyses. Four operable ADS valves (one non-functioning ADS in addition to the single failure) are conservatively assumed for large break analyses and a separate small break sensitivity study to determine the impact of an ADS valve out-of-service.



* NOTE: BOTH CORE SPRAY PUMPS IN A SYSTEM MUST OPERATE TO ASSURE ADEQUATE SPRAY DISTRIBUTION

Figure 4-1. Hope Creek ECCS Configuration

5.0 RESULTS

5.1 BREAK SPECTRUM CALCULATIONS

5.1.1 Recirculation Line Breaks

The recirculation line break spectrum was analyzed for the GE14 and SVEA-96+ fuel types using the nominal and Appendix K assumptions and inputs discussed in Section 4.0. The bottom head drain flow path was included in the recirculation line break cases. The results are listed in Table 5-1 and it can be seen that battery failure is the limiting single failure for both large and small breaks. A sufficient number of breaks were analyzed to establish the shape of the PCT versus break area curve (break spectra shown in Figure 5-1 for GE14 and Figure 5-2 for SVEA-96+). This ensures that the limiting combination of the break size, location, and single failure has been identified and is consistent with that determined in the generic evaluation.

5.1.1.1 Nominal Calculations

The nominal assumptions used in the analysis are listed in Table 3-1. Table 5-1 is a summary of the results. The resulting PCTs, plotted for the break spectra in Figures 5-1 and 5-2, show that nominal PCT decreases with decreasing break size from DBA to the 0.5 ft^2 range, which is consistent with the trends observed in the generic break spectra, Reference 2. In the large break range, the cladding temperature histories show two peaks during the heatup period. The first peak is due to early transition to film boiling (dryout) and is not sensitive to differences in break sizes. The second peak temperature is caused by core uncovery. Both 1st peak and 2nd peak PCTs are provided for large breaks in Table 5-1 to show the trend of PCTs with break sizes. Except for DBA break with SVEA-96+ fuel, which has a low 1st peak PCT, the nominal PCTs for the large breaks ($\geq$1 ft^2) are 1st peak limited; the 2nd peak PCT is strongly dependent on the ECCS performance. The dryout times were calculated for DBA suction break for both GE14 and SVEA-96+ fuels. The dryout times for other large break sizes were estimated based on the DBA dryout times adjusted for the smaller break sizes. No adjustment for penetration of the early boiling transition is made. This approach results in conservative estimation of the dryout times for non-DBA large breaks. The PCTs for the recirculation suction line breaks with nominal conditions are shown in Table 5-1. All break sizes in Table 5-1 are analyzed with a LPCI flow rate that assumes the minimum flow bypass valve remains open. [[

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For small breaks (≤ 1.0 ft^2), ECCS injection depends on reactor depressurization due to initiation of the Automatic Depressurization System (ADS). The highest calculated PCT in the small break range occurs near 0.1 ft^2. The calculated PCT decreases as the break size increases above the limiting small break and decreases as the break size decreases below the limiting small break size. For small breaks that do not experience early film boiling, the cladding heatup occurs due to core uncovery.

[[

]] The system response time histories for selected nominal cases are plotted in Appendix A.

5.1.1.2 Appendix K Calculations

Appendix K assumptions used in the analysis are listed in Table 3-2. Using the Appendix K input assumptions; DBA analyses with battery failure are performed for GE14 and SVEA-96+ fuels. Three large break sizes (100%, 80% and 60% DBA) and the limiting small break were analyzed using the Appendix K assumptions. This is intended to examine the sensitivity of Appendix K PCT to break size and to assure that the limiting break is consistent with the generic Appendix K results. The analysis of these three large break cases satisfies the Appendix K requirement for use of the Moody Slip Flow model with three discharge coefficients of 1.0, 0.8 and 0.6 (Table 3-2).

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The results of the Appendix K analyses are also shown in Table 5-1, and the plotted system response time histories for selected cases are plotted in Appendix B.

5.1.2 Non-Recirculation Line Breaks

Non-recirculation line breaks were analyzed for both GE14 and SVEA-96+ fuels using nominal assumptions with battery failure. All breaks are consistently analyzed with a LPCI flow rate that assumes the minimum flow bypass valve remains open. The results of these analyses (Table 5-2) show that these postulated breaks are significantly less severe than the postulated recirculation line breaks (Table 5-1).

5.2 COMPLIANCE EVALUATIONS

5.2.1 Licensing Basis PCT Evaluation

The Hope Creek Appendix K results confirm that the limiting DBA break is the recirculation suction line, which is consistent with the BWR-5/6 generic conclusions and demonstrate that the battery failure is limiting for all fuels. [[

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The Licensing Basis PCTs for Hope Creek are calculated for SVEA-96+ and GE14 fuel types based on the above Appendix K PCTs using the methodology described in Section 3.2 at the MELLLA condition and assuming the LPCI bypass valve does not close. Hope Creek unique variable uncertainties, including backflow leakage, ECCS signal, stored energy, gap pressure, and ADS time delay, were evaluated for both fuel types to determine plant-specific adders. The calculated Licensing Basis PCT is 1380°F for GE14. The Licensing Basis PCT of 1540°F for SVEA-96+ documented in Reference 11 is unchanged at power uprate conditions.

5.2.2 Removal of the Current Requirement for Evaluation of Upper Bound PCT

The NRC SER approving the original SAFER/GESTR-LOCA application methodology (described in Reference 2) placed a restriction of 1600°F on the Upper Bound PCT calculation. Additional supporting information was needed to support the use of the methodology for Upper Bound PCTs in excess of this limit. GENE provided this information on a generic basis in Reference 8. GENE received an SER from the NRC (Reference 7) eliminating the 1600°F restriction on the Upper Bound PCT. The elimination of the restriction on the Upper Bound PCT is applicable to all plants using the SAFER/GESTR-LOCA application methodology described in Reference 2, including Hope Creek. In addition, the 1600°F restriction on the Upper Bound

PCT is no longer applicable when evaluating the effect of changes and errors reported under the requirements of 10CFR50.46.

Plant-specific Upper Bound PCT Calculation

The primary purpose of the Upper Bound PCT calculation is to demonstrate that the Licensing Basis PCT is sufficiently conservative by showing that the Licensing Basis PCT is higher than the Upper Bound PCT. The NRC SER approving the SAFER/GESTR-LOCA application methodology also required confirmation that the plant-specific operating parameters have been conservatively bounded by the models and inputs used in the generic calculations. The SER also required confirmation that the plant-specific ECCS configuration is consistent with the referenced plant class ECCS configuration for the purpose of applying the generic LTR Upper Bound PCT calculations to the plant-specific analysis. Because of the wide variation in plant specific operating parameters and ECCS performance parameters within the BWR product lines, it is difficult to judge whether an individual plant is bounded by the generic calculations. Therefore, the practice has been to calculate the Upper Bound PCT on a plant-specific basis rather than rely on the generic Upper Bound PCT calculations in order to demonstrate that the Licensing Basis PCT is sufficiently conservative.

Reference 8 provided generic justification that the Licensing Basis PCT will be conservative with respect to the Upper Bound PCT and that the plant-specific Upper Bound PCT calculation was no longer necessary. The NRC SER in Reference 7 accepted this position by noting that because plant-specific Upper Bound PCT calculations have been performed for all plants, other means may be used to demonstrate compliance with the original SER limitations. These other means are acceptable provided there are no significant changes to the plant configuration that would invalidate the existing Upper Bound PCT calculations. For the purposes of the Upper Bound PCT calculation, the plant configuration includes the plant equipment and equipment performance (e.g., ECCS pumps and flow rates), fuel type, and the plant operating conditions (e.g., core power and flow) that may affect the PCT calculation. In order to demonstrate continued compliance with the original SER limitations, the PCT effect due to the changes in the plant configuration must be reviewed in order to confirm that the conclusions based on the original Upper Bound PCT calculation have not been invalidated by the changes.

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As demonstrated in the discussions above, the Upper Bound is no longer restricted by the 1600°F limit. Therefore, when evaluating the effect of changes and errors reported under the requirements of 10CFR50.46, the effect on the Upper Bound PCT no longer needs to be evaluated.

5.3 EXPANDED OPERATING DOMAIN AND ALTERNATE OPERATING MODES

Extended operating domains and alternate operating modes are presented as sensitivity studies to

the break spectrum analyses performed at rated conditions. Only the limiting DBA recirculation line break/failure combination is analyzed using nominal and Appendix K assumptions. The limiting break/failure combination is usually not affected by changes in the power / flow conditions.

5.3.1 Increased Core Flow (ICF)

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5.3.2 Reduced Core Flow (MELLLA / ELLLA)

The higher rod line in the MELLL region permits reactor operation at 94.8% of rated core flow for the rated power of 3840 MWt. For the low core flow portion of the MELLL region, boiling transition at the high power fuel nodes can occur sooner than at the rated core flow conditions. This phenomenon is referred to as early boiling transition (EBT). If EBT occurs for the higher power node as a result of the reduced initial core flow, the resulting PCT can exceed the corresponding results for the rated core flow. Low core flow effects on the ECCS analyses were generically addressed in Reference 9, which was approved by the NRC in Reference 10. These studies demonstrated that no MAPLHGR multiplier was required for low core flow operation for the BWR-5/6 plant class, which has ECCS similar to Hope Creek. The SAFER/GESTR-LOCA analysis for low core flow conditions in the MELLL region was evaluated for Hope Creek using the same ECCS inputs as used for the rated core flow conditions.

[[

]] The analysis was performed with both nominal and Appendix K assumptions. The results are shown in Table 5-3 with rated core flow results presented for comparison. The MELLLA results at 3339 MWt and 76.6% rated core flow documented in Reference 11 are also included for completeness.

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5.3.3 Single-Loop Operation (SLO)

The ECCS performance for Hope Creek under SLO was evaluated using SAFER/GESTR-LOCA for the DBA break with battery failure. The analysis approach in determining the SLO multiplier on MAPLHGR and LHGR, and the calculated SLO multipliers for both GE14 and SVEA-96+ fuels are documented in Reference 11. [[

The operating conditions for SLO are not changed with uprated power conditions. Therefore, the calculated SLO multiplier of 0.8 documented in Reference 11 for both GE14 and SVEA-96+ remain valid. The calculated SLO multipliers are conservative and assure that the SLO results satisfy the acceptance criteria of 10CFR50.46 and the NRC SER requirements for the SAFER application methodology.[3]]]

5.3.4 Additional Power Conditions

Additional SAFER/GESTR-LOCA analyses were performed at 3506 MWt and 3673 MWt and at 100% rated core flow conditions for Hope Creek with consistent input assumptions. Both nominal and Appendix K assumptions were considered and the analyses were performed for both GE14 and SVEA-96+ fuels. The power levels were selected by PSEG for future interested plant operating power conditions at Hope Creek. The Licensing Basis PCT determined in Section 5.2.1 was calculated at 3840 MWt based on MELLLA conditions. If Hope Creek is licensed at a power level of 3506 MWt or 3673 MWt, the plant Licensing Basis PCT needs to be addressed. The calculated results are shown in Table 5-4.

5.4 MAPLHGR LIMITS

The SAFER/GESTR-LOCA analysis was performed with a bounding Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) at the most limiting combination of power and exposure for each analyzed fuel type (SVEA-96+ and GE14). The ECCS-based exposure dependent MAPLHGR limits are determined on a fuel type bases.

Although the analyses does not credit any reductions in LHGR or MAPLHGR during two-loop operation, application of either the APRM setpoint requirements or the ARTS based fuel thermal-mechanical design analysis limits [LHGRFAC(p) / LHGRFAC(f) or MAPFAC(p) / MAPFAC(f)] are required to ensure that off-rated conditions not specifically analyzed will not be limiting.

In Single Loop Operation, specific multipliers on PLHGR and MAPLHGR are required. The SLO multiplier is independent of the two-loop limits discussed in the above paragraph. The SLO multiplier is applicable to all fuel rod exposures.

Table 5-1
SUMMARY OF HOPE CREEK SAFER/GESTR-LOCA RESULTS
FOR RECIRCULATION LINE BREAKS[1]

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Table 5-1 (continued)
SUMMARY OF HOPE CREEK SAFER/GESTR-LOCA RESULTS
FOR RECIRCULATION LINE BREAKS[1]

[[

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Table 5-2
SUMMARY OF HOPE CREEK SAFER/GESTR-LOCA RESULTS
FOR NON-RECIRCULATION LINE BREAKS[1]
(Nominal Analysis Basis)

[[

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Table 5-3

MAXIMUM EXTENDED LOAD LINE LIMIT ANALYSIS
RESULTS COMPARISON FOR HOPE CREEK[1]

LIMITING LOCA: DBA - Recirculation Suction Line Break, Battery Failure

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Table 5-4

SAFER/GESTR-LOCA RESULTS COMPARISON
AT VARIOUS POWER CONDITIONS FOR HOPE CREEK[1]
DBA Suction Break, Battery Failure, at 100% Rated Core Flow

[[

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[[

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Figure 5-1. Nominal and Appendix K LOCA Break Spectrum Results for GE14 Fuel

[[ ]]

Figure 5-2. Nominal and Appendix K LOCA Break Spectrum Results for SVEA-96+ Fuel

6.0 CONCLUSIONS

LOCA analyses have been performed for Hope Creek at thermal power of 3840 MWt (nominal assumptions) using the GE SAFER/GESTR-LOCA Application Methodology approved by the NRC. These analyses were performed to demonstrate conformance with 10CFR50.46 and Appendix K, and thus, support a revised licensing basis for Hope Creek with the GE SAFER/GESTR-LOCA methodology.

As the SAFER/GESTR-LOCA results presented in Section 5 indicate, a sufficient number of plant-specific PCT points have been evaluated to establish the shape of both the nominal and Appendix K PCT versus break size curves. The analyses demonstrate that the limiting Licensing Basis PCT occurs for the recirculation suction line break DBA with Battery failure at MELLLA conditions.

Table 6-1 summarizes the key SAFER/GESTR licensing results for Hope Creek. The analyses presented are performed in accordance with NRC requirements and demonstrate conformance with the ECCS acceptance criteria of 10CFR50.46 as shown in Table 6-1. Therefore, the results documented in this report may be used to provide a new LOCA Licensing Basis for Hope Creek.

The thermal limits applied to the GE14 and SVEA-96+ fuel types in the ECCS-LOCA evaluation are summarized in Table 6-2.

Table 6-1
SAFER/GESTR-LOCA LICENSING RESULTS FOR HOPE CREEK

	Parameter	SAFER/GESTR-LOCA RESULTS		LICENSING ACCEPTANCE CRITERIA
1.	Limiting Break	DBA (Recirculation Suction Line)		
2.	Limiting ECCS Failure	Battery		
3.	Fuel Type	GE14	SVEA-96+	
4.	Peak Cladding Temperature (Licensing Basis)	1380	1540	< 2200°F
5.	Maximum Local Oxidation	<1%	<1%	< 17%
6.	Core-Wide Metal-Water Reaction	<0.1%	<0.1%	< 1%
7.	Coolable Geometry	Items 4 & 5		PCT < 2200°F and Local Oxidation < 17%
8.	Long-Term Cooling	Core reflooded above Top of Active Fuel (TAF) or Core reflooded to the top of the jet pump suction and one Core Spray system in operation		Core temperature acceptably low and long-term decay heat removed; met by Core reflooded above Top of Active Fuel (TAF) or Core reflooded to the top of the jet pump suction and one Core Spray system in operation

Table 6-2

Thermal Limits

PARAMETER	Analysis Limit			
	GE14		SVEA-96+	
PLHGR – Exposure Limit Curve	GWD/MT	kW/ft	GWD/MT	kW/ft
	[[		Note 1	Note 1
			Note 1	Note 1
			Note 1	Note 1
		]]	Note 1	Note 1
MAPLHGR – Exposure Limit Curve	GWD/MT	kW/ft	GWD/MT	kW/ft
	0	12.82	Note 1	Note 1
	21.09	12.82	Note 1	Note 1
	63.50	8	Note 1	Note 1
	70.00	5	Note 1	Note 1
Initial Operating MCPR	1.25		1.25	
Minimum R-Factor	[[ ]]		[[ ]]	
SLO Multiplier on PLHGR & MAPLHGR	0.80		0.80	

Notes: (1) The PLHGR curve for SVEA-96+ fuel is Westinghouse Proprietary and cannot be included. The SVEA-96+ analysis was performed at the exposure with the highest PLHGR. The MAPLHGR curve for SVEA-96+ is based on the LHGR curve, so it is omitted.

7.0 REFERENCES

1) Letter, C.O. Thomas (NRC) to J.F. Quirk (GE), "Acceptance for Referencing of Licensing Topical Report NEDE-23785, Revision 1, Volume III (P), 'The GESTR-LOCA and SAFER Models for the Evaluation of the Loss-of-Coolant Accident," June 1, 1984.

2) "The GESTR-LOCA and SAFER Models for the Evaluation of the Loss-of-Coolant Accident, Volume III, SAFER/GESTR Application Methodology," NEDE-23785-1-PA, General Electric Company, Revision 1, October 1984.

3) "General Electric Company Analytical Model for Loss-of-Coolant Analysis in Accordance with 10CFR50 Appendix K," NEDO-20566A, General Electric Company, September 1986.

4) "The GESTR-LOCA and SAFER Models for the Evaluation of the Loss-of-Coolant Accident; Volume I, GESTR-LOCA - A Model for the Prediction of Fuel Rod Thermal Performance," NEDC-23785-2-P, General Electric Company, May 1984.

5) "SAFER Model for Evaluation of Loss-of-Coolant Accidents for Jet Pump and Non-Jet Pump Plants," NEDE-30996P-A, General Electric Company, October 1987.

6) "Compilation of Improvements to GENE's SAFER ECCS-LOCA Evaluation Model," NEDC-32950P, January 2000.

7) Stuart A. Richards (NRC) to James F. Klapproth (GENE), Review of NEDE-23785P, Vol. III, Supplement 1, Revision 1, "GESTR-LOCA and SAFER Models for Evaluation of Loss-of-Coolant Accident Volume III, Supplement 1, Additional Information for Upper Bound PCT Calculation," (TAC No. MB2774), February 1, 2002.

8) "GESTR-LOCA and SAFER Models for Evaluation of Loss-of Coolant Accident, Volume III, Supplement 1 – Additional Information for Upper Bound PCT Calculation, NEDE-23785P-A, Supplement 1, Revision 1, March 2002.

9) Letter, R. L. Gridley (GE) to D. G. Eisenhut (NRC), "Review of Low-Core Flow Effects on LOCA Analysis for Operating BWRs - Revision 2," May 8, 1978.

10) Letter, D. G. Eisenhut (NRC) to R. L. Gridley (GE), "Safety Evaluation Report on Revision of Previously Imposed MAPLHGR (ECCS-LOCA) Restriction for BWRs at Less Than Rated Core Flow," May 19, 1978.

11) "SAFER/GESTR-LOCA Loss of Coolant Accident Analysis for Hope Creek Generating Station," NEDC-33153P, Revision 1, September 2004.

APPENDIX A

SYSTEM RESPONSE CURVES FOR NOMINAL RECIRCULATION LINE BREAKS

Included in this Appendix are the system response curves for Hope Creek. Table A-1 shows the figure numbering sequence for the nominal recirculation breaks.

Table A-1

NOMINAL RECIRCULATION LINE BREAK FIGURE SUMMARY

Notes: All Plots are for GE14 fuel, except when noted.

- Recirc. Break - Single Failure	DBA Battery	80% DBA Battery	60% DBA Battery	1.0 ft^2 Battery	[[ ]]	[[ ]]
Water Level in Hot & Average Channels	A-1a	A-2a	A-3a	A-4a	A-5a	A-6a*
Reactor Vessel Pressure	A-1b	A-2b	A-3b	A-4b	A-5b	A-6b*
Peak Cladding Temperature	A-1c,f*	A-2c,f*	A-3c,f*	A-4c,f*	A-5c	A-6c*
Heat Transfer Coefficient	A-1d,g*	A-2d,g*	A-3d,g*	A-4d,g*	A-5d	A-6d*
ECCS Flow	A-1e	A-2e	A-3e	A-4e	A-5e	A-6e*

* Plots for SVEA-96+ are included.

Figure A-1a. Water Level in Hot and Average Channels - DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure A-1b. Reactor Vessel Pressure - DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure A-1c. Peak Cladding Temperature (GE14) - DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-1d. Heat Transfer Coefficient (GE14) - DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

[[

Figure A-1e. ECCS Flow - DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure A-1f. Peak Cladding Temperature (SVEA-96+) - DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure A-1g. Heat Transfer Coefficient (SVEA-96+) - DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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[[

Figure A-2a. Water Level in Hot and Average 80% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure A-2b. Reactor Vessel Pressure - 80% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-2c. Peak Cladding Temperature (GE14) - 80% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

[[

Figure A-2d. Heat Transfer Coefficient (GE14) - 80% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

]]

Figure A-2e. ECCS Flow - 80% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-2f. Peak Cladding Temperature (SVEA-96+) - 80% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-2g. Heat Transfer Coefficient (SVEA-96+) - 80% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-3a. Water Level in Hot and Average Channels - 60% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-3b. Reactor Vessel Pressure - 60% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-3c. Peak Cladding Temperature (GE14) - 60% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-3d. Heat Transfer Coefficient (GE14) - 60% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

[[

Figure A-3e. ECCS Flow - 60% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure A-3f. Peak Cladding Temperature (SVEA-96+) - 60% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-3g. Heat Transfer Coefficient (SVEA-96+) - 60% DBA Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

[[

Figure A-4a. Water Level in Hot and Average Channels - 1 ft^2 Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure A-4b. Reactor Vessel Pressure - 1 ft^2 Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-4c. Peak Cladding Temperature (GE14) - 1 ft^2 Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-4d. Heat Transfer Coefficient (GE14) - 1 ft^2 Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-4e. ECCS Flow - 1 ft^2 Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-4f. Peak Cladding Temperature (SVEA-96+) - 1 ft^2 Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure A-4g. Heat Transfer Coefficient (SVEA-96+) - 1 ft^2 Suction – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure A-5a. Water Level in Hot and Average Channels -

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Figure A-5b. Reactor Vessel Pressure -

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Figure A-5c. Peak Cladding Temperature (GE14) -

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[[

Figure A-5d. Heat Transfer Coefficient (GE14)

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[[

Figure A-5e. ECCS Flow -

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[[

Figure A-6a. Water Level in Hot and Average Channels (SVEA-96+) -

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[[

Figure A-6b. Reactor Vessel Pressure (SVEA-96+) -

]]

Figure A-6c. Peak Cladding Temperature (SVEA-96+)

[[

Figure A-6d. Heat Transfer Coefficient (SVEA-96+) –

]]

[[

Figure A-6e. ECCS Flow (SVEA-96+)

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APPENDIX B

SYSTEM RESPONSE CURVES FOR APPENDIX K RECIRCULATION LINE BREAKS

Included in this Appendix are the system response curves for Hope Creek. Table B-1 shows the figure numbering sequence for the Appendix K recirculation breaks.

Table B-1

APPENDIX K RECIRCULATION LINE BREAK FIGURE SUMMARY

Note: All Plots are for GE14 fuel, except when noted.

- Recirc. Break - Single Failure	DBA Suction – Rated – Battery	DBA Suction – MELLLA – Battery	80% DBA Suction – Battery Failure	60% DBA Suction – Battery Failure	[[ ]]
Water Level in Hot & Average Channels	B-1a	B-2a	B-3a	B-4a	B-5a
Reactor Vessel Pressure	B-1b	B-2b	B-3b	B-4b	B-5b
Peak Cladding Temperature	B-1c,h*	B-2c,f*	B-3c,f*	B-4c,f*	B-5c,f*
Heat Transfer Coefficient	B-1d,i*	B-2d,g*	B-3d,g*	B-4d,g*	B-5d,g*
ECCS Flow	B-1e	B-2e	B-3e	B-4e	B-5e
Core Inlet Flow	B-1f				
MCPR	B-1g				

* Plots for SVEA-96+ are included.

Figure B-1a. Water Level in Hot and Average Channels (GE14) - DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-1b. Reactor Vessel Pressure (GE14) - DBA Suction – DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

[[

Figure B-1c. Peak Cladding Temperature (GE14) - DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

]]

Figure B-1d. Heat Transfer Coefficient (GE14) - DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-1e. ECCS Flow (GE14) - DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-1f. Core Average Inlet Flow (GE14) - DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-1g. Minimum Critical Power Ratio (GE14 & SVEA-96+) - DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-1h. Peak Cladding Temperature (SVEA-96+) - DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-1i. Heat Transfer Coefficient (SVEA-96+) - DBA Suction – Rated – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-2a. Water Level in Hot and Average Channels - DBA Suction – MELLLA – Battery Failure (App. K)
3LPCI+LPCS+ADS Available

Figure B-2b. Reactor Vessel Pressure- DBA Suction – MELLLA – Battery Failure (App. K) — 3LPCI+LPCS+ADS
Available

[[

Figure B-2c. Peak Cladding Temperature (GE14) - DBA Suction – MELLLA – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

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```
NN    NN UU   UU  LLLL     LLLL     YY   YY
NNN   NN UU   UU   LL       LL      YY   YY
NNNN  NN UU   UU   LL       LL      YY   YY
NN NNNN  UU   UU   LL       LL       YYYY
NN  NNN  UU   UU   LL    L  LL    L   YY
NN   NN  UU   UU   LL   LL  LL   LL   YY
NN   NN  UUUUUU  LLLLLLL LLLLLLL  YYYY
```

USERID: NULLY

DOCUMENT NUMBER: 71

PRINTED ON 3/29/05 10:46:28 AM

Yeager, Linda L.
From: Thompson, Jack W.
Sent: Tuesday, March 29, 2005 6:22 AM
To: Yeager, Linda L.
Subject: RE: Credit Card Supervisor update

Robert Kolo

-----Original Message-----
From: Yeager, Linda L.
Sent: Monday, March 28, 2005 3:55 PM
To: Hassler, Matthew J.; Racer, Jacqueline J.; Thompson, Jack W.
Subject: Credit Card Supervisor update
Importance: High

Please provide your respective Supervisor and employee number. We need to change Paymentnet with your new supervisor. Thank you.

268	HASSLER MATTHEW J	OUTAGE	**5130200**	**1350**	**O.00745.2.3.5**	01
3						
293	RACER JACQUELINE J	REFUELING OUTAGE GROUP	**5130200**	**1350**	**O.00745.7.1.I**	01
7						
837	THOMPSON JOHN W	OUTAGE MAINTENANCE	**5130200**	**1350**	**O.01049.2.3.5**	01
0						

Linda Yeager
Financial Analysis & Controls, M/C N07
Wk:856/339-7850
Fax: 856/339-1369
Email: Linda.Yeager@PSEG.com

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Figure B-2d. Heat Transfer Coefficient (GE14) - DBA Suction – MELLLA – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

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Figure B-2e. ECCS Flow - DBA Suction – MELLLA – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-2f. Peak Cladding Temperature (SVEA-96+) - DBA Suction – MELLLA – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-2g. Heat Transfer Coefficient (SVEA-96+) - DBA Suction – MELLLA – Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-3a. Water Level in Hot and Average Channels - 80% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-3b. Reactor Vessel Pressure - 80% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-3c. Peak Cladding Temperature (GE14) - 80% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-3d. Heat Transfer Coefficient (GE14) - 80% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

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Figure B-3e. ECCS Flow - 80% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

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Figure B-3f. Peak Cladding Temperature (SVEA-96+) - 80% DBA Suction -Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

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Figure B-3g. Heat Transfer Coefficient (SVEA-96+) - 80% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-4a. Water Level in Hot and Average Channels - 60% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-4b. Reactor Vessel Pressure - 60% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-4c. Peak Cladding Temperature (GE14) - 60% DBA Suction -Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-4d. Heat Transfer Coefficient (GE14) - 60% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

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Figure B-4e. ECCS Flow - 60% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

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Figure B-4f. Peak Cladding Temperature (SVEA-96+) - 60% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

Figure B-4g. Heat Transfer Coefficient (SVEA-96+) - 60% DBA Suction –Battery Failure (App. K) — 3LPCI+LPCS+ADS Available

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Figure B-5a. Water Level in Hot and Average Channels -

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Figure B-5b. Reactor Vessel Pressure -

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Figure B-5c. Peak Cladding Temperature (GE14)

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Figure B-5d. Heat Transfer Coefficient (GE14) - Available

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Figure B-5e. ECCS Flow -

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Figure B-5f. Peak Cladding Temperature (SVEA-96+) -

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Figure B-5g. Heat Transfer Coefficient (SVEA-96+) -

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APPENDIX C

SYSTEM RESPONSE CURVES FOR NOMINAL NON-RECIRCULATION LINE BREAKS

Included in this Appendix are the system response curves for Hope Creek. Table C-1 shows the figure numbering sequence for the Nominal Non-recirculation breaks.

Table C-1

NOMINAL NON-RECIRCULATION LINE BREAK FIGURE SUMMARY

Note: All Plots are for GE14 fuel, except when noted.

- Non-Recirc. Break - Single Failure	Core Spray Line – Battery	Steamline Inside Containment – Battery	Steamline Outside Containment – Battery	Feedwater Line –Battery	LPCI Line –Battery
Water Level in Hot & Average Channels	C-1a	C-2a	C-3a	C-4a	C-5a
Reactor Vessel Pressure	C-1b	C-2b	C-3b	C-4b	C-5b
Peak Cladding Temperature	C-1c,h*	C-2c,f*	C-3c,f*	C-4c,f*	C-5c,f*
Heat Transfer Coefficient	C-1d,i*	C-2d,g*	C-3d,g*	C-4d,g*	C-5d,g*
ECCS Flow	C-1e	C-2e	C-3e	C-4e	C-5e

* Plots for SVEA-96+ are included.

Figure C-1a. Water Level in Hot and Average Channels – Core Spray Line Break – Battery Failure (Nominal) – 3LPCI+ADS Available

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Figure C-1b. Reactor Vessel Pressure – Core Spray Line Break – Battery Failure (Nominal) – 3LPCI+ADS Available

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Figure C-1c. Peak Cladding Temperature (GE14) – Core Spray Line Break – Battery Failure (Nominal) – 3LPCI+ADS Available

Figure C-1d. Heat Transfer Coefficient (GE14) – Core Spray Line Break – Battery Failure (Nominal) – 3LPCI+ADS Available

Figure C-1e. ECCS Flow - Core Spray Line Break– Battery Failure (Nominal) – 3LPCI+ADS Available

Figure C-1f. Peak Cladding Temperature (SVEA-96+) – Core Spray Line Break – Battery Failure (Nominal) – 3LPCI+ADS Available

Figure C-1g. Heat Transfer Coefficient (SVEA-96+) – Core Spray Line Break– Battery Failure (Nominal) – 3LPCI+ADS Available

Figure C-2a. Water Level in Hot and Average Steamline Break Inside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-2b. Reactor Vessel Pressure - Steamline Break Inside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-2c. Peak Cladding Temperature (GE14) - Steamline Break Inside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-2d. Heat Transfer Coefficient (GE14) - Steamline Break Inside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-2e. ECCS Flow - Steamline Break Inside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-2f. Peak Cladding Temperature (SVEA-96+) - Steamline Break Inside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-2g. Heat Transfer Coefficient (SVEA-96+) - Steamline Break Inside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-3a. Water Level in Hot and Average Channels - Steamline Break Outside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-3b. Reactor Vessel Pressure - Steamline Break Outside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-3c. Peak Cladding Temperature (GE14) - Steamline Break Outside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-3d. Heat Transfer Coefficient (GE14) - Steamline Break Outside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-3e. ECCS Flow - Steamline Break Outside Containment – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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(Nominal) –

3LPCI+LPCS+ADS Available

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[[

3LPCI+LPCS+ADS Available

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Figure C-4a. Water Level in Hot and Average Channels - Feedwater Line Break – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-4b. Reactor Vessel Pressure - Feedwater Line Break – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-4c. Peak Cladding Temperature (GE14) - Feedwater Line Break – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-4d. Heat Transfer Coefficient (GE14) - Feedwater Line Break – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-4e. ECCS Flow - Feedwater Line Break – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure C-4f. Peak Cladding Temperature (SVEA-96+) - Feedwater Line Break – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

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Figure C-4g. Heat Transfer Coefficient (SVEA-96+) - Feedwater Line Break – Battery Failure (Nominal) – 3LPCI+LPCS+ADS Available

Figure C-5a. Water Level in Hot and Average Channels - LPCI Line Break – Battery Failure (Nominal) – 2LPCI+LPCS+ADS Available

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Figure C-5b. Reactor Vessel Pressure - LPCI Line Break – Battery Failure (Nominal) – 2LPCI+LPCS+ADS Available

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Figure C-5c. Peak Cladding Temperature (GE14) - LPCI Line Break – Battery Failure (Nominal) – 2LPCI+LPCS+ADS Available

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Figure C-5d. Heat Transfer Coefficient (GE14) - LPCI Line Break – Battery Failure (Nominal) – 2LPCI+LPCS+ADS Available

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Figure C-5e. ECCS Flow - LPCI Line Break – Battery Failure (Nominal) – 2LPCI+LPCS+ADS Available

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Figure C-5f. Peak Cladding Temperature (SVEA-96+) - LPCI Line Break – Battery Failure (Nominal) – 2LPCI+LPCS+ADS Available

Figure C-5g. Heat Transfer Coefficient (SVEA-96+) - LPCI Line Break – Battery Failure (Nominal) – 2LPCI+LPCS+ADS Available