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Enclosures 1, 3, 5, and 7 Contain Proprietary Information
Withhold in Accordance with 10 CFR 2.390

October 23, 2019

Serial: RA-19-0411 10 CFR 50.90

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

Subject: Brunswick Steam Electric Plant, Unit Nos. 1 and 2
Renewed Facility Operating License Nos. DPR-71 and DPR-62
Docket Nos. 50-325 and 50-324
Supplement to Request for License Amendment Regarding Application of Advanced Framatome Methodologies

Reference:

1. Letter from William R. Gideon (Duke Energy) to the U.S. Nuclear Regulatory Commission Document Control Desk, *Request for License Amendment Regarding Application of Advanced Framatome Methodologies*, dated October 11, 2018, ADAMS Accession Number ML18284A395.

2. Letter from William R. Gideon (Duke Energy) to the U.S. Nuclear Regulatory Commission Document Control Desk, *Supplement to Request for License Amendment Regarding Application of Advanced Framatome Methodologies*, dated March 18, 2019, ADAMS Accession Number ML19077A293.

Ladies and Gentlemen:

By letter dated October 11, 2018 (i.e., Reference 1), Duke Energy Progress, LLC (Duke Energy), submitted a license amendment request (LAR) for the Brunswick Steam Electric Plant (BSEP), Unit Nos. 1 and 2. The proposed license amendment revises Technical Specification 5.6.5.b to allow application of Advanced Framatome Methodologies for determining core operating limits in support of loading Framatome fuel type ATRIUM 11.

As committed to in the subject LAR, the BSEP Unit 1 Cycle 23 Reload Safety Analysis Report (i.e., ANP-3808P) and the BSEP Unit 1 Cycle 23 ATRIUM 11 Fuel Rod Design Report (i.e., ANP-3791P) are being transmitted to the NRC for information. These reports are included in Enclosures 1 and 3 respectively.

In addition, the BSEP Unit 1 Cycle 23 Fuel Cycle Design Report (i.e., ANP-3759P) and the BSEP Unit 1 Cycle 23 Nuclear Fuel Bundle Design Report (i.e., ANP-3758P), which were transmitted to the NRC for information under Reference 2, have been revised and are included in Enclosures 5 and 7, respectively.

Enclosures 1, 3, 5, and 7 contain information considered proprietary to Framatome. The proprietary information in these reports has been denoted by brackets. As owner of the proprietary information, Framatome has executed the affidavits contained in Enclosure 9 which identifies the information as proprietary, is customarily held in confidence, and should be withheld from public disclosure in accordance with 10 CFR 2.390. Enclosures 2, 4, 6, and 8 provide the non-proprietary versions of these reports.

Please refer any questions regarding this submittal to Ms. Sabrina Salazar, Manager – Nuclear Support Services, at (910) 832-3207.

I declare, under penalty of perjury, that the foregoing is true and correct. Executed on October 23, 2019.

Sincerely,

John A. Krakuszeski

John A. Krakuszeski

SBY/sby

Enclosures:

1. ANP-3808P, *Brunswick Unit 1 Cycle 23 Reload Safety Analysis,* Revision 0 **[Proprietary Information – Withhold from Public Disclosure in Accordance with 10 CFR 2.390]**
2. ANP-3808NP, *Brunswick Unit 1 Cycle 23 Reload Safety Analysis,* Revision 0
3. ANP-3791P, *ATRIUM 11 Fuel Rod Thermal-Mechanical Evaluation for Brunswick Unit 1 Cycle 23,* Revision 0 **[Proprietary Information – Withhold from Public Disclosure in Accordance with 10 CFR 2.390]**
4. ANP-3791NP, *ATRIUM 11 Fuel Rod Thermal-Mechanical Evaluation for Brunswick Unit 1 Cycle 23,* Revision 0
5. ANP-3759P, *Brunswick Unit 1 Cycle 23 Fuel Cycle Design Report,* Revision 2 **[Proprietary Information – Withhold from Public Disclosure in Accordance with 10 CFR 2.390]**
6. ANP-3759NP, *Brunswick Unit 1 Cycle 23 Fuel Cycle Design Report,* Revision 2
7. ANP-3758P, *Brunswick Unit 1 Cycle 23 ATRIUM 11 Fuel Nuclear Fuel Design Report,* Revision 1 **[Proprietary Information – Withhold from Public Disclosure in Accordance with 10 CFR 2.390]**
8. ANP-3758NP, *Brunswick Unit 1 Cycle 23 ATRIUM 11 Fuel Nuclear Fuel Design Report,* Revision 1
9. Affidavits for ANP-3808P, ANP-3791P, ANP-3759P, and ANP-3758P

cc (with all Enclosures):

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ANP-3808NP, *Brunswick Unit 1 Cycle 23 Reload Safety Analysis*, Revision 0

framatome

Brunswick Unit 1 Cycle 23 Reload Safety Analysis

ANP-3808NP
Revision 0

October 2019

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Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	All	Initial Issue

Contents

Tables

Figures

Nomenclature

ABSP	automated backup stability protection
APRM	average power range monitor
AOO	anticipated operational occurrence
ARO	all control rods out
ASME	American Society of Mechanical Engineers
AST	alternative source term
ATWS	anticipated transient without scram
ATWS-I	anticipated transient without scram with instability
ATWS-RPT	anticipated transient without scram recirculation pump trip
BEO-III	best estimate enhanced option III
BOC	beginning-of-cycle
BPWS	banked position withdrawal sequence
BSP	backup stability protection
BWROG	Boiling Water Reactor Owners Group
CDA	confirmation density algorithm
CFR	Code of Federal Regulations
COLR	core operating limits report
CPR	critical power ratio
CRDA	control rod drop accident
CRWE	control rod withdrawal error
EFPD	effective full-power days
EFPH	effective full-power hours
EOC	end-of-cycle
EOCLB	end-of-cycle licensing basis
EOFP	end of full power
EOOS	equipment out-of-service
FFTR	final feedwater temperature reduction
FHA	fuel handling accident
FHOOS	feedwater heaters out-of-service
FWCF	feedwater controller failure
GE	General Electric
GSF	generic shape function
HCOM	hot channel oscillation magnitude
HFCL	high flow control line
ICF	increased core flow
LFWH	loss of feedwater heating
LHGR	linear heat generation rate
$LHGRFAC_f$	flow-dependent linear heat generation rate multipliers
$LHGRFAC_p$	power-dependent linear heat generation rate multipliers
LOCA	loss-of-coolant accident
LPRM	local power range monitor
LRNB	generator load rejection with no bypass

Nomenclature *(Continued)*

MAPLHGR	maximum average planar linear heat generation rate
MCPR	minimum critical power ratio
$MCPR_f$	flow-dependent minimum critical power ratio
$MCPR_p$	power-dependent minimum critical power ratio
MELLLA	maximum extended load line limit analysis
MELLLA+	maximum extended load line limit analysis plus
MSIV	main steam isolation valve
MSIVIS	main steam isolation valve in-service
MSIVOOS	main steam isolation valve out-of-service
NCL	natural circulation line
NEOC	near end-of-cycle
NSS	nominal scram speed
NRC	Nuclear Regulatory Commission, U.S.
OLMCPR	operating limit minimum critical power ratio
OOS	out-of-service
OPRM	oscillation power range monitor
P_{bypass}	power below which direct scram on TSV/TCV closure is bypassed
PCT	peak cladding temperature
PLU	power load unbalance
PRFDS	pressure regulator failure downscale
PRFO	pressure regulator failure open
PROOS	pressure regulator out-of-service
RBM	(control) rod block monitor
RDF	recirculation drive flow
RHR	residual heat removal
RPS	reactor protection system
RPT	recirculation pump trip
RTP	rated thermal power
S_{AD}	amplitude discriminator setpoint
SLC	standby liquid control
SLMCPR	safety limit minimum critical power ratio
SLO	single-loop operation
SRV	safety/relief valve
SRVOOS	safety/relief valve out-of-service
SS	steady state
STP	simulated thermal power
TBVOOS	turbine bypass valves out-of-service
TCV	turbine control valve
TIP	traversing incore probe
TLO	two-loop operation
TSSS	technical specifications scram speed
TSV	turbine stop valve
TTNB	turbine trip with no bypass
ΔCPR	change in critical power ratio
2PT	2 pump trip

1.0 INTRODUCTION

Reload licensing analyses results generated by Framatome Inc. are presented in support of Brunswick Unit 1 Cycle 23. The analyses reported in this document, with the exception of the ATWS-I and stability methodologies, were performed using methodologies previously approved for generic application to boiling water reactors and demonstrated in Reference 1 to be applicable for ATRIUM 11 fuel operating in the MELLLA+ extended flow operating domain, Reference 2. The NRC technical limitations associated with the application of the approved methodologies have been satisfied by these analyses. The ATWS-I and stability methodologies were applied on a plant specific basis which are currently under NRC review in Reference 8.

The Cycle 23 core consists of a total of 560 fuel assemblies, including 226 fresh ATRIUM 11 assemblies, and 334 irradiated ATRIUM 10XM assemblies. The licensing analysis supports the core design presented in Reference 3 and the use of the MELLLA+ operating domain.

The Cycle 23 reload licensing analyses were performed for the potentially limiting events and analyses that were identified in the disposition of events. The results of the analyses are used to establish the Technical Specifications/COLR limits and ensure that the design and licensing criteria are met. The design and safety analyses are based on the design and operational assumptions and plant parameters provided by the utility. The results of the reload licensing analysis support operation for the power/flow map presented in Figure 1.1. This reload licensing also supports operation with the equipment out-of-service (EOOS) scenarios presented in Table 1.1.

The results in this report comply with the license condition related to the range of applicability for the channel bow model. This license condition was added with the inclusion of the SAFLIM3D methodology to the list of approved references in Section 5.6.5(b) of the Brunswick Technical Specifications.

Table 1.1 EOOS
Operating Conditions*

Single-loop operation (SLO)†, ‡
Turbine bypass valves out-of-service (TBVOOS)
Feedwater heaters out-of-service (FHOOS)†
One safety relief valve out-of-service (SRVOOS)
One main steam isolation valve out-of-service§ (MSIVOOS)
One pressure regulator out-of-service**
Up to 40% of the TIP channels out-of-service (100% available at startup)
Up to 50% of the LPRMs out-of-service

* Each EOOS condition is supported in combination with 1 SRVOOS, up to 40% of the TIP channels out-of-service, and/or up to 50% of the LPRMs out-of-service.

† Note that single-loop operation, and feedwater heaters out-of-service conditions are not allowed when operating in the MELLLA+ domain.

‡ Operation in SLO is only supported up to a maximum power level of 71.1% of rated.

§ Operation with one MSIVOOS is only supported at power levels less than 70% of rated.

** Operation with one pressure regulator out-of-service is only supported at power levels greater than 90% of rated and less than 50% of rated.

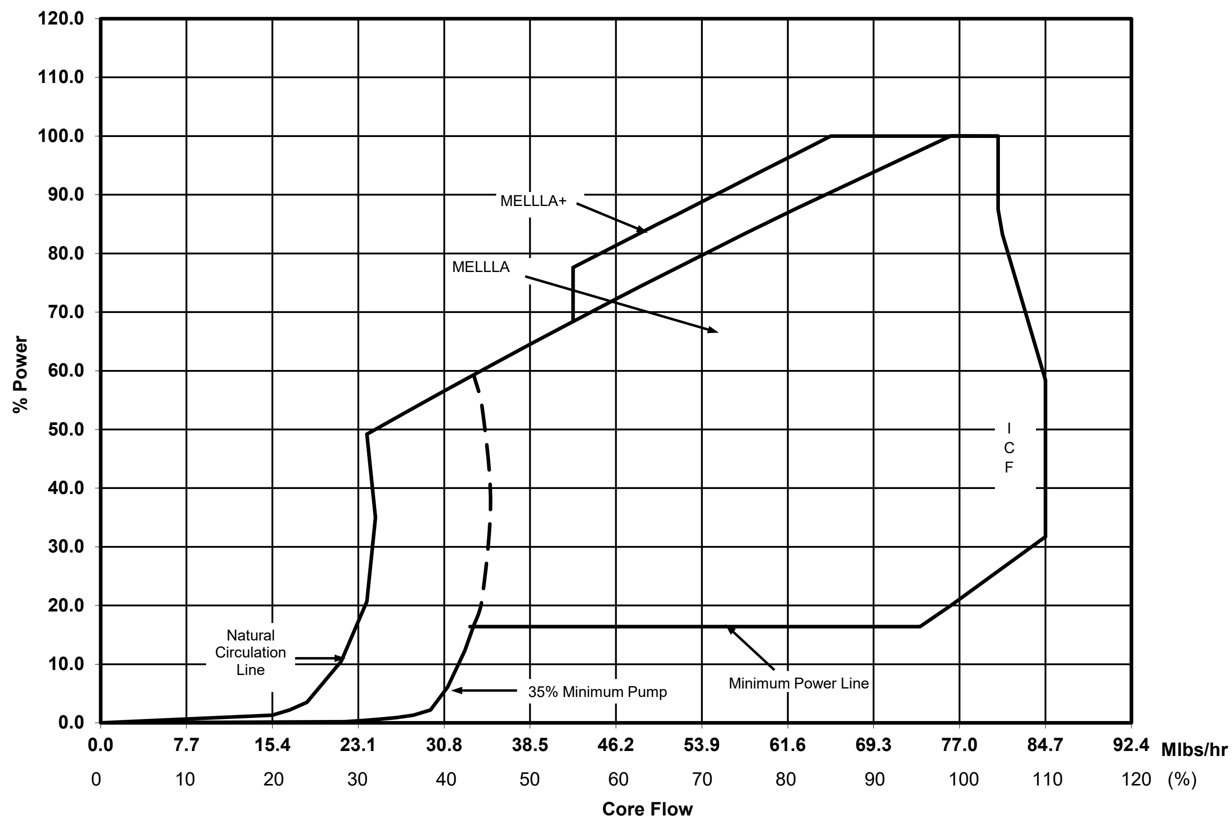

**Figure 1.1 Brunswick Unit 1
Power/Flow Map**

2.0 DISPOSITION OF EVENTS AND PLANT MODELING SENSITIVITIES

2.1 *Disposition of Events for ATRIUM 11 Fuel Introduction*

A disposition of events to identify the limiting events which need to be analyzed to support operation at the Brunswick Steam Electric Plant was performed for the introduction of ATRIUM 11 fuel. Events and analyses identified as potentially limiting were either evaluated generically for the introduction of ATRIUM 11 fuel or are performed on a cycle-specific basis.

The first step in the disposition of events is to identify the licensing basis of the plant. Included in the licensing basis are descriptions of the postulated events/analyses and the associated criteria. Fuel-related system design criteria which must be met to ensure regulatory compliance and safe operation are also included. The BSEP licensing basis is contained in the Updated Final Safety Analysis Report (UFSAR), the Technical Specifications, Core Operating Limits Reports (COLR), and other reload analysis reports.

Framatome reviewed all the fuel-related design criteria, events, and analyses identified in the licensing basis. In many cases, when the operating limits are established to ensure acceptable consequences of an anticipated operational occurrence or accident, the fuel-related aspects of the system design criteria are met. All the fuel-related events were reviewed and dispositioned into one of the following categories:

- ***No further analysis required.*** This classification may result from one of the following:
  - The consequences of the event are bound by consequences of a different event.
  - The consequences of the event are benign, i.e., the event causes no significant change in margins to the operating limits.
  - The event is not affected by the introduction of a new fuel design and/or the current analysis of record remains applicable.
- ***Address event each reload.*** The consequences of the event are potentially limiting and need to be addressed each reload.
- ***Address for initial reload.*** This classification may result from one of the following:
  - The analysis is performed using conservative bounding assumptions and inputs such that the initial reload results will remain applicable for future reloads of the same fuel design.
  - Results from the first reload will be used to quantitatively demonstrate that the results remain applicable for future reloads of the same fuel design because the consequences are benign or bound by those of another event.

The impacts of the EOOS scenarios presented in Table 1.1 were also considered in the disposition of events.

A summary of the disposition of events is presented in Tables 2.1 and 2.2. Table 2.1 presents a list of the events and analyses, the corresponding UFSAR section, the disposition status, and any applicable comments. Table 2.2 presents a summary of the disposition of events for the EOOS scenarios. Note that operation in the ICF and MELLLA+ regions of the power/flow map are included in the disposition results presented in Table 2.1.

Table 2.1 Disposition of Events Summary for ATRIUM 11 Fuel Introduction at Brunswick

UFSAR Section	Event /Analysis	Disposition Status	Comments
3.9	Seismic Evaluation	Address initial reload.	ATRIUM 11 fuel has been shown to meet seismic analysis acceptance criteria.
4.4	Thermal-Hydraulic Compatibility	Address initial reload.	ATRIUM 11 fuel has been shown to meet thermal-hydraulic compatibility acceptance criteria.
4.4	Safety Limit MCPR	Address each reload.	Required to establish operating limits.
4.A	Nuclear System Stability Analysis	Address each reload.	Required to establish operating limits.
5.2.2	Overpressurization Protection	Address each reload.	Potentially limiting event.
6.2.5	Combustible Gas Control in Containment	No further analysis required.	Current analysis of record remains applicable.
9.1.1	New Fuel Storage Criticality	Address for initial reload.	Evaluate for new fuel storage vault. Confirm applicability each reload. This issue is addressed in a separate report.
9.1.2	Spent Fuel Storage Criticality	Address for initial reload.	Evaluate for spent fuel pool. Confirm applicability each reload. This issue is addressed in a separate report.
9.3.4	Standby Liquid Control (SLC) System	Address each reload.	Analysis performed to verify adequate SLC system shutdown capacity.
9.5.1	Fire Protection Systems	Address initial reload.	ATRIUM 11 fuel has been shown to meet Appendix R acceptance criteria.
15.1.1	Loss of Feedwater Heater (LFWH)	Address each reload.	Potentially limiting AOO.
15.1.2	Feedwater Controller Failure (FWCF) - Maximum Demand	Address each reload.	Potentially limiting AOO.
15.1.3	Inadvertent HPCI or RCIC Pump Start	No further analysis required.	Consequences bound by the FWCF.

Table 2.1 Disposition of Events Summary for ATRIUM 11 Fuel Introduction at Brunswick
(Continued)

UFSAR Section	Event /Analysis	Disposition Status	Comments
15.1.4	Pressure Regulator Failure Open (PRFO)	No further analysis required.	Consequences bound by the TTNB.
15.1.5	Inadvertent Opening of a Relief Valve or Safety Valve	No further analysis required.	Benign event.
15.1.6	Inadvertent RHR Shutdown Cooling Operation	No further analysis required.	Benign event.
15.2.1	Generator Load Rejection with and without bypass (LRNB)	Address each reload.	Potentially limiting AOO with bypass inoperable.
15.2.2	Turbine Trip with and without bypass (TTNB)	Address for initial reload.	Potentially limiting AOO. It is expected that results will show that this event is bound by LRNB.
15.2.3	Main Steam Isolation Valve (MSIV) Closure	No further analysis required.	Consequences bound by the LRNB and TTNB.
15.2.4	Loss of Condenser Vacuum	No further analysis required.	Consequences bound by the LRNB and TTNB.
15.2.5	Loss of Auxiliary Power	No further analysis required.	Consequences bound by the LRNB.
15.2.6	Loss of Feedwater Flow	No further analysis required.	Benign event.
15.2.7	Loss of RHR Shutdown Cooling	No further analysis required.	Benign event.
15.2.8	Pressure Regulator Failure-Closed	No further analysis required.	Benign event with the backup pressure regulator in service.
15.3.1	Recirculation Pump Trip	No further analysis required.	Benign event.
15.3.2	Recirculation Flow Control Failure - Decreasing Flow	No further analysis required.	Benign event and bound by the trip of one recirculation pump.

Table 2.1 Disposition of Events Summary for ATRIUM 11 Fuel Introduction at Brunswick
(Continued)

UFSAR Section	Event /Analysis	Disposition Status	Comments
15.3.3	Recirculation Pump Seizure	No further analysis required.	Consequences of the pump seizure event are bound by other limiting rated power AOO events.
15.4.1	Rod Withdrawal Error During Low Power Operation	No further analysis required.	Benign event.
15.4.2	Rod Withdrawal Error at Power	Address each reload.	Potentially limiting AOO.
15.4.3	Startup of Idle Recirculation Loop	No further analysis required.	Nonlimiting event.
15.4.4	Recirculation Flow Control Failure - Increasing Flow	No further analysis required.	Nonlimiting event.
15.4.5	Fuel Assembly Error During Refueling	No further analysis required.	Benign event.
15.4.6	Control Rod Drop Accident	Address each reload.	Potentially limiting accident.
15.6.3	Main Steam Line Break Accident	No further analysis required.	Fuel-related consequences bound by other LOCA events. Results of the current radiological release evaluation remain applicable.
15.6.4 also 6.3	Loss of Coolant Accident (LOCA)	Address for initial reload.	Potentially limiting accident.
15.7.1	Refueling Accident	Address for initial reload.	Potentially limiting accident.

Table 2.1 Disposition of Events Summary for ATRIUM 11 Fuel Introduction at Brunswick
(Continued)

UFSAR Section	Event /Analysis	Disposition Status	Comments
15.8	Anticipated Transient Without Scram	Address each reload.	Potentially limiting event. Over-pressurization analysis portion of the event is expected for follow-on reloads. Long term ATWS evaluations for suppression pool temperature and containment pressure requires **[** **]**. PCT and MWR are bound by other analyses. ATWS with core instability evaluations for ATRIUM 11 have been completed and meet acceptance criteria.
15.9	Analytical Methods for Evaluating Radiological Effects With Alternative Source Term	Address for initial reload.	Analyses that demonstrate the AST evaluation is applicable to ATRIUM 11 fuel have been completed.
	Slow Flow Runup	Address each reload.	Analysis results are used to establish the flow-dependent operating limits.
	Backup Stability Protection	Address each reload.	Required to establish exclusion regions.
	Mislocated or Misoriented Fuel Assembly	Address each reload.	Potentially limiting event.

Table 2.2 Disposition of Operating Flexibility and EOOS Options on Limiting Events

Option	Affected Limiting Events/Analyses	Comments
MSIV Out-of-Service	Slow flow runup	The impact of the increase in steam line pressure drop on the slow flow runup analysis will be evaluated each reload.
One SRV Out-of-Service	ASME Overpressurization FWCF LRNB TTNB ATWS	This scenario will be included as part of the base case condition for the events/analyses identified.
One ADS Valve Out-of-Service	LOCA	The scenario will be included in the break spectrum analyses (Reference 26) for the initial cycle.
FFTR/Feedwater Heater Out-of-Service	Stability Solution FWCF LRNB TTNB Backup Stability Protection (BSP)	This scenario will be examined each reload for most of these events /analyses. LRNB and TTNB events with reduced feedwater temperature will be evaluated for the initial reload.
Single-Loop Operation (SLO)	LOCA SLMCPR	The impact of SLO on LOCA will be addressed for the initial cycle in the break spectrum analyses. The SLO SLMCPR will be addressed each reload.
Turbine Bypass Valves Out-of-Service	FWCF	The FWCF event with TBVOOS will be evaluated each reload.

Table 2.2 Disposition of Operating Flexibility and EOOS Options on Limiting Events
(Continued)

Option	Affected Limiting Events/Analyses	Comments
ICF/MELLLA+	ASME Overpressure FWCF LRNB TTNB LOCA ATWS SLMCPR Slow flow runup Stability Solutions	For ATWS with core instabilities, analyses have been performed to show that ATRIUM 11 fuel will meet the appropriate acceptance criteria during MELLLA+ operation. The remaining events need to be performed to cover the range of flows for MELLLA+.

2.2 *Plant Specific Modeling Sensitivities*

As part of the initial application of the AURORA-B AOO methodology to a plant, justification must be provided to ensure that conservative plant parameters are being used. This requirement is defined in Limitation and Conditions 7 and 11 of the Reference 19 safety evaluation. In particular, these limitations and conditions state:

7. As discussed in Section 3.6 of this SE, licensees should provide justification for the key plant parameters and initial conditions selected for performing sensitivity analyses on an event-specific basis. Licensees should further justify that the input values ultimately chosen for these key plant parameters and initial conditions will result in a conservative prediction of FoMs when performing calculations according to the AURORA-B EM described in ANP-10300P.

11. AREVA will provide justification for the uncertainties used for the highly ranked plant-specific PIRT parameters C12, R01, R02, and SL02 on a plant-specific basis, as described in Table 3.2 of this SE.

In order to comply with these requirements, a set of sensitivity studies was performed. Separate sensitivity studies were performed for each of the three figures of merit that were required to license Brunswick Unit 1 Cycle 23: ΔMCPR (Table 2.3), transient nodal power (Table 2.4), and overpressure (Table 2.5). These sensitivity studies address the key parameters required for licensing with the exception of C12 which is described below. In addition to these sensitivity studies, licensing calculations will also look at a wide range of core exposures and flow rates to ensure that the conservative statepoints have been analyzed.

Uncertainties associated with PIRT parameters R01, R02, and SL02 were evaluated for the initial transition. **[**

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Limitation and Condition 16 of the Reference 19 SE, given below, also requires a plant specific justification.

*16. **[** **]** is not sampled as part of the methodology, justification should be provided on a plant-specific basis that a conservative flow rate has been assumed **[** **]**.*

The **[** **]** is provided by Duke and accounts for **[** **]**. The AURORA-B model **[** **]**

Table 2.3 Plant Parameter Sensitivity Results for ΔMCPR

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Table 2.3 Plant Parameter Sensitivity Results for ΔMCPR (continued)

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Table 2.3 Plant Parameter Sensitivity Results for ΔMCPR (continued)

Table 2.3 Plant Parameter Sensitivity Results for ΔMCPR (continued)

[ ]

Table 2.4 Plant Parameter Sensitivity Results for Transient Nodal Power

**Table 2.4 Plant Parameter Sensitivity Results
for Transient Nodal Power
(continued)**

Table 2.4 Plant Parameter Sensitivity Results for Transient Nodal Power (continued)

Table 2.4 Plant Parameter Sensitivity Results for Transient Nodal Power (continued)

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Table 2.5 Plant Parameter Sensitivity Results for Overpressurization

Table 2.5 Plant Parameter Sensitivity Results for Overpressurization (continued)

Table 2.5 Plant Parameter Sensitivity Results for Overpressurization (continued)

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3.0 MECHANICAL DESIGN ANALYSIS

The mechanical design analyses for ATRIUM 10XM and ATRIUM 11 fuel assemblies are presented in the applicable mechanical design reports (References 5, 6, 7, and 36). The maximum exposure limits for the ATRIUM 10XM and ATRIUM 11 fuel designs are:

54.0 GWd/MTU average assembly exposure (ATRIUM 10XM)
57.0 GWd/MTU average assembly exposure (ATRIUM 11)

62.0 GWd/MTU rod average exposure (full-length fuel rods)

The ATRIUM 10XM and ATRIUM 11 LHGR limits are presented in Section 8.0. The fuel cycle design analyses (Reference 3) have verified that the ATRIUM 10XM and ATRIUM 11 fuel assemblies remain within licensed burnup limits.

4.0 THERMAL-HYDRAULIC DESIGN ANALYSIS

4.1 *Thermal-Hydraulic Design and Compatibility*

The results of the thermal-hydraulic characterization and compatibility analyses are presented in the thermal-hydraulic design report (Reference 9). The analysis results demonstrate that the thermal-hydraulic design and compatibility criteria are satisfied for the Brunswick Unit 1 transition core consisting of ATRIUM 10XM and ATRIUM 11 fuel assemblies.

4.2 *Safety Limit MCPR Analysis*

The safety limit MCPR (SLMCPR) is defined as the minimum value of the critical power ratio which ensures that less than 0.1% of the fuel rods in the core are expected to experience boiling transition during normal operation or an anticipated operational occurrence (AOO). The SLMCPR for all fuel in the Brunswick Unit 1 Cycle 23 core was determined using the methodology described in Reference 10. The analysis was performed with a power distribution that conservatively represents expected reactor operating states that could both exist at the MCPR operating limit and produce a MCPR equal to the SLMCPR during an AOO.

The Brunswick Unit 1 Cycle 23 SLMCPR analysis used the ACE/ATRIUM 10XM critical power correlation additive constants and additive constant uncertainty described in Reference 11 for the ATRIUM 10XM fuel. The ACE/ATRIUM 11 critical power correlation, described in Reference 12, was applied to the ATRIUM 11 fuel assemblies.

In the Framatome methodology, the effects of channel bow on the critical power performance are accounted for in the SLMCPR analysis. Reference 10 discusses the application of a realistic channel bow model.

The fuel- and plant-related uncertainties used in the SLMCPR analysis are presented in Table 4.1. The radial power uncertainty used in the analysis includes the effects of up to 40% of the TIP channels out-of-service, up to 50% of the LPRMs out-of-service, and a 2500 EFPH LPRM calibration interval. For TLO, analyses were performed for the minimum and maximum core flow conditions associated with rated power (85% and 104.5%), as well as the maximum core power at 55% core flow for the Brunswick power/flow map, Figure 1.1. For the maximum core flow statepoint, the TLO core flow uncertainty given in Table 4.1 was used. For the minimum core flow at full power, and 55% core flow statepoints, the SLO core flow uncertainty

in Table 4.1 was used consistent with the restrictions listed in Section 2.2.1.1 of the Reference 2 Safety Evaluation Report.

The analysis results support a two-loop operation (TLO) SLMCPR of 1.07 and a single-loop operation (SLO) SLMCPR of 1.09. Consistent with the approved Brunswick Unit 1 Technical Specification SLMCPR values, the Cycle 23 operating limits are based on SLMCPR values of 1.07 for TLO and 1.09 for SLO. Table 4.2 presents a summary of the analysis results including the SLMCPR and the percentage of rods expected to experience boiling transition.

4.3 *Core Hydrodynamic Stability*

Brunswick Unit 1 will implement a plant specific application of the Best-estimate Enhanced Option III (BEO-III) analysis methodology to support operation using the Confirmation Density Algorithm (CDA) as described in References 16 and 17. The CDA enabled through the OPRM system and the BSP solution described in References 16 and 17 will be the stability licensing basis for Brunswick. Cycle-specific analyses have been performed with RAMONA5-FA modeling recirculation pump trips from limiting MELLLA+, MELLLA with FWHOOS and SLO statepoints. The LPRM traces for limiting cases were analyzed with the CDA by Duke Energy consistent with the Reference 16 methodology. The minimum required TLO and SLO stability operating limits are 1.17 and 1.25, respectively. All cases with a channel decay ratio greater than 1.0 within the 95/95 population were confirmed to meet the requirements of the References 16 and 17 methodologies. The cycle-specific analyses have been performed consistent with the conditions provided by the NRC in Reference 37.

Analyses have shown that if shallow control blades (i.e. greater than Notch 36) are withdrawn, then the BEO-III acceptance criteria may not be met for ATRIUM 10XM fuel. Therefore, for Brunswick Unit 1 Cycle 23 operation, the control rods at a shallow position cannot be withdrawn further than their notch position specified in Reference 3. If this restriction cannot be met, the BEO-III with CDA analysis may nevertheless remain valid, but further assessment will be required.

The Backup Stability Protection (BSP) solution may be used by the plant in the event that the OPRM system is declared inoperable. Reference 16 Section 5 describes two BSP options that are based on selected elements from three distinct constituents: BSP Manual Regions, BSP Boundary, and Automated BSP (ABSP) setpoints.

The Manual BSP region boundaries were validated for Brunswick Unit 1 Cycle 23 using STAIF (Reference 15 with modified fuel rod properties documented in Reference 17) for nominal and reduced feedwater temperature operation. The endpoints of the regions are defined in Table 4.3 and Table 4.4 for nominal and reduced feedwater temperature, respectively. The Manual BSP region boundary endpoints are connected using the Generic Shape Function (GSF).

The ABSP Average Power Range Monitor (APRM) Simulated Thermal Power (STP) setpoints associated with the ABSP Scram Region are listed in Table 4.5. These ABSP setpoints are applicable to both TLO and SLO as well as nominal and reduced feedwater temperature operation.

4.4 *Voiding in the Channel Bypass Region*

To demonstrate compliance with the NRC's requirement that there be less than 5% bypass voiding around the LPRMs (see Section 5.1.1.5.1 of the Reference 2 Safety Evaluation), the bypass void level has been evaluated throughout the cycle. The maximum bypass void value applicable to the Cycle 23 design [

]

[

]

Table 4.1 Fuel- and Plant-Related Uncertainties for Safety Limit MCPR Analyses

Parameter	Uncertainty
Fuel-Related Uncertainties	
[	
	]
Plant-Related Uncertainties	
Feedwater flow rate	1.8%
Feedwater temperature	0.8%
Core pressure	0.8%
Total core flow rate TLO SLO	 2.5% 6%

[ ]

Table 4.2 Results Summary
for Safety Limit MCPR Analyses

Power/Flow (%)	Minimum Supported SLMCPR*	Percentage of Rods in Boiling Transition
[ ]	TLO – 1.07	0.0916
[ ]	TLO – 1.07	0.0916
[ ]	TLO – 1.07	0.0933
[ ]	SLO – 1.09	0.0790

* The OLMCPR shown in Tables 8.1 through 8.9 were developed assuming a TLO SLMCPR of 1.07 and a SLO SLMCPR of 1.09.

Table 4.3 BSP Endpoints For Nominal Feedwater Temperature

Endpoint	Power (%)	Flow (%)	Definition
A1	57.0	40.6	Scram Region Boundary, HFCL
B1	42.0	31.7	Scram Region Boundary, NCL
A2	64.5	50.0	Controlled Entry Region Boundary, HFCL
B2	28.9	31.9	Controlled Entry Region Boundary, NCL

Table 4.4 BSP Endpoints For Reduced Feedwater Temperature

Endpoint	Power (%)	Flow (%)	Definition
A1	65.9	51.8	Scram Region Boundary, HFCL
B1	36.5	31.9	Scram Region Boundary, NCL
A2	69.8	56.8	Controlled Entry Region Boundary, HFCL
B2	28.9	31.9	Controlled Entry Region Boundary, NCL

Table 4.5 ABSP Setpoints for the Scram Region

Parameter	Symbol	Value
Slope of ABSP APRM flow-biased trip linear segment.	m_{TRIP}	2.00 %RTP/%RDF
ABSP APRM flow-biased trip setpoint power intercept. Constant Power Line for Trip from zero Drive Flow to Flow Breakpoint value.	$P_{BSP\text{-}TRIP}$	42.0 %RTP
ABSP APRM flow-biased trip setpoint drive flow intercept. Constant Flow Line for Trip.	$W_{BSP\text{-}TRIP}$	≥ 37.5 %RDF
Flow Breakpoint value	$W_{BSP\text{-}BREAK}$	25.0 %RDF

Table 4.6 Maximum Bypass Voiding at LPRM Level D*

Power (%) Flow (%) Condition	Cycle Exposure (GWd/MTU)	Bypass Void (%)
[		]

* The voiding at LPRM level D bounds the voiding at LPRM levels A, B, and C.

5.0 ANTICIPATED OPERATIONAL OCCURRENCES

This section describes the analyses performed to determine the power- and flow-dependent MCPR operating limits for base case operation for Brunswick Unit 1 Cycle 23.

The AURORA-B methodology (Reference 19) is used with the Framatome THERMEX methodology (Reference 20) for the generation of thermal limits. AURORA-B is a comprehensive evaluation model developed for predicting the dynamic response of boiling water reactors (BWRs) during transient, postulated accident, and beyond design-basis accident scenarios. The evaluation model (EM) contains a multi-physics code system with flexibility to incorporate all the necessary elements for analysis of the full spectrum of BWR events that are postulated to affect the nuclear steam supply system of the BWR plant. Deterministic analysis principles are applied to satisfy plant operational and Technical Specification requirements through the use of conservative initial conditions and boundary conditions.

The foundation of AURORA-B AOO is built upon three computer codes, S-RELAP5, MB2-K, and RODEX4. Working together as a system, they make up the multi-physics evaluation model that provides the necessary systems, components, geometries, processes, etc. to assure adequate predictions of the relevant BWR event characteristics for its intended applications. The three codes making up the foundation of the code system are:

- S-RELAP5 – This code provides the transient thermal-hydraulic, thermal conduction, control systems, and special process capabilities (i.e. valves, jet-pumps, steam separator, critical power correlations, etc.) necessary to simulate a BWR plant.

- MB2-K – This code uses advanced nodal expansion methods to solve the three-dimensional, two-group, neutron kinetics equations. The MB2-K code is consistent with the MICROBURN-B2 steady state core simulator. MB2-K receives a significant portion of its input from the steady state core simulator.

- RODEX4 – A subset of routines from this code are used to evaluate the transient thermal-mechanical fuel rod (including fuel/clad gap) properties as a function of temperature, rod internal pressure, etc. The fuel rod properties are used by S-RELAP5 when solving the transient thermal conduction equations in lieu of standard S-RELAP5 material property tables.

The AURORA-B AOO methodology (Reference 19) includes an evaluation of the impact of code uncertainties on Figures of Merit (FoM) (e.g. ΔMCPR, peak pressure) [

] that has wide acceptance in the nuclear industry.

The ACE/ATRIUM 10XM critical power correlation (Reference 11) is used to evaluate the thermal margin for the ATRIUM 10XM fuel. The ACE/ATRIUM 11 critical power correlation (Reference 12) is used in the thermal margin evaluations for the ATRIUM 11 fuel.

5.1 *System Transients*

The reactor plant parameters for the system transient analyses were provided by the utility. Analyses have been performed to determine power-dependent MCPR limits that protect operation throughout the power/flow domain shown in Figure 1.1.

At Brunswick, direct scram on turbine stop valve (TSV) position and turbine control valve (TCV) fast closure are bypassed at power levels less than 26% of rated (P_{bypass}). Scram will occur when the high pressure or high neutron flux scram setpoint is reached. Reference 22 indicates that MCPR limits only need to be monitored at power levels greater than or equal to 23% of rated, which is the lowest power analyzed for this report.

The limiting exposure for rated power pressurization transients is typically at end of full power (EOFP) when the control rods are fully withdrawn. The end-of-cycle licensing basis (EOCLB) analysis was performed at EOFP + 15 EFPD. Analyses were performed at cycle exposures prior to EOCLB to ensure that the operating limits provide the necessary protection. Analyses were also performed to support extended cycle operation with final feedwater temperature reduction (FFTR) and power coastdown. The Brunswick Unit 1 Cycle 23 licensing basis exposures used to develop the limits breakpoints are presented in Table 5.1.

All pressurization transients assumed that one of the lowest setpoint safety relief valves (SRV) was inoperable. This basis supports operation with 1 SRV out-of-service.

The Brunswick Unit 1 turbine bypass system includes four bypass valves. However, for base case analyses in which credit is taken for turbine bypass operation, only three of the turbine bypass valves are assumed operable.

Reductions in feedwater temperature of less than or equal to 10°F from the nominal feedwater temperature and variation of ± 10 psi in dome pressure are considered base case operation, not an EOOS condition. This decrease in feedwater temperature causes a small increase in the core inlet subcooling which changes the axial power shape and core void fraction. In addition, the steam flow for a given power level decreases since more power is used to increase the coolant enthalpy to saturated conditions. The consequences of the FWCF event can be more severe as a result of the increase in core inlet subcooling during the overcooling phase of the event. Analyses were performed to evaluate the impact of reduced feedwater temperature on the FWCF event. While a decrease in steam flow tends to make the LRNB event less severe, the TCV initial position is further closed which tends to make the event more severe, especially at higher power levels. LRNB and TTNB events for base case operation were evaluated for both nominal and 10°F reduced feedwater temperatures. The analyses were performed with the limiting feedwater and dome pressure conditions in the allowable ranges.

FFTR is used to extend rated power operation by decreasing the feedwater temperature. The amount of feedwater temperature reduction is a function of power with the maximum decrease of 110.3°F at rated power. Analyses were performed to support both nominal ± 10 psi and constant rated dome pressure with combined FFTR/Coastdown operation to the maximum licensing exposure (Table 5.1). The FWCF analyses were performed with the lowest feedwater temperature associated with the initial power level. Operation with FFTR is not allowed in the MELLLA+ extension of the Brunswick operating domain.

The results of the system pressurization transients are sensitive to the scram speed used in the calculations. To take advantage of average scram speeds faster than those associated with the Technical Specifications requirements, scram speed-dependent $MCPR_p$ limits are provided. The nominal scram speed (NSS) insertion times, extended scram speed (ESS), and the Technical Specifications scram speed (TSSS) insertion times used in the analyses are presented in Table 5.2. The NSS or ESS $MCPR_p$ limits can only be applied if the scram speed test results meet their respective insertion times. System transient analyses were performed to establish $MCPR_p$ limits for NSS, ESS, and TSSS insertion times. The Brunswick Unit 1 Technical Specifications (Reference 22) allow for operation with up to 10 “slow” and 1 stuck control rod. One additional control rod is assumed to fail to scram. The NSS, ESS, and TSSS analyses were performed to conservatively account for the effect of the slow and stuck rods on scram

reactivity. For transient events below 50% power without direct scram, the results are relatively insensitive to scram speed, and only TSSS analyses are performed.

Tables 5.10, 5.11, and 5.12 present the limiting LHGRFACp transient analysis results for base case operation used to develop the operating limits for NSS, ESS, and TSSS insertion times, respectively.

5.1.1 Load Rejection No Bypass (LRNB)

The load rejection causes a fast closure of the turbine control valves. The resulting compression wave travels through the steam lines into the vessel and creates a rapid pressurization. The increase in pressure causes a decrease in core voids, which in turn causes a rapid increase in power. The fast closure of the turbine control valves also causes a reactor scram. Turbine bypass system operation, which also mitigates the consequences of the event, is not credited. The excursion of the core power due to the void collapse is terminated primarily by the reactor scram and revoiding of the core.

For power levels less than 50% of rated, the LRNB analyses assume that the power load unbalance (PLU) is inoperable. With the PLU inoperable, the LRNB sequence of events is different than the standard event. Instead of a fast closure, the TCVs close in servo mode and there is no direct scram on TCV closure. The power and pressure excursion continues until the high pressure scram occurs. Given that there is no direct scram when the PLU is inoperable, the above and below P_{bypass} system responses at 26% power are identical.

LRNB analyses were performed for a range of power/flow conditions to support generation of the thermal limits. Tables 5.3, 5.4, and 5.5 present the base case limiting transient event and results as a function of power used to generate the EOCLB operating limits for NSS, ESS, and TSSS insertion times, respectively. Figures 5.1 – 5.3 show the responses of various reactor and plant parameters during the LRNB event initiated at 100% of rated power and 104.5% of rated core flow with TSSS insertion times at EOCLB.

5.1.2 Turbine Trip No Bypass (TTNB)

The turbine trip causes a closure of the turbine stop valves. The resulting compression wave travels through the steam lines into the vessel and creates a rapid pressurization. The increase in pressure causes a decrease in core voids, which in turn causes a rapid increase in power. The closure of the turbine stop valves also causes a reactor scram. Turbine bypass system

operation, which also mitigates the consequences of the event, is not credited. The excursion of the core power due to the void collapse is terminated primarily by the reactor scram and revoiding of the core.

TTNB analyses were performed for a range of power/flow conditions for which the TTNB event is potentially limiting to support generation of the thermal limits. Tables 5.3, 5.4, and 5.5 present the base case limiting transient event and results as a function of power used to generate the EOCLB operating limits for NSS, ESS, and TSSS insertion times, respectively. Figures 5.4 – 5.6 show the responses of various reactor and plant parameters during the TTNB event initiated at 100% of rated power and 104.5% of rated core flow with TSSS insertion times at EOCLB.

5.1.3 Feedwater Controller Failure (FWCF)

The increase in feedwater flow due to a failure of the feedwater control system to maximum demand results in an increase in the water level and a decrease in the coolant temperature at the core inlet. The increase in core inlet subcooling causes an increase in core power. As the feedwater flow continues at maximum demand, the water level continues to rise and eventually reaches the high water level trip setpoint. The initial water level is conservatively assumed to be at the low-level normal operating range to delay the high-level trip and maximize the core inlet subcooling that results from the FWCF. The high water level trip causes the turbine stop valves to close in order to prevent damage to the turbine from excessive liquid inventory in the steam line. The valve closures create a compression wave that travels to the core causing a void collapse and subsequent rapid power excursion. The closure of the turbine stop valves also initiates a reactor scram. Three of the four installed turbine bypass valves are assumed operable and provide pressure relief. The core power excursion is mitigated in part by the pressure relief, but the primary mechanism for termination of the event is reactor scram.

FWCF analyses were performed for a range of power/flow conditions to support generation of the thermal limits. Tables 5.3, 5.4, and 5.5 present the base case limiting transient event and results as a function of power used to generate the EOCLB operating limits for NSS, ESS, and TSSS insertion times, respectively. Figures 5.7 – 5.9 show the responses of various reactor and plant parameters during the FWCF event initiated at 100% of rated power and 104.5% of rated core flow with TSSS insertion times at EOCLB.

5.1.4 Pressure Regulator Failure Downscale (PRFDS)

The pressure regulator failure downscale event occurs when the pressure regulator system fails and sends a signal to close all four turbine control valves in control mode. Normally, a backup pressure regulator device would take control and maintain the setpoint pressure, resulting in a mild pressure excursion and a benign event. If 5 of the 6 pressure regulator devices were out-of-service, there would be no backup pressure regulator device and the event would be more severe. The core would pressurize resulting in void collapse and a subsequent power increase. The event would be terminated by scram when either the high-neutron flux or high-pressure setpoint is reached. Operation with only one pressure regulator device is not supported for Brunswick Unit 1 over the entire power/flow map. However, Duke Energy requested that Framatome review the PRFDS event with one pressure device in service to determine if it is bound by the LRNB event at power levels greater than 90% of rated and less than 50% of rated. Analysis results demonstrate that the LRNB is more limiting at power levels greater than 90% of rated. Since LRNB analyses assume the PLU is inoperable below 50% of rated power, the TCVs close in servo or control mode without a direct scram on fast closure. Therefore, the consequences of the PRFDS event with 5 of the 6 pressure regulators out of service are no more severe than the LRNB event at power levels less than 50% of rated.

5.1.5 Loss of Feedwater Heating

The loss of feedwater heating (LFWH) event analysis supports an assumed 100°F decrease in the feedwater temperature. The result is an increase in core inlet subcooling, which reduces voids, thereby increasing core power and shifting the axial power distribution toward the bottom of the core. As a result of the axial power shift and increased core power, voids begin to build up in the bottom region of the core, acting as negative feedback to the increased subcooling effect. The negative feedback moderates the core power increase. Although there is a substantial increase in core thermal power during the event, the increase in steam flow is much less because a large part of the added power is used to overcome the increase in inlet subcooling. The increase in steam flow is accommodated by the pressure control system via the TCVs or the turbine bypass valves, so no pressurization occurs. For Brunswick Unit 1 Cycle 23, a cycle-specific analysis was performed in accordance with the Reference 23 methodology to determine the change in MCPR for the event. The LFWH results are presented in Table 5.6.

5.1.6 Control Rod Withdrawal Error

The control rod withdrawal error (CRWE) transient is an inadvertent reactor operator initiated withdrawal of a control rod. This withdrawal increases local power and core thermal power, lowering the core MCPR. The CRWE transient is typically terminated by control rod blocks initiated by the rod block monitor (RBM). The CRWE event was analyzed assuming no xenon and allowing credible instrumentation out-of-service in the rod block monitor (RBM) system. The analysis further assumes that the plant could be operating in either an A or B sequence control rod pattern. The rated power CRWE results are shown in Table 5.7 for selected analytical RBM high power setpoint values from 108% to 117%. An assumed RBM high power setpoint of 111% was used to develop the $MCPR_p$ limits. At the corresponding intermediate and lower power setpoint values, the $MCPR_p$ values bound, or are equal to, the CRWE MCPR values. Framatome analyses show that standard filtered RBM setpoint reductions are supported. Analyses demonstrate that the 1% strain and centerline melt criteria are met with the LHGR limits presented in Section 8.2. The recommended operability requirements based on the unblocked CRWE results are shown in Table 5.8 based on the SLMCPR values presented in Section 4.2.

5.2 *Slow Flow Runup Analysis*

Flow-dependent MCPR and LHGR limits are established to support operation at off-rated core flow conditions. The limits are based on the CPR and heat flux changes experienced by the fuel during slow flow excursions. The slow flow excursion event assumes a failure of the recirculation flow control system such that the core flow increases slowly to the maximum flow physically permitted by the equipment (107% of rated core flow). An uncontrolled increase in flow creates the potential for a significant increase in core power and heat flux. Operation with one MSIVOOS causes a larger increase in pressure and power during the flow excursion which results in a steeper flow runup path. A conservatively steep flow runup path was used in the analysis. The slow flow runup analyses were performed to support operation in all the EOOS scenarios.

XCOBRA is used to calculate the change in critical power ratio during a two-loop flow runup to the maximum flow rate. The $MCPR_f$ limit is set such that the increase in core power, resulting from the maximum increase in core flow, assures that the TLO safety limit MCPR is not violated. Calculations were performed for a range of initial flow rates to determine the corresponding

MCPR values that put the limiting assembly on the safety limit MCPR at the high flow condition at the end of the flow excursion.

Results of the flow runup analysis are presented in Table 5.9. $MCPR_f$ limits that provide the required protection are presented in Table 8.10 and 8.11. The $MCPR_f$ limits are applicable for all Cycle 23 exposures.

Flow runup analyses were performed with CASMO-4/MICROBURN-B2 to determine flow-dependent LHGR multipliers ($LHGRFAC_f$) for ATRIUM 10XM and ATRIUM 11 fuel. The analysis assumes that the recirculation flow increases slowly along the limiting rod line to the maximum flow physically permitted by the equipment. A series of flow excursion analyses were performed at several exposures throughout the cycle starting from different initial power/flow conditions. Xenon is assumed to remain constant during the event. The $LHGRFAC_f$ multipliers are established to provide protection against fuel centerline melt and overstraining of the cladding during a flow runup. The Cycle 23 $LHGRFAC_f$ multipliers are presented in Table 8.19.

The maximum flow during a flow excursion in single-loop operation is much less than the maximum flow during two-loop operation. Therefore, the flow-dependent MCPR limits and LHGR multipliers for two-loop operation are applicable for SLO.

5.3 *Equipment Out-of-Service Scenarios*

The equipment out-of-service (EOOS) scenarios supported for Brunswick Unit 1 Cycle 23 are presented in Table 1.1 and discussed further in the following subsections. Tables 5.10, 5.11, and 5.12 present the limiting LHGRFACp transient analysis results for each EOOS scenario used to develop the operating limits for NSS, ESS, and TSSS insertion times, respectively.

5.3.1 **FHOOS**

The FHOOS scenario assumes a feedwater temperature reduction of 110.3°F at rated power and steam flow. The effect of the reduced feedwater temperature is an increase in the core inlet subcooling which can change the axial power shape and core void fraction. In addition, the steam flow for a given power level decreases since more power is required to increase the enthalpy of the coolant to saturated conditions. The consequences of the FWCF event are potentially more severe as a result of the increase in core inlet subcooling during the overcooling phase of the event. While the decrease in steam flow tends to make the LRNB event less severe, the TCV initial position is further closed which tends to make the event more

severe, especially at higher power levels. FWCF events were analyzed to ensure that appropriate FHOOS operating limits are established. Operation with FHOOS or the related FFTR scenario is not allowed in the MELLLA+ region.

5.3.2 TBVOOS

For this EOOS scenario, operation with TBVOOS means that the fast opening capability of two or more of the turbine bypass valves cannot be assured, thereby reducing the pressure relief capacity during fast pressurization transients. While the base case LRNB and TTNB events are analyzed assuming the turbine bypass valves out-of-service, operation with TBVOOS has an adverse effect on the FWCF event. Analyses of the FWCF event with TBVOOS were performed to establish the TBVOOS operating limits.

5.3.3 Combined FHOOS and TBVOOS

FWCF analyses with both FHOOS and TBVOOS were performed. Operating limits for this combined EOOS scenario were established using these FWCF results. This scenario is not allowed in the MELLLA+ region.

5.3.4 One SRVOOS

As noted earlier, all pressurization transient analyses were performed with one of the lowest setpoint SRVs assumed inoperable. Therefore, the base case operating limits support operation with one SRVOOS. The EOOS operating limits also support operation with one SRVOOS.

5.3.5 One MSIVOOS

Operation with one MSIVOOS is supported for operation less than 70% of rated power. At these reduced power levels, the flow through any one steam line will not be greater than the flow at rated power when all MSIVs are available. Since all four turbine control valves are available, adequate pressure control can be maintained. The main difference in operation with one MSIVOOS is that the steam line pressure drop between the steam dome and the turbine valves is higher than if all MSIVs are available. Since low steam line pressure drop is limiting for pressurization transients, the results of the pressurization events with all MSIVs in service bound the results with one MSIVOOS. In addition, operation with one MSIVOOS has no impact on the other nonpressurization events evaluated to establish power-dependent operating limits. Therefore, the power-dependent operating limits applicable to base case operation with all

MSIVs in service remain applicable for operation with one MSIVOOS for power levels less than or equal to 70% of rated. As noted earlier, slow flow runup analyses were performed to support operation with one MSIVOOS.

5.3.6 Single-Loop Operation

Operation in SLO is only supported up to a maximum core flow of 45 Mlbm/hr which corresponds to a maximum power level of 71.1% of rated at the MELLLA boundary. In SLO, the two-loop operation limiting ∆MCPRs and LHGRFAC multipliers remain applicable. The only impacts on the MCPR, LHGR, and MAPLHGR limits for SLO are an increase of 0.02 in the SLMCPR as discussed in Section 4.2, and the application of an SLO MAPLHGR multiplier discussed in Section 8.3. The net result is a 0.02 increase in the base case $MCPR_p$ limits and a decrease in the MAPLHGR limit. The same situation is true for the EOOS scenarios. Adding 0.02 to the corresponding two-loop operation EOOS $MCPR_p$ limits results in SLO $MCPR_p$ limits for the EOOS conditions. The TLO EOOS LHGRFAC multipliers remain applicable in SLO. This scenario is not allowed in the MELLLA+ region.

5.4 *Licensing Power Shape*

The licensing axial power profile used by Framatome for the plant transient analyses bounds the projected end of full power axial power profile. The conservative licensing axial power profile generated at the EOCLB core average exposure of 35,829 MWd/MTU is given in Table 5.13. Cycle 23 operation is considered to be in compliance when:

- The integrated normalized power generated in the bottom 7 nodes from the projected EOFP solution at the state conditions provided in Table 5.13 is greater than the integrated normalized power generated in the bottom 7 nodes in the licensing basis axial power profile, *and* the individual normalized power from the projected EOFP solution is greater than the corresponding normalized power from the licensing basis axial power profile for at least 6 of the 7 bottom nodes.
- The projected EOFP condition occurs at a core average exposure less than or equal to EOCLB.

If the criteria cannot be fully met, the licensing basis may nevertheless remain valid but further assessment will be required.

The licensing basis power profile in Table 5.13 was calculated using the MICROBURN-B2 code. Compliance analyses must also be performed using MICROBURN-B2. Note that the power profile comparison should be done without incorporating instrument updates to the axial profile

because the updated power is not used in the core monitoring system to accumulate assembly burnups.

Table 5.1 Exposure Basis for Brunswick Unit 1 Cycle 23 Transient Analysis

Cycle Exposure at End of Interval (MWd/MTU)	Core Average Exposure (MWd/MTU)*	Comments
0	16,658	Beginning of cycle
16,000	32,658	Break point for exposure-dependent $MCPR_p$ limits (NEOC)
19,171	35,829	Design basis rod patterns to EOFP + 15 EFPD (EOCLB)
20,697	37,355	Maximum licensing core exposure – including FFTR /Coastdown

* Note that the limits presented in Tables 8.1 – 8.9 and Tables 8.13 – 8.18 are based on core average exposure.

Table 5.2 Scram Speed Insertion Times

Control Rod Position (notch)	TSSS Time (sec)	ESS Time (sec)	NSS Time (sec)
48 (*full-out*)	0.000	0.000	0.000
48	0.200	0.200	0.200
46	0.440	0.326	0.303
36	1.080	0.853	0.814
26	1.830	1.419	1.351
6	3.350	2.586	2.466
0 (*full-in*)	3.806	2.936	2.800

Table 5.3 EOCLB Base Case Limiting Transient Event NSS Insertion Time

Power	ATRIUM 10XM ΔMCPR	Limiting Event	ATRIUM 11 ΔMCPR	Limiting Event
100	0.29	LRNB	0.31	TTNB
90	0.29	LRNB	0.33	LRNB
80	0.32	LRNB	0.37	LRNB
70	0.36	LRNB	0.42	LRNB
60	0.38	LRNB	0.44	LRNB
50	0.44	FWCF	0.54	FWCF
50 at > 65%F PLU inoperable	0.74	LRNB	0.77	LRNB
50 at ≤ 65%F PLU inoperable	0.62	LRNB	0.54	LRNB
30	1.05	LRNB	1.03	LRNB
26 at > 65%F PLU inoperable	1.08	LRNB	1.05	LRNB
26 at ≤ 65%F PLU inoperable	0.91	LRNB	0.83	LRNB
26 at > 65%F below P_{bypass}	1.15	FWCF	1.16	FWCF
26 at ≤ 65%F below P_{bypass}	1.10	FWCF	1.06	FWCF
23 at > 65%F below P_{bypass}	1.27	FWCF	1.18	FWCF
23 at ≤ 65%F below P_{bypass}	1.27	FWCF	1.18	FWCF

Table 5.4 EOCLB Base Case Limiting Transient Event ESS Insertion Time

Power	ATRIUM 10XM ΔMCPR	Limiting Event	ATRIUM 11 ΔMCPR	Limiting Event
100	0.29	LRNB	0.32	TTNB
90	0.29	LRNB	0.33	LRNB
80	0.32	LRNB	0.37	LRNB
70	0.36	LRNB	0.42	LRNB
60	0.38	LRNB	0.44	LRNB
50	0.44	FWCF	0.54	FWCF
50 at > 65%F PLU inoperable	0.74	LRNB	0.77	LRNB
50 at ≤ 65%F PLU inoperable	0.62	LRNB	0.54	LRNB
30	1.05	LRNB	1.03	LRNB
26 at > 65%F PLU inoperable	1.08	LRNB	1.05	LRNB
26 at ≤ 65%F PLU inoperable	0.91	LRNB	0.83	LRNB
26 at > 65%F below P_{bypass}	1.15	FWCF	1.16	FWCF
26 at ≤ 65%F below P_{bypass}	1.10	FWCF	1.06	FWCF
23 at > 65%F below P_{bypass}	1.27	FWCF	1.18	FWCF
23 at ≤ 65%F below P_{bypass}	1.27	FWCF	1.18	FWCF

Table 5.5 EOCLB Base Case Limiting Transient Event TSSS Insertion Time

Power	ATRIUM 10XM ΔMCPR	Limiting Event	ATRIUM 11 ΔMCPR	Limiting Event
100	0.38	LRNB	0.41	LRNB
90	0.37	LRNB	0.39	LRNB
80	0.39	LRNB	0.45	LRNB
70	0.43	LRNB	0.52	LRNB
60	0.45	LRNB	0.56	LRNB
50	0.58	LRNB	0.61	LRNB
50 at > 65%F PLU inoperable	0.74	LRNB	0.77	LRNB
50 at ≤ 65%F PLU inoperable	0.62	LRNB	0.54	LRNB
30	1.05	LRNB	1.03	LRNB
26 at > 65%F PLU inoperable	1.08	LRNB	1.05	LRNB
26 at ≤ 65%F PLU inoperable	0.91	LRNB	0.83	LRNB
26 at > 65%F below P_{bypass}	1.15	FWCF	1.16	FWCF
26 at ≤ 65%F below P_{bypass}	1.10	FWCF	1.06	FWCF
23 at > 65%F below P_{bypass}	1.27	FWCF	1.18	FWCF
23 at ≤ 65%F below P_{bypass}	1.27	FWCF	1.18	FWCF

Table 5.6 Loss of Feedwater Heating Transient Analysis Results

Power (% rated)	ATRIUM 10XM ΔCPR	ATRIUM 11 ΔCPR
100	0.15	0.17
90	0.15	0.18
80	0.16	0.18
70	0.17	0.19
60	0.18	0.21
50	0.20	0.23
40	0.23	0.26
30	0.28	0.31
23	0.34	0.37

Table 5.7 Control Rod Withdrawal Error ΔCPR Results

Analytical RBM Setpoint (without filter) (%)	ATRIUM 10XM ΔCPR	ATRIUM 11 ΔCPR
108	0.22	0.20
111	0.27	0.23
114	0.30	0.25
117	0.40	0.33

Table 5.8 RBM Operability Requirements

Thermal Power (% rated)	Applicable ATRIUM 10XM OLMCPR	Applicable ATRIUM 11 OLMCPR
≥ 29% and < 90%	1.59 TLO 1.62 SLO	1.49 TLO 1.52 SLO
≥ 90%	1.49 TLO	1.42 TLO

Table 5.9 Flow-Dependent MCPR Results

Core Flow (% rated)	ATRIUM 10XM Limiting MCPR MSIVIS	ATRIUM 10XM Limiting MCPR MSIVOOS	ATRIUM 11 Limiting MCPR MSIVIS	ATRIUM 11 Limiting MCPR MSIVOOS
31	1.47	1.65	1.40	1.55
40	1.42	1.56	1.33	1.45
50	1.41	1.53	1.30	1.39
60	1.39	1.47	1.27	1.34
70	1.32	1.38	1.24	1.29
80	1.24	1.29	1.20	1.24
90	1.20	1.23	1.17	1.19
100	1.14	1.16	1.12	1.13
107	1.10	1.10	1.08	1.08

Table 5.10 EOCLB LHGRFACp Transient Results
NSS Insertion Time

Power	Base Case	FHOOS	TBVOOS	FHOOS/ TBVOOS
ATRIUM 11 Fuel				
100	1.00	1.00	1.00	0.98
90	1.00	1.00	1.00	0.97
50	0.96	0.91	0.92	0.88
50 at > 65%F PLU inoperable	0.85	0.85	0.85	0.85
50 at ≤ 65%F PLU inoperable	0.93	0.93	0.93	0.93
26 at > 65%F PLU inoperable	0.67	0.67	0.67	0.67
26 at ≤ 65%F PLU inoperable	0.79	0.79	0.79	0.79
26 at > 65%F below P_{bypass}	0.46	0.44	0.41	0.37
26 at ≤ 65%F below P_{bypass}	0.48	0.46	0.48	0.46
23 at > 65%F below P_{bypass}	0.46	0.43	0.37	0.34
23 at ≤ 65%F below P_{bypass}	0.48	0.45	0.45	0.42
ATRIUM 10XM Fuel				
100	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	0.96
50 at > 65%F PLU inoperable	0.92	0.92	0.92	0.92
50 at ≤ 65%F PLU inoperable	1.00	1.00	1.00	1.00
26 at > 65%F PLU inoperable	0.75	0.75	0.75	0.75
26 at ≤ 65%F PLU inoperable	0.86	0.86	0.86	0.86
26 at > 65%F below P_{bypass}	0.50	0.48	0.45	0.42
26 at ≤ 65%F below P_{bypass}	0.51	0.49	0.51	0.49
23 at > 65%F below P_{bypass}	0.50	0.47	0.41	0.38
23 at ≤ 65%F below P_{bypass}	0.51	0.49	0.50	0.47

Table 5.11 EOCLB LHGRFACp Transient Results
ESS Insertion Time

Power	Base Case	FHOOS	TBVOOS	FHOOS/ TBVOOS
ATRIUM 11 Fuel				
100	1.00	1.00	1.00	0.97
90	1.00	1.00	1.00	0.97
50	0.96	0.91	0.92	0.88
50 at > 65%F PLU inoperable	0.85	0.85	0.85	0.85
50 at ≤ 65%F PLU inoperable	0.93	0.93	0.93	0.93
26 at > 65%F PLU inoperable	0.67	0.67	0.67	0.67
26 at ≤ 65%F PLU inoperable	0.79	0.79	0.79	0.79
26 at > 65%F below P_{bypass}	0.46	0.44	0.41	0.37
26 at ≤ 65%F below P_{bypass}	0.48	0.46	0.48	0.46
23 at > 65%F below P_{bypass}	0.46	0.43	0.37	0.34
23 at ≤ 65%F below P_{bypass}	0.48	0.45	0.45	0.42
ATRIUM 10XM Fuel				
100	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00
50	1.00	1.00	1.00	0.96
50 at > 65%F PLU inoperable	0.92	0.92	0.92	0.92
50 at ≤ 65%F PLU inoperable	1.00	1.00	1.00	1.00
26 at > 65%F PLU inoperable	0.75	0.75	0.75	0.75
26 at ≤ 65%F PLU inoperable	0.86	0.86	0.86	0.86
26 at > 65%F below P_{bypass}	0.50	0.48	0.45	0.42
26 at ≤ 65%F below P_{bypass}	0.51	0.49	0.51	0.49
23 at > 65%F below P_{bypass}	0.50	0.47	0.41	0.38
23 at ≤ 65%F below P_{bypass}	0.51	0.49	0.50	0.47

Table 5.12 EOCLB LHGRFACp Transient Results
TSSS Insertion Time

Power	Base Case	FHOOS	TBVOOS	FHOOS/ TBVOOS
ATRIUM 11 Fuel				
100	1.00	0.96	0.99	0.94
90	--	--	--	--
50	0.93	0.88	0.87	0.83
50 at > 65%F PLU inoperable	0.85	0.85	0.85	0.83
50 at ≤ 65%F PLU inoperable	0.93	0.93	0.93	0.93
26 at > 65%F PLU inoperable	0.67	0.67	0.67	0.67
26 at ≤ 65%F PLU inoperable	0.79	0.79	0.79	0.79
26 at > 65%F below P_{bypass}	0.46	0.44	0.41	0.37
26 at ≤ 65%F below P_{bypass}	0.48	0.46	0.48	0.46
23 at > 65%F below P_{bypass}	0.46	0.43	0.37	0.34
23 at ≤ 65%F below P_{bypass}	0.48	0.45	0.45	0.42
ATRIUM 10XM Fuel				
100	1.00	1.00	1.00	1.00
90	1.00	1.00	1.00	1.00
50	1.00	0.96	0.95	0.91
50 at > 65%F PLU inoperable	0.92	0.92	0.92	0.91
50 at ≤ 65%F PLU inoperable	1.00	1.00	1.00	1.00
26 at > 65%F PLU inoperable	0.75	0.75	0.75	0.75
26 at ≤ 65%F PLU inoperable	0.86	0.86	0.86	0.86
26 at > 65%F below P_{bypass}	0.50	0.48	0.45	0.42
26 at ≤ 65%F below P_{bypass}	0.51	0.49	0.51	0.49
23 at > 65%F below P_{bypass}	0.50	0.47	0.41	0.38
23 at ≤ 65%F below P_{bypass}	0.51	0.49	0.50	0.47

Table 5.13 Licensing Basis Core Average Axial Power Profile

State Conditions for Power Shape Evaluation	
Power, MWt	2923.0
MICROBURN-B2 pressure, psia	1044.8
Inlet subcooling, Btu/lbm	20.3
Flow, Mlb/hr	80.5
Control state	ARO
Core average exposure (EOCLB), MWd/MTU	35,829

Licensing Axial Power Profile (Normalized)

	Node	Power
Top	25	0.273
	24	0.609
	23	1.010
	22	1.197
	21	1.304
	20	1.384
	19	1.416
	18	1.437
	17	1.428
	16	1.399
	15	1.392
	14	1.342
	13	1.365
	12	1.320
	11	1.242
	10	1.195
	9	1.119
	8	1.010
	7	0.887
	6	0.756
	5	0.617
	4	0.493
	3	0.402
	2	0.310
Bottom	1	0.091

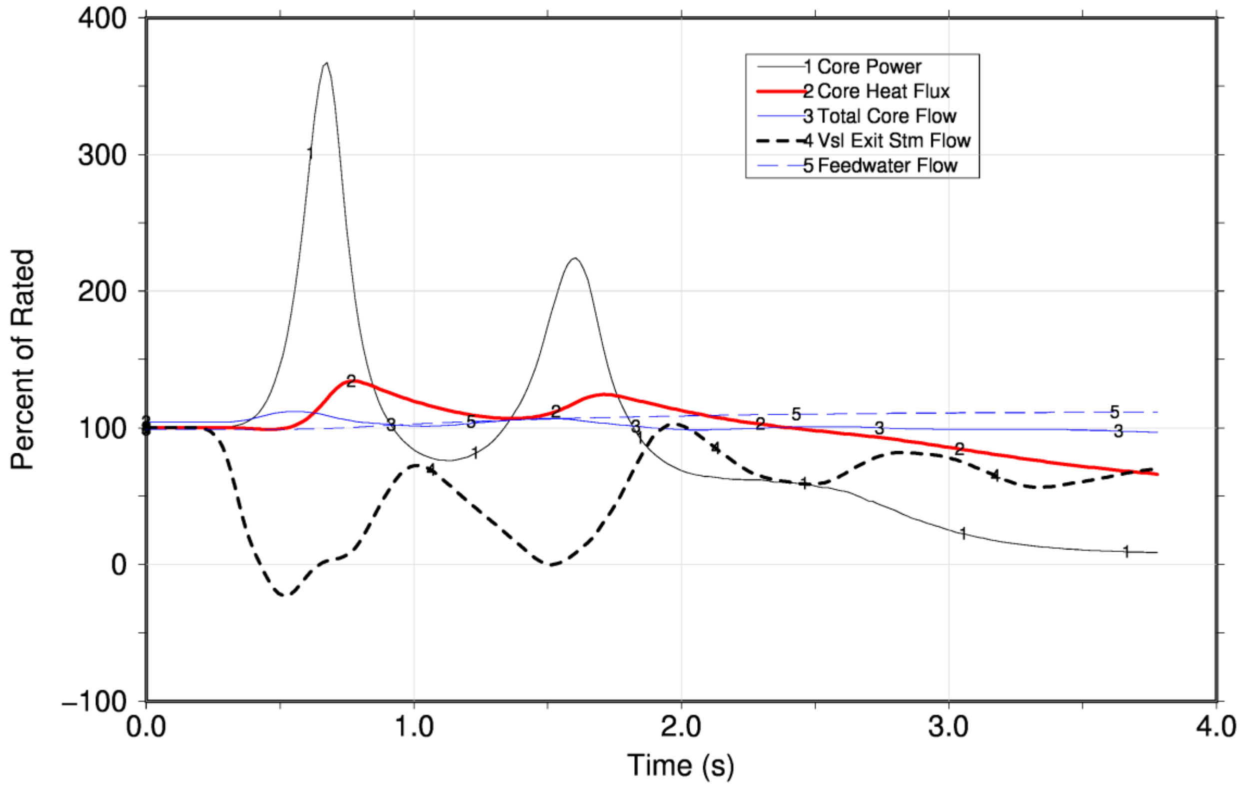

**Figure 5.1 EOCLB LRNB at 100P/104.5F – TSSS
Key Parameters**

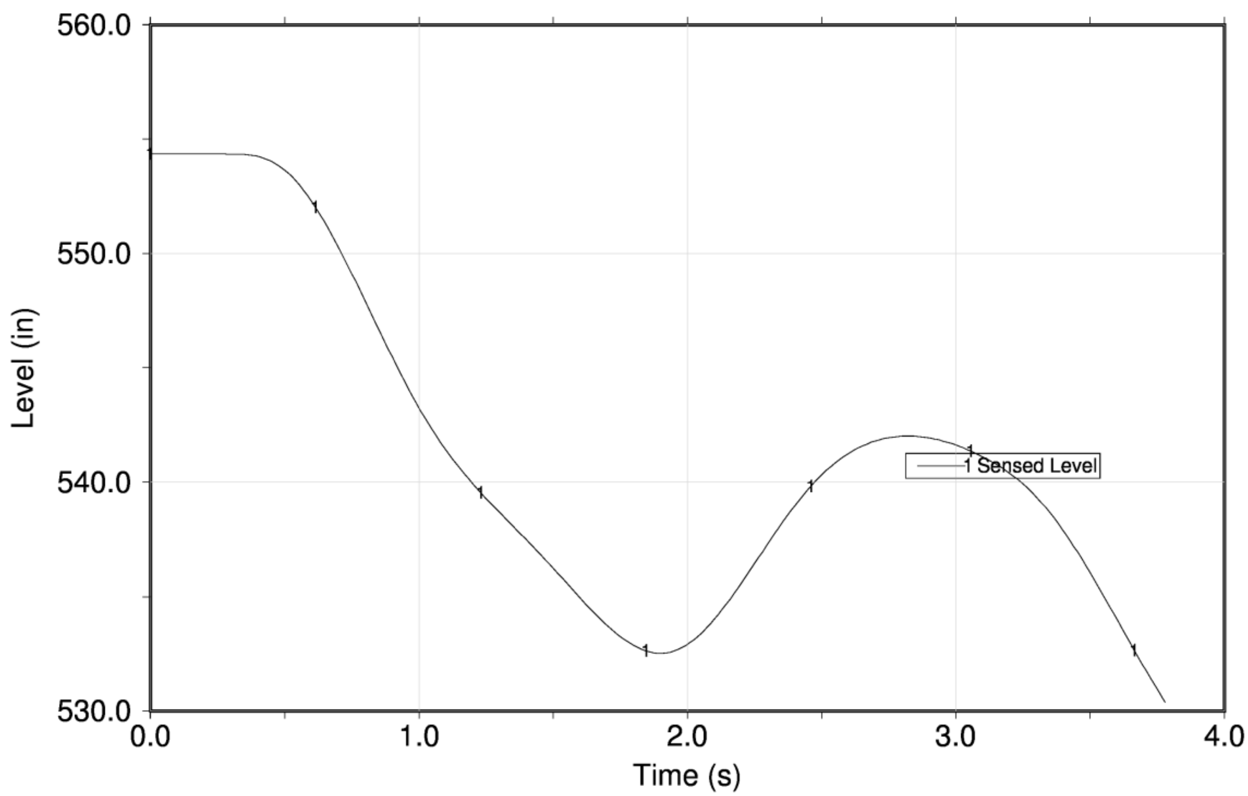

**Figure 5.2 EOCLB LRNB at 100P/104.5F – TSSS
Sensed Water Level**

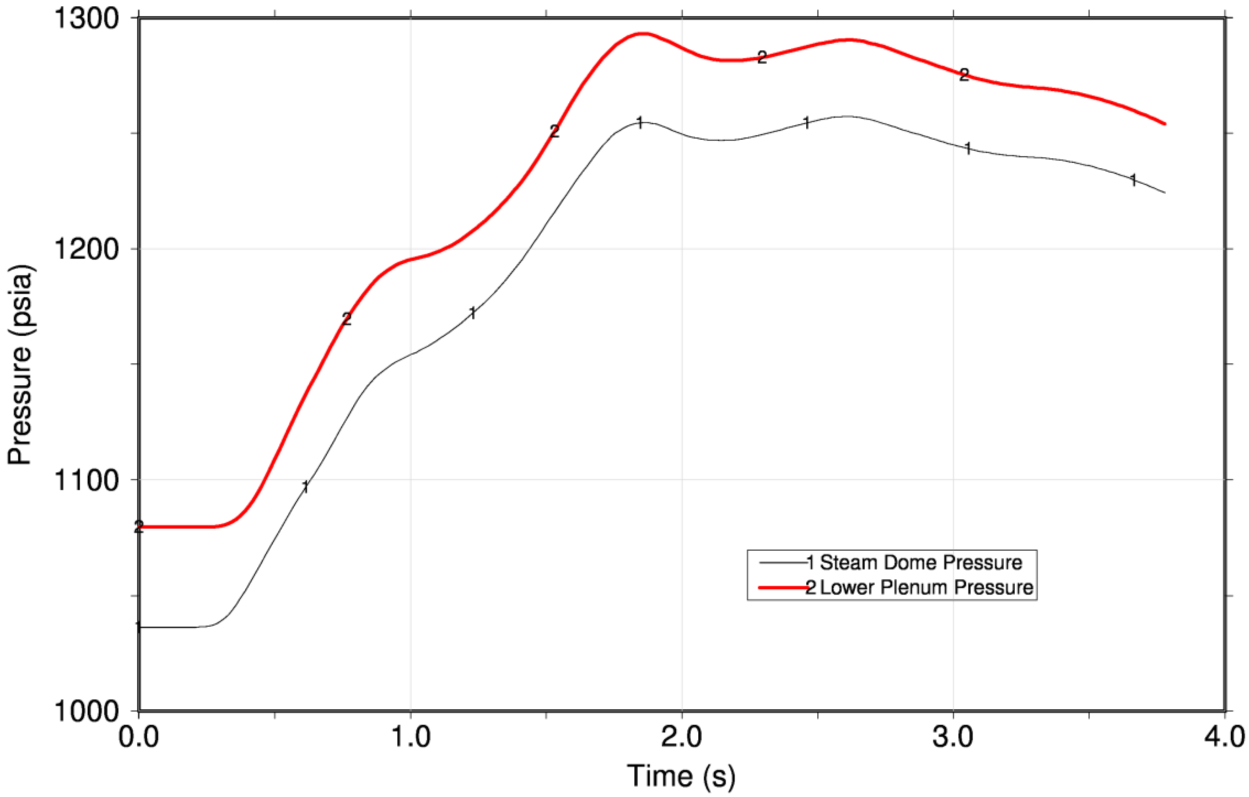

Figure 5.3 EOCLB LRNB at 100P/104.5F – TSSS
Vessel Pressures

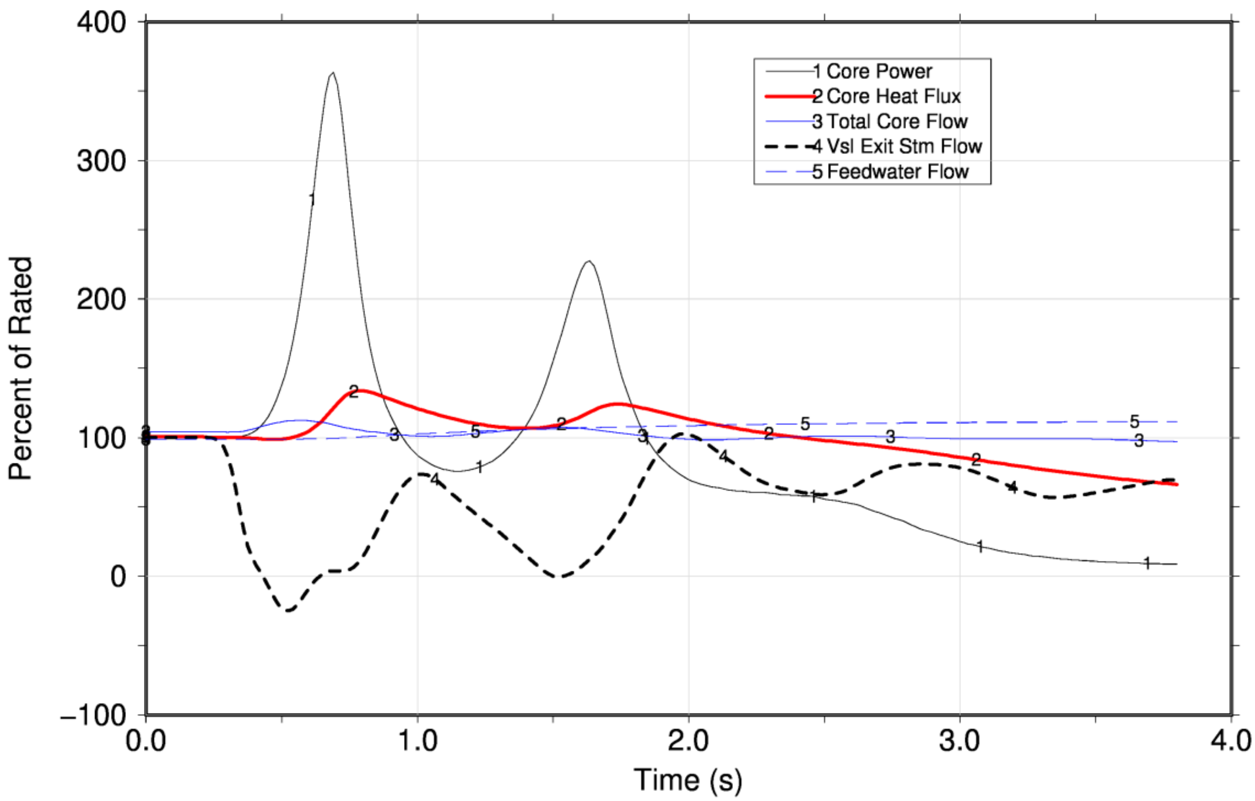

Figure 5.4 EOCLB TTNB at 100P/104.5F – TSSS Key Parameters

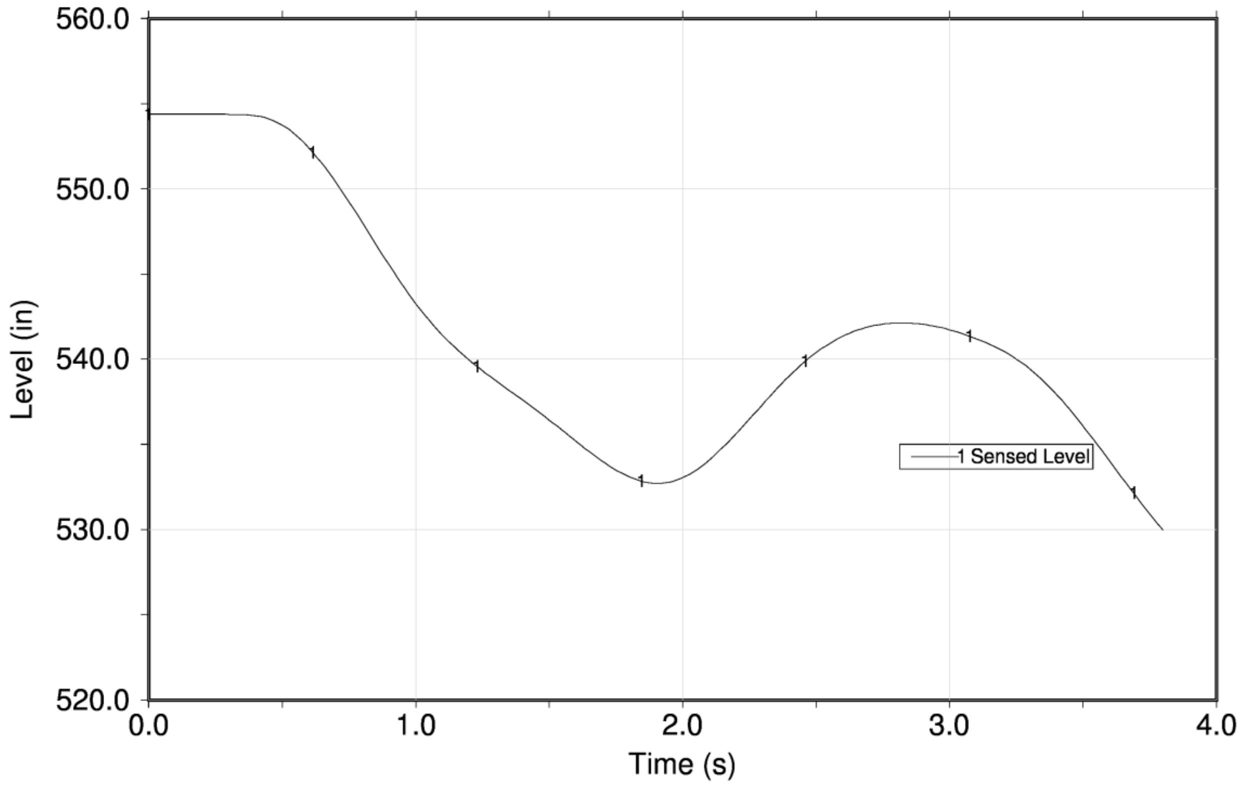

Figure 5.5 EOCLB TTNB at 100P/104.5F – TSSS Sensed Water Level

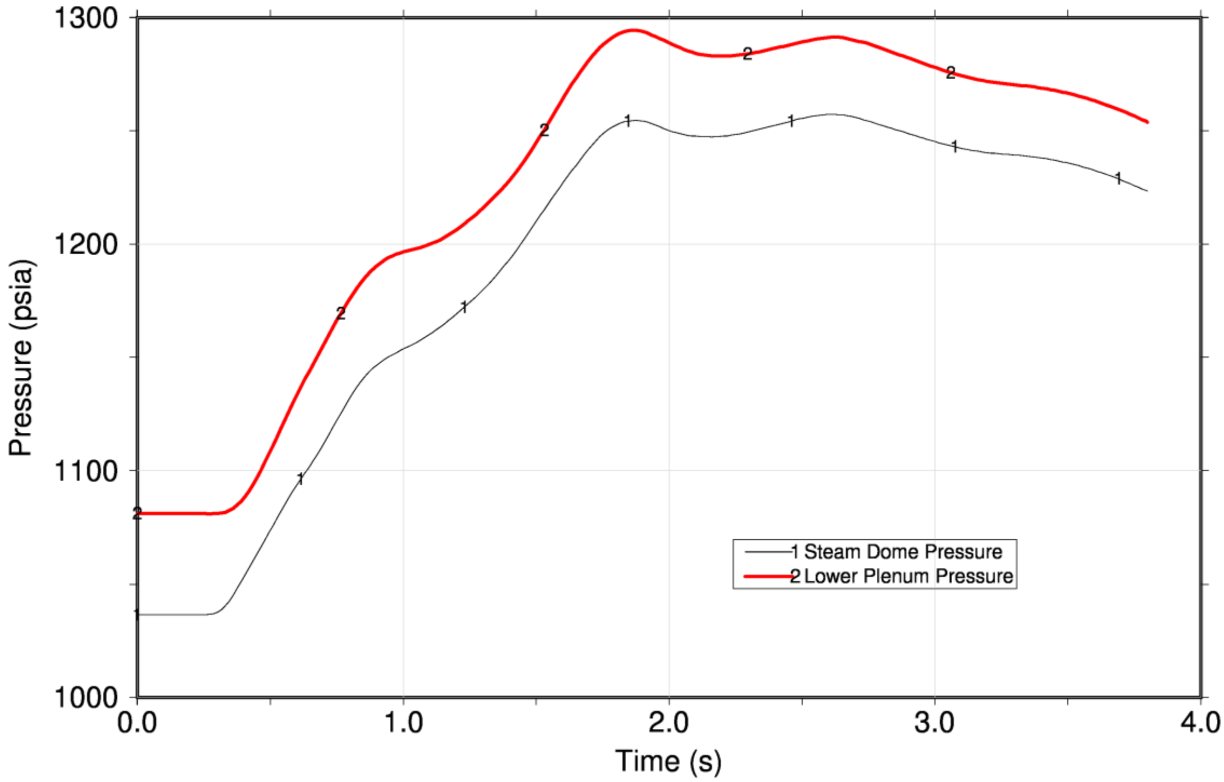

Figure 5.6 EOCLB TTNB at 100P/104.5F – TSSS
Vessel Pressures

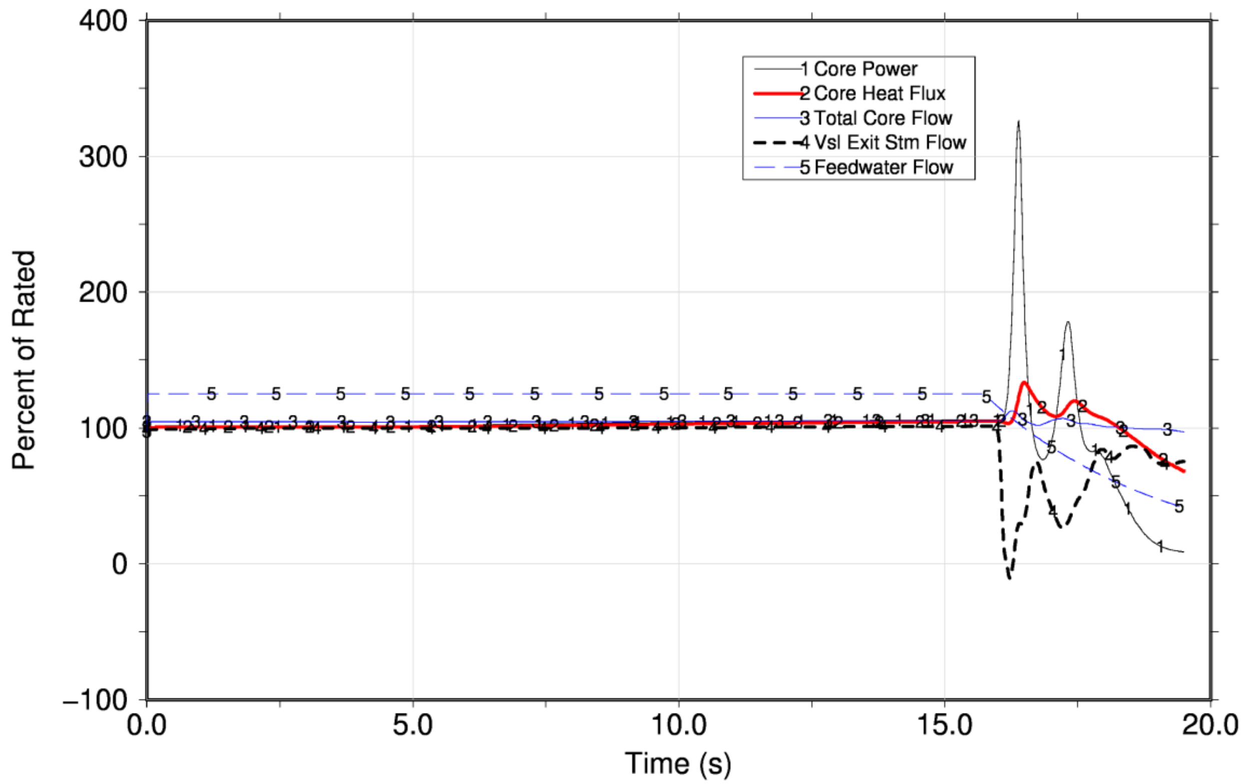

Figure 5.7 EOCLB FWCF at 100P/104.5F – TSSS
Key Parameters

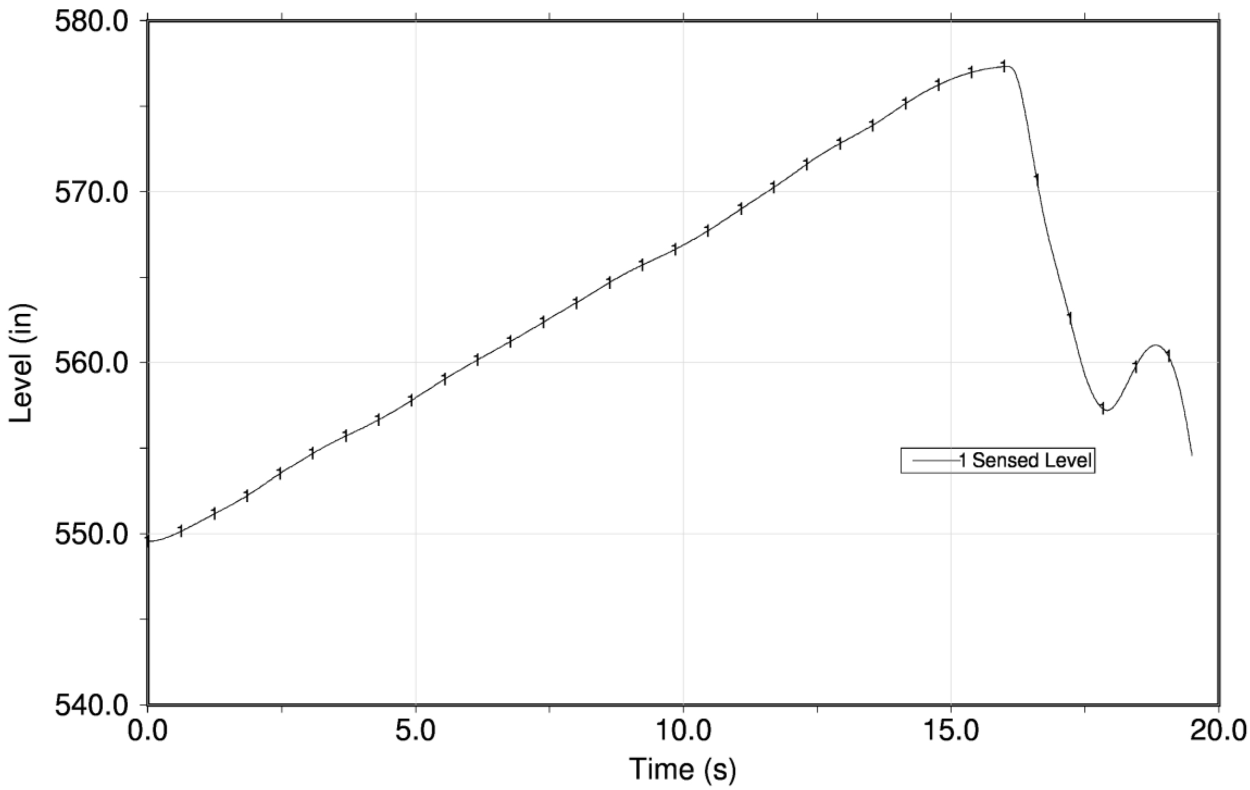

**Figure 5.8 EOCLB FWCF at 100P/104.5F – TSSS
Sensed Water Level**

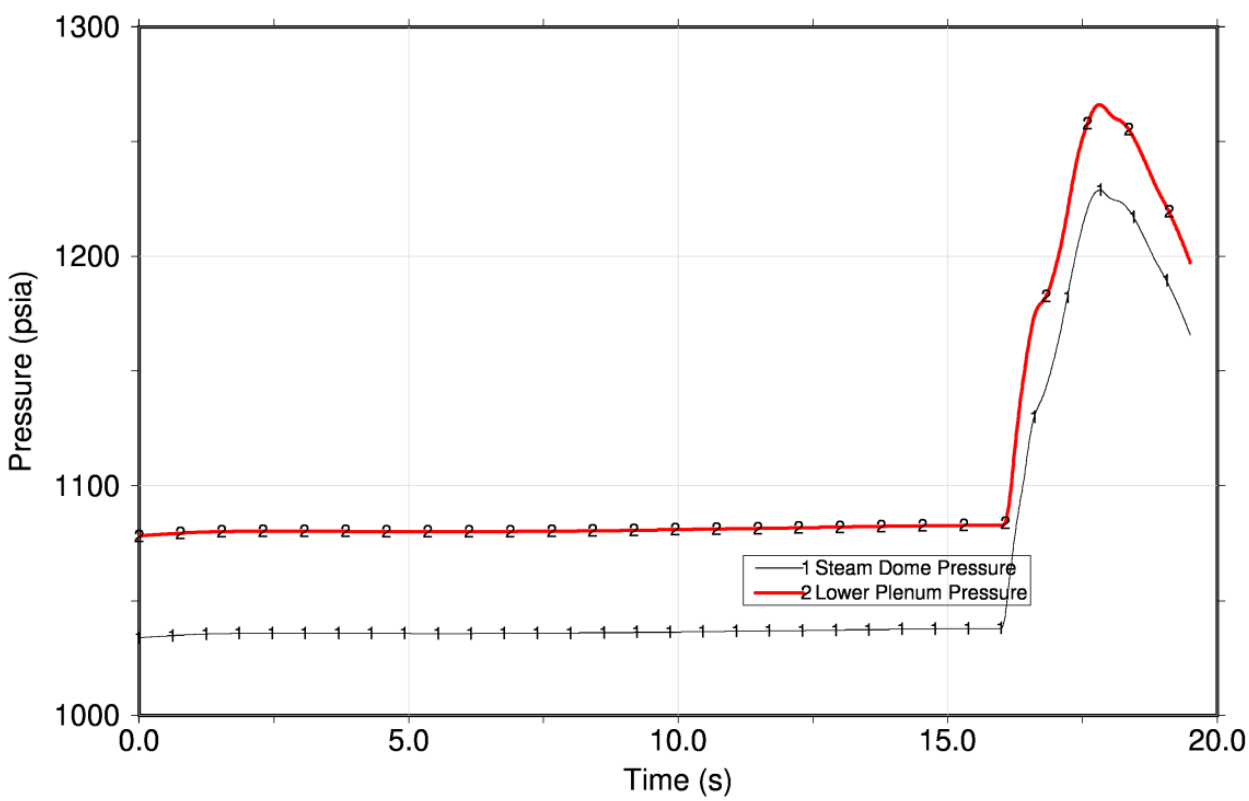

Figure 5.9 EOCLB FWCF at 100P/104.5F – TSSS
Vessel Pressures

6.0 POSTULATED ACCIDENTS

6.1 *Loss-of-Coolant Accident (LOCA)*

The results of the ATRIUM 10XM LOCA analysis are presented in References 24 and 25 and provide a PCT of 1923°F, as supplemented by Reference 27. The peak local metal water reaction is 1.23% and the core wide metal water reaction is < 0.56%. The SLO MAPLHGR multiplier is 0.80; however SLO is not allowed when operating in the MELLLA+ domain. The cycle-specific OLMCPRs and off-rated flow dependent LHGR setdown bounds those assumed in References 24 and 25.

A LOCA evaluation was performed for the ATRIUM 11 fuel for MELLLA+ operation and the results are presented in Reference 26. The ATRIUM 11 PCT is 1957°F, occurring at 0.0 MWd/MTU. The peak local metal water reaction is 4.75% and the core wide metal water reaction is 0.41%. The ATRIUM 11 SLO MAPLHGR multiplier is 0.85. The cycle-specific OLMCPRs and off-rated flow dependent LHGR setdown bounds those assumed in Reference 26. The ATRIUM 11 LOCA analyses are based on the **[**

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The Brunswick LOCA radiological analysis implementing the alternative source term methodology was performed in consideration of ATRIUM 10XM and ATRIUM 11 fuel in the core inventory source terms. Duke Energy has evaluated the radiological consequences of a LOCA and determined ATRIUM 10XM and ATRIUM 11 fuel meets the applicable acceptance criteria for Brunswick Unit 1 Cycle 23.

6.2 *Control Rod Drop Accident (CRDA)*

Brunswick Unit 1 uses a bank position withdrawal sequence (BPWS) including reduced notch worth rod pull to limit high worth control rod movements. The CRDA evaluation is performed for both A and B sequence startups consistent with the withdrawal sequence specified by Duke Energy. Framatome's AURORA-B CRDA methodology (Reference 32) is used. The applicability of this methodology for the Brunswick plant is demonstrated in Reference 33.

The analysis utilized the current Brunswick failure criteria as well as that proposed in draft guidance (DG-1327 Reference 34). The failure criterion of DG-1327 protects the existing failure criteria used by the Brunswick station. The CRDA analysis results demonstrate that the core

coolability is maintained with total fuel enthalpy remaining below 230 cal/g and no fuel melting. The radiological consequences are shown to be bounded by the Brunswick CRDA AST analysis.

The following table identifies the limiting rod drop with the actual number of rod failures and the number of rod failures scaled up to account for the revised release fractions of DG-1327* compared to those of RG 1.183. Duke Energy has determined the radiological release assumed in the current Brunswick CRDA AST analysis bounds 955 rod failures for core source terms based on ATRIUM 10XM fuel and 1129 rod failures for core source terms based on ATRIUM 11 (Reference 35).

					ATRIUM 10XM		ATRIUM 11		
Sequence	Max Prompt Enthalpy Increase (cal / g)	Max Total Enthalpy (cal / g)	Fuel Melting	Bundles with Failures	Actual Rod Failures†	BRK FSAR Dose-Equivalent Failures‡	Actual Rod Failures	BRK FSAR Dose-Equivalent Failures	Fraction of Allowed Rod Failures
B1234 B1243	191.99	207.06	no	4	8	11	104	154	0.15§

6.3 *Fuel and Equipment Handling Accident*

Duke Energy has determined the radiological release assumed in the current fuel handling accident (FHA) analysis implementing the AST methodology bounds 161 rod failures for core source terms based on ATRIUM 10XM fuel. Framatome has performed an analysis that shows that the number of failed fuel rods due to a fuel handling accident involving the ATRIUM 10XM

* Results are provided using the criteria specified in the Reference 34 version of DG-1327 which is consistent with the criteria previously used in ANP-3714P (Reference 33).

† The actual numbers of rod failures are the total unique rod failures from the PCMI, high temperature, and fuel melt criteria.

‡ The FSAR dose-equivalent rod failures account for the difference in release fraction between those used in the Brunswick plant licensing based on RG 1.183 and a conservative scaling based on revised release fractions proposed in DG-1327. These scaled values account for revision in calculation method for transient fission gas release fraction (Reference 35).

§ Dose-equivalent fuel rod failures from each fuel type are counted toward their number of allowed failures individually and those fractions are summed to give an effective total fraction of failed fuel rods.

fuel is 161. These results are consistent with the number of failed rods supported by the current Brunswick AST analysis.

Framatome has also performed an analysis that shows that the number of failed fuel rods due to a fuel handling accident involving the ATRIUM 11 fuel does not exceed 194. These results are consistent with the number of failed rods supported by the current Brunswick AST analysis.

6.4 *Fuel Loading Error (Infrequent Event)*

There are two types of fuel loading errors possible in a BWR: the mislocation of a fuel assembly in a core position prescribed to be loaded with another fuel assembly, and the misorientation of a fuel assembly with respect to the control blade. As described in Reference 14, the fuel loading error is characterized as an infrequent event. The acceptance criteria are that the offsite dose consequences due to the event shall not exceed a small fraction of the 10 CFR 50.67 limits.

6.4.1 *Mislocated Fuel Bundle*

Framatome has performed a fuel mislocation error analysis for Brunswick Unit 1 Cycle 23. This analysis evaluated the impact of a mislocated assembly against potential fuel rod failure mechanisms due to increased LHGR and reduced CPR. Based on this analysis, the offsite dose criteria (a small fraction of 10 CFR 50.67) is conservatively satisfied. A dose consequence evaluation is not necessary since no rod approached the fuel centerline melt or 1% strain limits, and less than 0.1% of the fuel rods are expected to experience boiling transition which could result in a dryout induced failure.

6.4.2 *Misoriented Fuel Bundle*

Framatome has performed a fuel assembly misorientation analysis for all fuel assemblies in Brunswick Unit 1 Cycle 23 (monitored with the ACE critical power correlation). The analysis was performed assuming that the limiting assembly was loaded in the worst orientation (rotated 180°) and depleted through the cycle without operator interaction. The analysis demonstrates that the small fraction of 10 CFR 50.67 offsite dose criteria is conservatively satisfied. A dose consequence evaluation is not necessary since no rod approached the fuel centerline melt or 1% strain limits and less than 0.1% of the fuel rods are expected to experience boiling transition.

7.0 SPECIAL ANALYSES

7.1 *ASME Overpressurization Analysis*

This section describes the maximum overpressurization analyses performed to demonstrate compliance with the ASME Boiler and Pressure Vessel Code. The analysis shows that the safety/relief valves at Brunswick Unit 1 have sufficient capacity and performance to prevent the reactor vessel pressure from reaching the safety limit of 110% of the design pressure.

For Brunswick Unit 1 Cycle 23, a set of MSIV closure runs were first performed for 102% power and 104.5% flow and 85% flow at the highest Cycle 23 exposure where rated power operation can be attained. The MSIV closure event is similar to the other steam line valve closure events in that the valve closure results in a rapid pressurization of the core. The increase in pressure causes a decrease in void which in turn causes a rapid increase in power. The turbine bypass valves do not impact the system response and are not modeled in the analysis. **[**

] The following assumptions were made in the analysis:

- The most critical active component (direct scram on valve position) was assumed to fail. However, scram on high neutron flux and high dome pressure is available.
- The plant configuration analyzed assumed degraded lift setpoints of the limiting bank of SRVs (Reference 4, Item V.A). The SRV degradation scheme is based on actual plant performance using a 95/95 approach which bounds the 3% Technical Specifications requirement. In addition, one of the lowest setpoint SRVs is assumed inoperable.
- TSSS insertion times were used.
- The initial dome pressure was set at the maximum allowed by the Technical Specifications, 1059.7 psia (1045 psig).
- A fast MSIV closure time of 2.7 seconds was used.

Results of the limiting MSIV closure overpressurization analysis are presented in Table 7.1. Figures 7.1 – 7.4 show the response of various reactor plant parameters during the MSIV closure event. The maximum pressure of 1344 psig occurs in the lower plenum. The maximum dome pressure for the same event is 1310 psig. The results demonstrate that the maximum vessel pressure limit of 1375 psig and dome pressure limit of 1325 psig are not exceeded.

7.2 *ATWS Event Evaluation*

7.2.1 ATWS Overpressurization Analysis

This section describes the analyses performed to demonstrate that the peak vessel pressure for the limiting ATWS event is less than the ASME Service Level C limit of 120% of the design pressure (1500 psig). The ATWS overpressurization analyses were performed at 100% power at 85% and 104.5% flow. The MSIV closure and pressure regulator failure open (PRFO) events were evaluated. Failure of the pressure regulator in the open position causes the turbine control and turbine bypass valves to open such that steam flow increases until the maximum combined steam flow limit is attained. The system pressure decreases until the low pressure setpoint is reached, resulting in the closure of the MSIVs. The resulting pressurization wave causes a decrease in core voids and an increase in core pressure thereby increasing the core power. For the MSIV closure event, the event is initiated by a fast closure of the MSIVs. This results in a pressurization wave that causes a decrease in core voids which results in an increase in core power and pressure.

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The following assumptions were made in the analyses:

- The analytical limit ATWS-RPT setpoint and function were assumed.
- The plant configuration analyzed assumed degraded lift setpoints of the limiting bank of SRVs (Reference 4, Item V.B). The SRV degradation scheme is based on actual plant performance using a 95/95 approach which bounds the 3% Technical Specifications requirement. To support operation with one SRVOOS, the plant configuration analyzed assumed that one of the lowest setpoint SRVs was inoperable.
- All scram functions were disabled.
- The initial dome pressure was set to the nominal pressure with a -10 psi uncertainty (1035 psia).
- The MSIV closure is based on a nominal closure time of 4.0 seconds for both events.

Results of ATWS overpressurization analyses are presented in Table 7.2. Figures 7.5 – 7.8 show the response of various reactor plant parameters during the limiting MSIV closure event, the event which results in the maximum vessel pressure. The maximum lower plenum pressure

is 1461 psig and the maximum dome pressure is 1444 psig. The results demonstrate that the ATWS maximum vessel pressure limit of 1500 psig is not exceeded.

7.2.2 Long-Term Evaluation

Fuel design differences may impact the power and pressure excursion experienced during the ATWS event. This in turn may impact the amount of steam discharged to the suppression pool and containment. **[**

] A review of the current licensing basis for Brunswick ATWS containment, which is a full core of ATRIUM 10XM fuel, shows that peak suppression pool temperature for MELLLA+ was 174 °F and the peak containment pressure was 8.4 psig, Section 9.3.1 of Reference 18.

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Relative to the 10 CFR 50.46 acceptance criteria (i.e., PCT and cladding oxidation), the consequences of an ATWS event are bound by those of the limiting LOCA event.

7.2.3 ATWS with Core Instability

The ATWS with core instability (ATWS-I) event was originally approved for ATRIUM 10XM in MELLLA+ at Brunswick in Reference 18. For ATRIUM 11 fuel, the Brunswick plant specific ATWS-I methodology, Reference 31 was used. The Brunswick ATRIUM 11 results given in Appendix F of Reference 31 demonstrate that the acceptance criteria are met.

7.3 *Standby Liquid Control System*

In the event that the control rod scram function becomes incapable of rendering the core in a shutdown state, the standby liquid control (SLC) system is required to be capable of bringing the reactor from full power to a cold shutdown condition at any time in the core life. The Brunswick Unit 1 SLC system is required to be able to inject 720 ppm natural boron equivalent at 70°F into the reactor coolant (including a 25% allowance for imperfect mixing, leakage, and volume of other piping connected to the reactor). An analysis that demonstrates that the SLC system meets the required shutdown capability for Cycle 23 has been performed. The analysis was performed to support a coolant temperature of 360.8°F with a boron concentration equivalent to 720 ppm at 70°F. The temperature of 360.8°F corresponds to the low pressure permissive for the RHR shutdown cooling suction valves, and represents the maximum reactivity condition with soluble boron in the coolant. The analysis shows the core to be subcritical throughout the cycle by at least 1.01% Δk.

7.4 *Fuel Criticality*

The new fuel storage vault criticality analysis for ATRIUM 11 fuel is presented in Reference 28. The spent fuel pool criticality analysis for ATRIUM 11 fuel is presented in Reference 29. The ATRIUM 11 fuel assemblies identified for loading in Cycle 23 meet both the new and spent fuel storage requirements.

7.5 *Strongest Rod Out Shutdown Margin*

The BRK1-23 core has a minimum strongest rod out shutdown margin of 1.07 %Δk. This value is produced at the beginning of the cycle at the minimum coolant temperature condition (68°F). This value assumes that BRK1-22 ended operation at the lowest allowable exposure.

Table 7.1 ASME Overpressurization Analysis Results *

Event	Peak Neutron Flux (% rated)	Peak Heat Flux (% rated)	Maximum Vessel Pressure Lower-Plenum (psig)	Maximum Dome Pressure (psig)
MSIV closure (102P/104.5F)	199	131	1344	1310

* The SRV degradation scheme is based on actual plant performance using a 95/95 approach.

Table 7.2 ATWS Overpressurization Analysis Results *

Event	Peak Neutron Flux (% rated)	Peak Heat Flux (% rated)	Maximum Vessel Pressure Lower-Plenum (psig)	Maximum Dome Pressure (psig)
MSIV closure (100P/85F)	223	159	1461	1444

* The SRV degradation scheme is based on actual plant performance using a 95/95 approach.

Table 7.3 [

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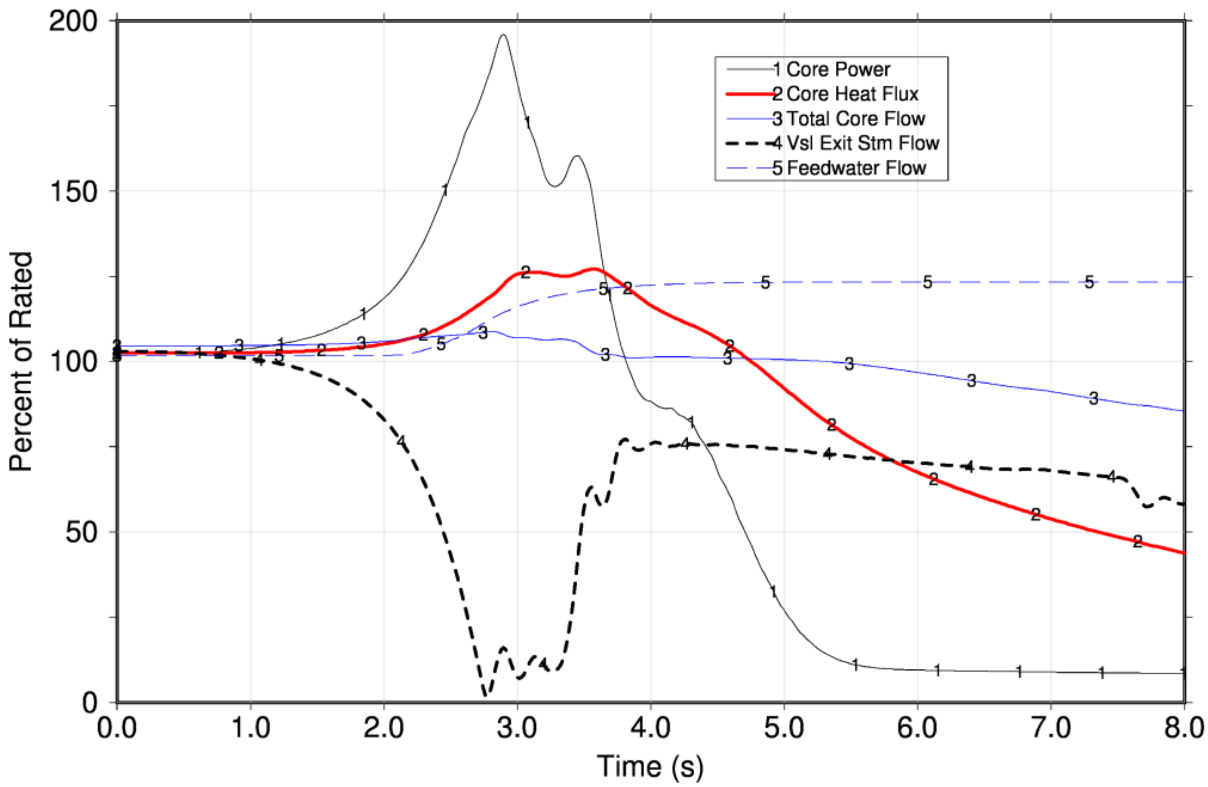

Figure 7.1 MSIV Closure Overpressurization Event at 102P/104.5F – Key Parameters

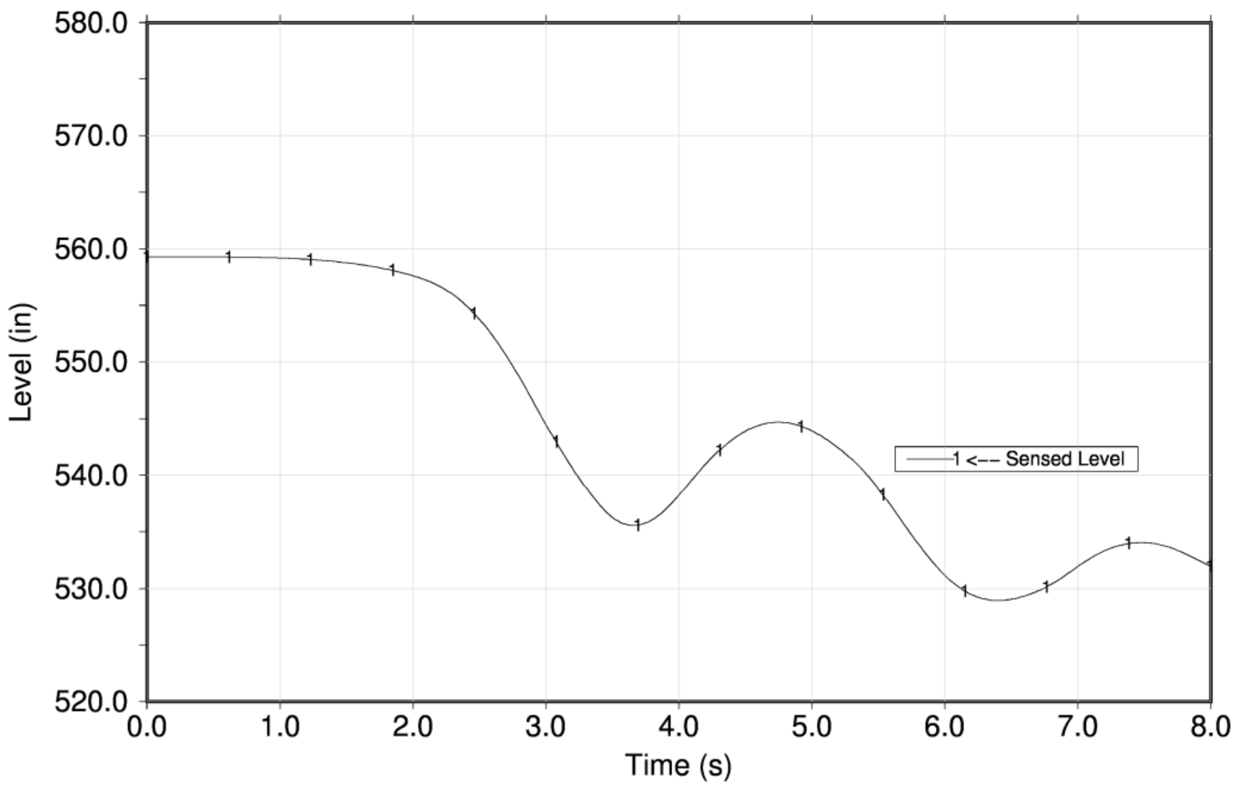

Figure 7.2 MSIV Closure Overpressurization Event at 102P/104.5F – Sensed Water Level

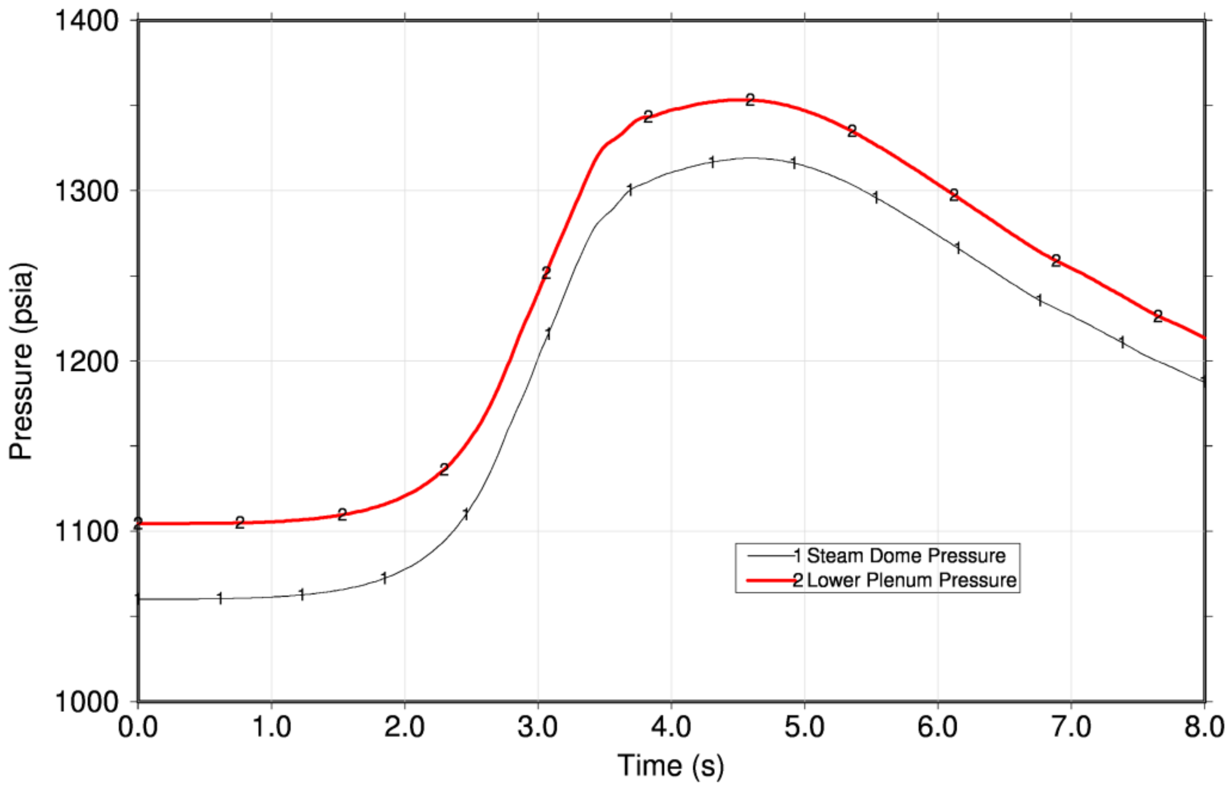

Figure 7.3 MSIV Closure Overpressurization Event at 102P/104.5F – Vessel Pressures

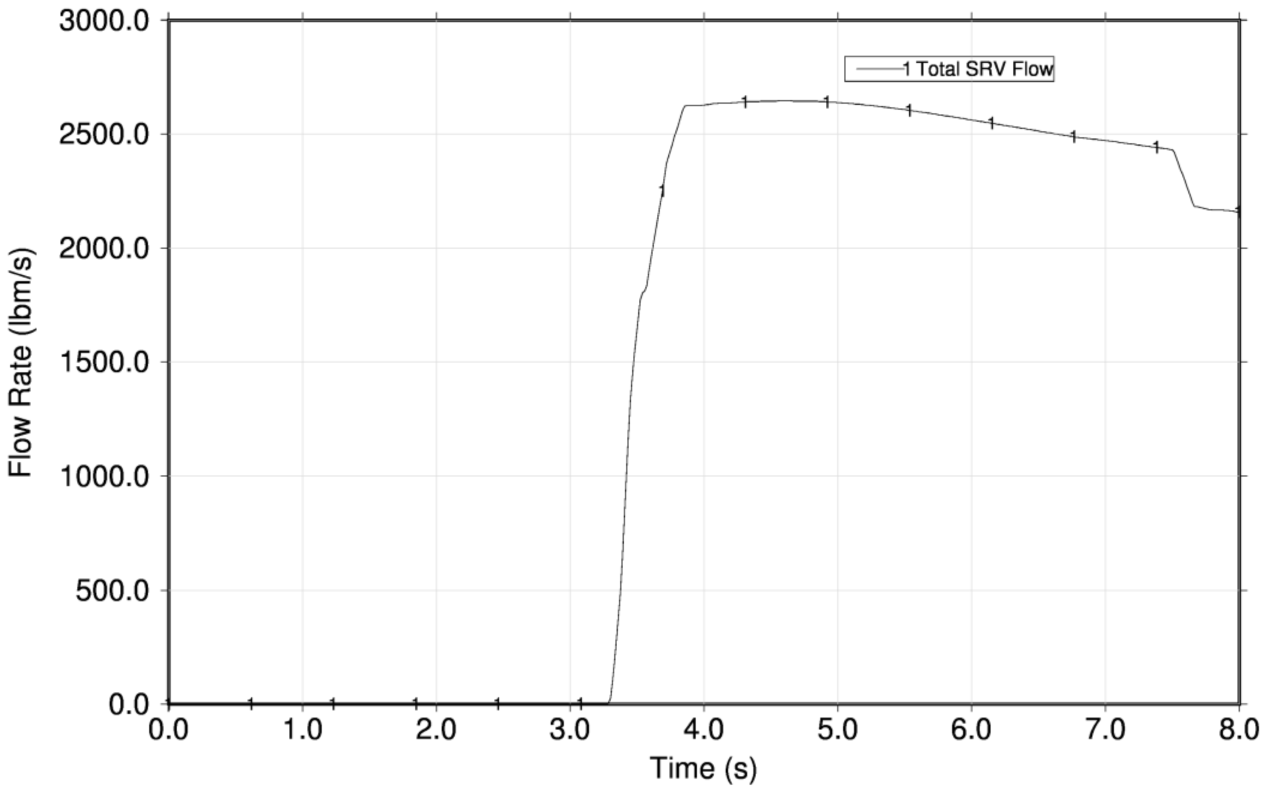

Figure 7.4 MSIV Closure Overpressurization Event at 102P/104.5F – Safety/Relief Valve Flow Rates

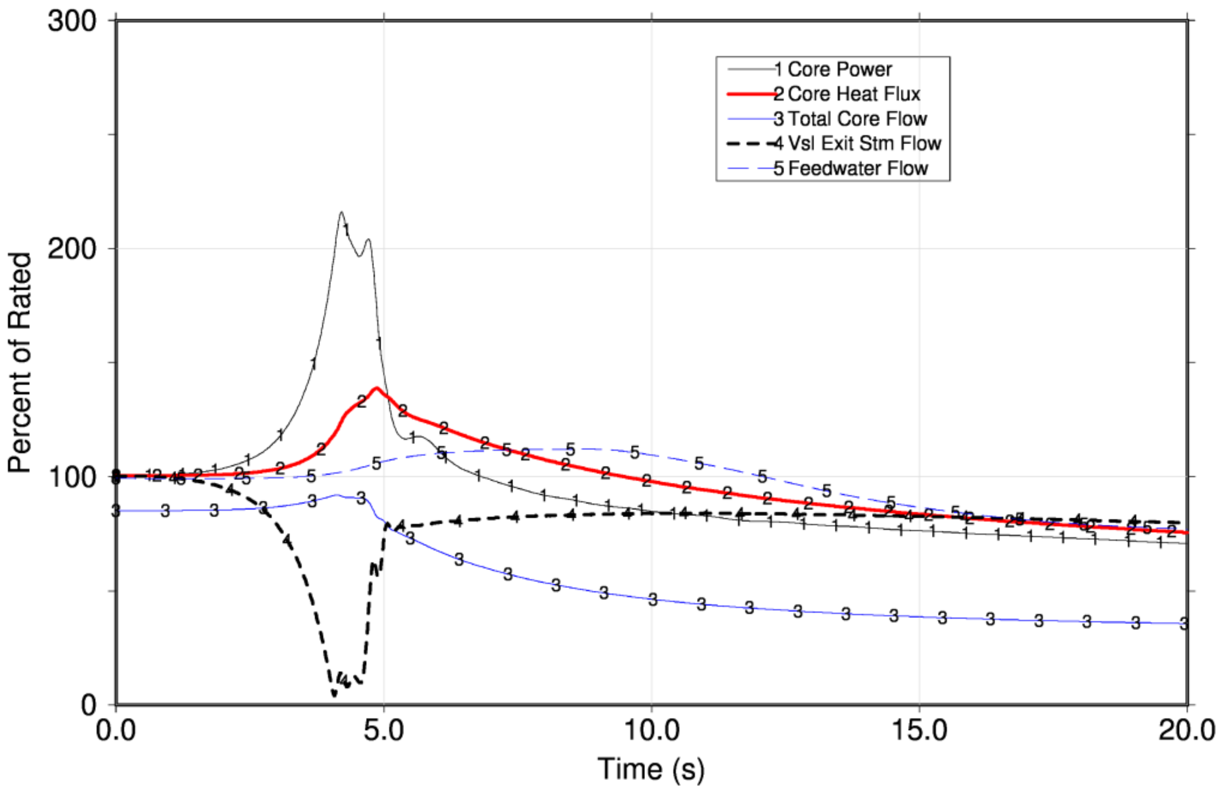

Figure 7.5 MSIV ATWS Overpressurization Event at 100P/85F – Key Parameters

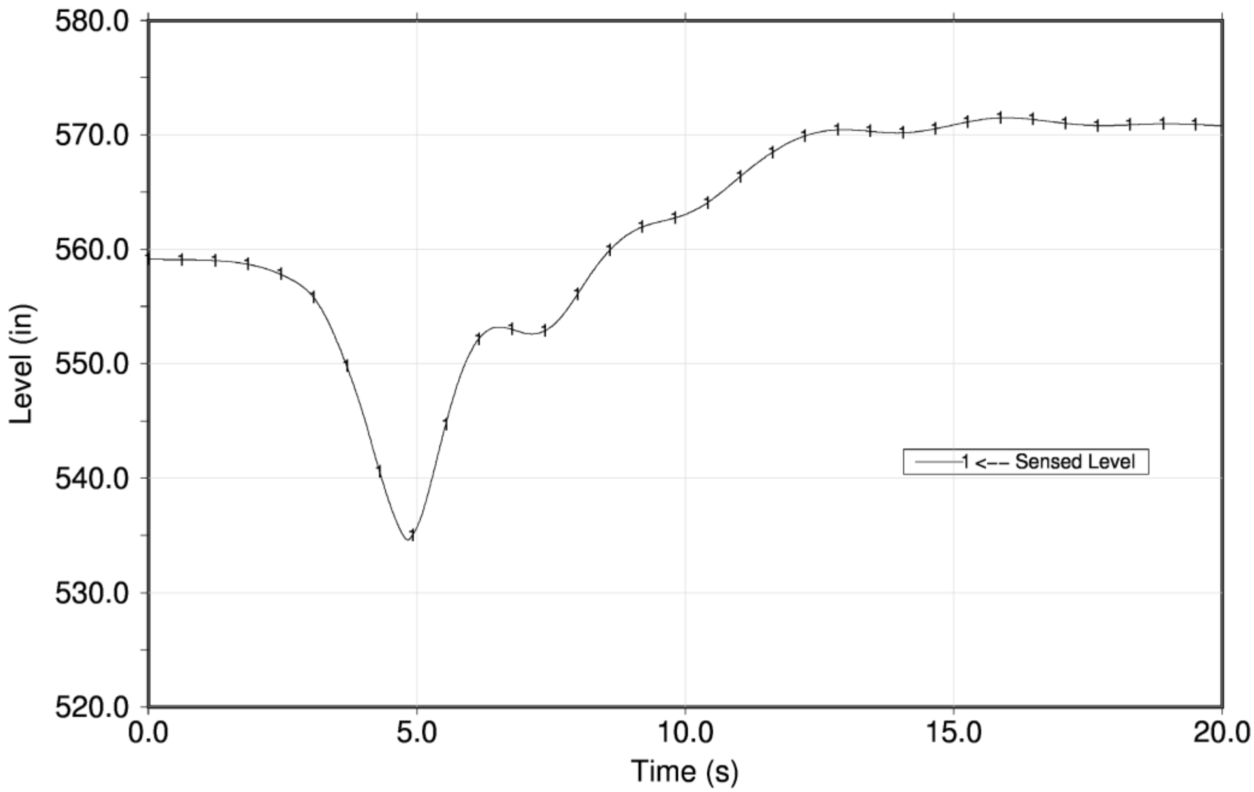

Figure 7.6 MSIV ATWS Overpressurization Event at 100P/85F – Sensed Water Level

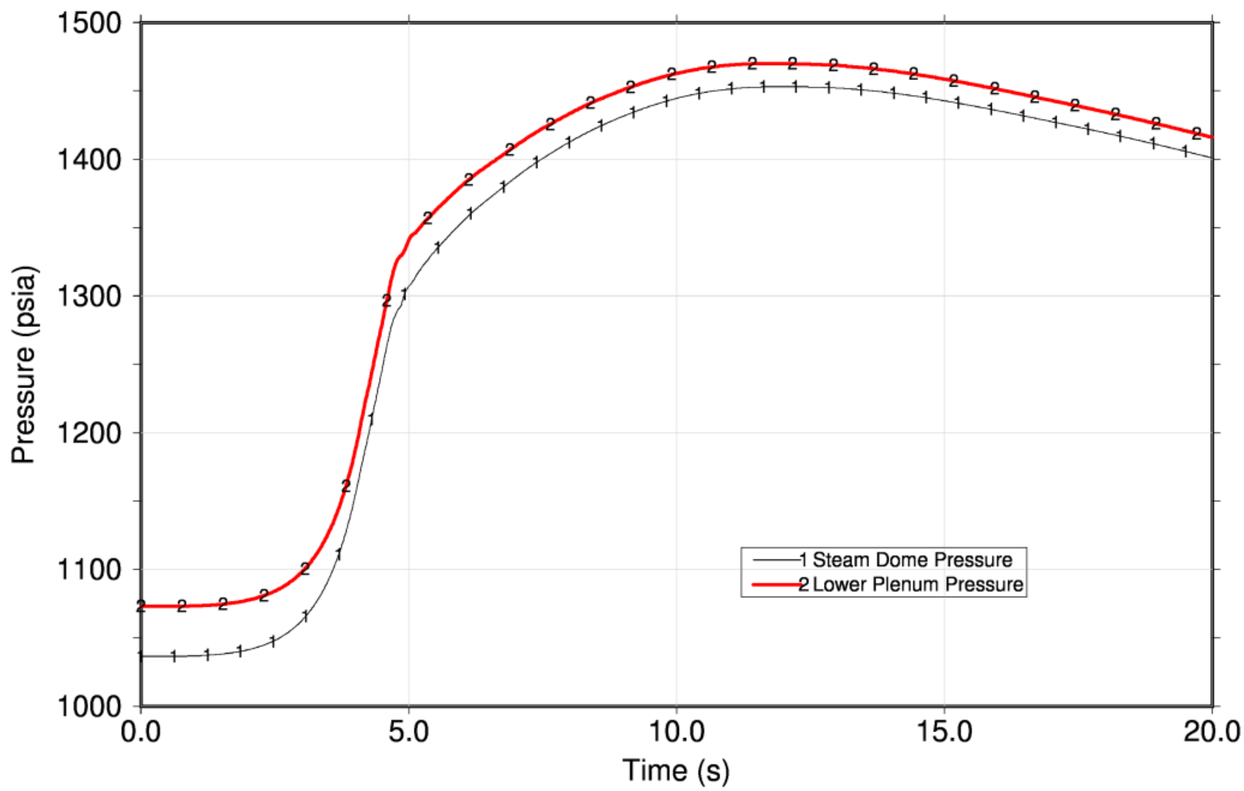

Figure 7.7 MSIV ATWS Overpressurization Event at 100P/85F – Vessel Pressures

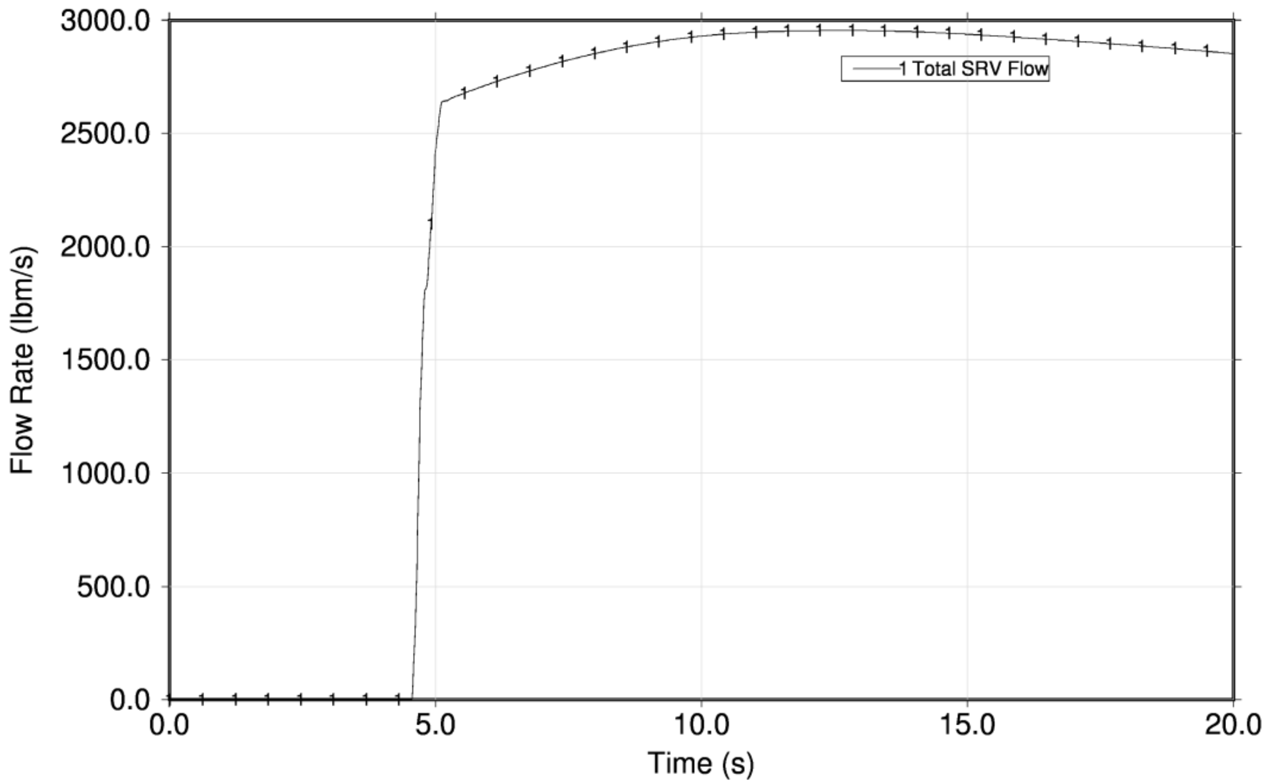

Figure 7.8 MSIV ATWS Overpressurization Event at 100P/85F – Safety/Relief Valve Flow Rates

8.0 OPERATING LIMITS AND COLR INPUT

8.1 *MCPR Limits*

The determination of the MCPR limits for Brunswick Unit 1 Cycle 23 is based on the analyses of the limiting anticipated operational occurrences (AOOs). For Brunswick Unit 1 Cycle 23, [

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The MCPR operating limits are established so that less than 0.1% of the fuel rods in the core are expected to experience boiling transition during an AOO initiated from rated or off-rated conditions and are based on a two-loop operation SLMCPR of 1.07 and a single-loop operation SLMCPR of 1.09. Exposure-dependent MCPR limits were established to support operation from BOC to near end of cycle (NEOC), BOC to end-of-cycle licensing basis (EOCLB), and combined FFTR/Coastdown as defined by the core average exposures listed in Table 5.1. MCPR limits are established to support base case operation and the EOOS scenarios presented in Table 1.1.

Cycle 23 two-loop operation $MCPR_p$ limits for ATRIUM 10XM and ATRIUM 11 fuel are presented in Tables 8.1 – 8.9 for base case operation and the EOOS conditions. Limits are presented for nominal scram speed (NSS), extended scram speed (ESS), and Technical Specification scram speed (TSSS) insertion times for the exposure ranges considered. An assumed RBM high power setpoint of 111% was used to develop the $MCPR_p$ limits. Tables 8.1 through 8.3 present the $MCPR_p$ limits for the BOC to NEOC exposure range. Tables 8.4 through 8.6 present the $MCPR_p$ limits for the BOC to EOCLB exposure range. Tables 8.7 through 8.9 present the $MCPR_p$ limits for FFTR/Coastdown operation. The FFTR/Coastdown limits (both base case and TBVOOS) support both nominal and constant rated dome pressure operation

with feedwater temperatures consistent with a feedwater temperature reduction of up to 110.3°F at rated power. $MCPR_p$ limits for single-loop operation are 0.02 higher for all cases.

$MCPR_f$ limits that protect against fuel failures during a postulated slow flow excursion are presented in Tables 8.10 and 8.11. These $MCPR_f$ limits are applicable for all Cycle 23 exposures and the EOOS conditions identified in Table 1.1.

8.2 *LHGR Limits*

The LHGR limits for ATRIUM 11 and ATRIUM 10XM are presented in Table 8.12 (References 6 and 36, respectively). Power- and flow-dependent multipliers ($LHGRFAC_p$ and $LHGRFAC_f$) are applied directly to the LHGR limits to protect against fuel melting and overstraining of the cladding during an AOO for both UO_2 and gadolinia bearing rods.

The ATRIUM 10XM and ATRIUM 11 $LHGRFAC_p$ multipliers are determined using the RODEX4 thermal-mechanical methodology (Reference 30) using the AURORA-B transient simulations. For the LHGRFACp evaluations **[**

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Exposure-dependent ATRIUM 11 and ATRIUM 10XM $LHGRFAC_p$ multipliers were established to support operation from BOC to EOCLB (Tables 8.13 – 8.15), and combined FFTR/Coastdown (Tables 8.16 – 8.18) for NSS, ESS, and TSSS insertion times, respectively and for the EOOS conditions identified in Table 1.1. The FFTR/Coastdown limits (both base case and TBVOOS) support both nominal and constant rated dome pressure operation with

feedwater temperatures consistent with a feedwater temperature reduction of up to 110.3°F at rated power.

$LHGRFAC_f$ multipliers are established to provide protection against fuel centerline melt and overstraining of the cladding during a postulated slow flow excursion. For ATRIUM 10XM and ATRIUM 11 fuel, the $LHGRFAC_f$ multipliers are presented in Table 8.19 and are applicable for all Cycle 23 exposures and the EOOS conditions identified in Table 1.1.

8.3 *MAPLHGR Limits*

The ATRIUM 10XM TLO MAPLHGR limits are presented in Table 8.20. For operation in SLO, a multiplier of 0.80 must be applied to the TLO MAPLHGR limits.

The ATRIUM 11 TLO MAPLHGR limits are presented in Table 8.20. For operation in SLO, a multiplier of 0.85 must be applied to the TLO MAPLHGR limits.

Table 8.1 $MCPR_p$ Limits for NSS Insertion Times BOC to < NEOC*,†

EOOS Condition	Power (% rated)	ATRIUM 10XM $MCPR_p$		ATRIUM 11 $MCPR_p$	
Base case operation	100.0	1.36		1.36	
	90.0	1.41		1.40	
	50.0	1.72		1.63	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.65
	26.0	2.23	2.06	2.17	1.98
	26.0	2.30	2.24	2.29	2.18
	23.0	2.41	2.41	2.30	2.30
TBVOOS	100.0	1.37		1.39	
	90.0	1.41		1.43	
	50.0	1.72		1.76	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.66
	26.0	2.23	2.06	2.17	2.00
	26.0	3.21	3.21	2.95	2.95
	23.0	3.28	3.28	2.99	2.99
FHOOS‡	100.0	1.36		1.36	
	90.0	1.41		1.40	
	50.0	1.72		1.67	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.65
	26.0	2.23	2.06	2.17	1.98
	26.0	2.42	2.31	2.37	2.19
	23.0	2.54	2.46	2.45	2.36
TBVOOS FHOOS‡	100.0	1.40		1.42	
	90.0	1.43		1.46	
	50.0	1.72		1.79	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.88	1.67
	26.0	2.23	2.06	2.22	2.02
	26.0	3.24	3.24	3.09	3.09
	23.0	3.37	3.37	3.09	3.09

* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, $MCPR_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that FHOOS is not allowed in MELLLA+.

Table 8.2 MCPR$_p$ Limits for ESS Insertion Times BOC to < NEOC*,†

EOOS Condition	Power (% rated)	ATRIUM 10XM MCPR$_p$		ATRIUM 11 MCPR$_p$	
Base case operation	100.0	1.36		1.36	
	90.0	1.41		1.40	
	50.0	1.72		1.63	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.65
	26.0	2.23	2.06	2.17	1.98
	26.0	2.30	2.24	2.29	2.18
	23.0	2.41	2.41	2.30	2.30
TBVOOS	100.0	1.37		1.39	
	90.0	1.41		1.43	
	50.0	1.72		1.76	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.69
	26.0	2.23	2.06	2.17	2.00
	26.0	3.21	3.21	2.95	2.95
	23.0	3.28	3.28	2.99	2.99
FHOOS‡	100.0	1.36		1.36	
	90.0	1.41		1.40	
	50.0	1.72		1.67	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.65
	26.0	2.23	2.06	2.17	1.98
	26.0	2.42	2.31	2.37	2.19
	23.0	2.54	2.46	2.45	2.36
TBVOOS FHOOS‡	100.0	1.44		1.44	
	90.0	1.45		1.47	
	50.0	1.74		1.80	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.88	1.76	1.89	1.72
	26.0	2.25	2.08	2.23	2.03
	26.0	3.26	3.26	3.10	3.10
	23.0	3.39	3.39	3.10	3.10

* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, MCPR$_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that FHOOS is not allowed in MELLLA+.

Table 8.3 MCPR$_p$ Limits for TSSS Insertion Times BOC to < NEOC*,†

EOOS Condition	Power (% rated)	ATRIUM 10XM MCPR$_p$		ATRIUM 11 MCPR$_p$	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
Base case operation	100.0	1.46		1.44	
	90.0	1.47		1.47	
	50.0	1.75		1.75	
	50.0	1.89	1.77	1.89	1.75
	26.0	2.26	2.09	2.19	2.00
	26.0	2.33	2.27	2.31	2.20
	23.0	2.44	2.44	2.32	2.32
TBVOOS	100.0	1.52		1.50	
	90.0	1.53		1.54	
	50.0	1.78		1.85	
	50.0	1.92	1.80	1.92	1.86
	26.0	2.29	2.12	2.22	2.17
	26.0	3.27	3.27	3.00	3.00
	23.0	3.34	3.34	3.04	3.04
FHOOS‡	100.0	1.46		1.44	
	90.0	1.47		1.47	
	50.0	1.75		1.76	
	50.0	1.89	1.77	1.89	1.75
	26.0	2.26	2.09	2.19	2.00
	26.0	2.45	2.34	2.39	2.21
	23.0	2.57	2.49	2.47	2.38
TBVOOS FHOOS‡	100.0	1.52		1.56	
	90.0	1.56		1.60	
	50.0	1.80		1.95	
	50.0	1.92	1.80	1.95	1.89
	26.0	2.29	2.12	2.47	2.25
	26.0	3.30	3.30	3.16	3.16
	23.0	3.43	3.43	3.16	3.16

* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, MCPR$_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that FHOOS is not allowed in MELLLA+.

Table 8.4 MCPR$_p$ Limits for NSS Insertion Times BOC to < EOCLB*,†

EOOS Condition	Power (% rated)	ATRIUM 10XM MCPR$_p$		ATRIUM 11 MCPR$_p$	
Base case operation	100.0	1.38		1.38	
	90.0	1.41		1.40	
	50.0	1.72		1.63	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.66
	26.0	2.23	2.06	2.17	1.98
	26.0	2.30	2.24	2.29	2.18
	23.0	2.41	2.41	2.30	2.30
TBVOOS	100.0	1.42		1.44	
	90.0	1.44		1.47	
	50.0	1.73		1.78	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.87	1.75	1.89	1.71
	26.0	2.24	2.07	2.19	2.02
	26.0	3.22	3.22	2.97	2.97
	23.0	3.29	3.29	3.01	3.01
FHOOS‡	100.0	1.38		1.38	
	90.0	1.41		1.40	
	50.0	1.72		1.67	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.66
	26.0	2.23	2.06	2.17	1.98
	26.0	2.42	2.31	2.37	2.19
	23.0	2.54	2.46	2.45	2.36
TBVOOS FHOOS‡	100.0	1.44		1.46	
	90.0	1.46		1.48	
	50.0	1.74		1.81	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.88	1.76	1.90	1.73
	26.0	2.25	2.08	2.24	2.04
	26.0	3.26	3.26	3.11	3.11
	23.0	3.39	3.39	3.11	3.11

* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, MCPR$_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that FHOOS is not allowed in MELLLA+.

Table 8.5 $MCPR_p$ Limits for ESS Insertion Times BOC to < EOCLB[*,†]

EOOS Condition	Power (% rated)	ATRIUM 10XM $MCPR_p$		ATRIUM 11 $MCPR_p$	
Base case operation	100.0	1.38		1.39	
	90.0	1.41		1.40	
	50.0	1.72		1.63	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.66
	26.0	2.23	2.06	2.17	1.98
	26.0	2.30	2.24	2.29	2.18
	23.0	2.41	2.41	2.30	2.30
TBVOOS	100.0	1.44		1.46	
	90.0	1.45		1.48	
	50.0	1.74		1.79	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.88	1.76	1.90	1.72
	26.0	2.25	2.08	2.20	2.03
	26.0	3.23	3.23	2.98	2.98
	23.0	3.30	3.30	3.02	3.02
FHOOS[‡]	100.0	1.38		1.39	
	90.0	1.41		1.40	
	50.0	1.72		1.67	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.66
	26.0	2.23	2.06	2.17	1.98
	26.0	2.42	2.31	2.37	2.19
	23.0	2.54	2.46	2.45	2.36
TBVOOS FHOOS[‡]	100.0	1.44		1.48	
	90.0	1.46		1.49	
	50.0	1.74		1.82	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.88	1.76	1.91	1.74
	26.0	2.25	2.08	2.25	2.05
	26.0	3.26	3.26	3.12	3.12
	23.0	3.39	3.39	3.12	3.12

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* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, $MCPR_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that FHOOS is not allowed in MELLLA+.

Table 8.6 MCPR$_p$ Limits for TSSS Insertion Times BOC to < EOCLB[*,†]

EOOS Condition	Power (% rated)	ATRIUM 10XM MCPR$_p$		ATRIUM 11 MCPR$_p$	
Base case operation	100.0	1.54		1.56	
	90.0	1.54		1.56	
	50.0	1.79		1.81	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.93	1.81	1.95	1.81
	26.0	2.30	2.13	2.25	2.06
	26.0	2.37	2.31	2.37	2.26
	23.0	2.48	2.48	2.38	2.38
TBVOOS	100.0	1.58		1.62	
	90.0	1.58		1.62	
	50.0	1.81		1.93	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.95	1.83	1.98	1.92
	26.0	2.32	2.15	2.28	2.23
	26.0	3.30	3.30	3.06	3.06
	23.0	3.37	3.37	3.10	3.10
FHOOS[‡]	100.0	1.54		1.56	
	90.0	1.54		1.56	
	50.0	1.79		1.82	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.93	1.81	1.95	1.81
	26.0	2.30	2.13	2.25	2.06
	26.0	2.49	2.38	2.45	2.27
	23.0	2.61	2.53	2.53	2.44
TBVOOS FHOOS[‡]	100.0	1.58		1.62	
	90.0	1.59		1.63	
	50.0	1.83		1.98	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.95	1.83	1.98	1.92
	26.0	2.32	2.15	2.50	2.28
	26.0	3.33	3.33	3.19	3.19
	23.0	3.46	3.46	3.19	3.19

* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, MCPR$_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that FHOOS is not allowed in MELLLA+.

Table 8.7 MCPR$_p$ Limits for NSS Insertion Times FFTR/Coastdown*,†,‡

EOOS Condition	Power (% rated)	ATRIUM 10XM MCPR$_p$		ATRIUM 11 MCPR$_p$	
Base case operation	100.0	1.38		1.38	
	90.0	1.41		1.40	
	50.0	1.72		1.67	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.66
	26.0	2.23	2.06	2.17	1.98
	26.0	2.42	2.31	2.37	2.19
	23.0	2.54	2.46	2.45	2.36
TBVOOS	100.0	1.46		1.46	
	90.0	1.47		1.48	
	50.0	1.75		1.81	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.89	1.77	1.90	1.73
	26.0	2.26	2.09	2.24	2.04
	26.0	3.27	3.27	3.11	3.11
	23.0	3.40	3.40	3.11	3.11

* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, MCPR$_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that reduced feedwater temperatures such as FFTR are not allowed in MELLLA+; however, the FFTR/Coastdown limits may be conservatively applied to operation in the MELLLA+ domain at these exposures.

Table 8.8 MCPR$_p$ Limits for ESS Insertion Times FFTR/Coastdown*,†,‡

EOOS Condition	Power (% rated)	ATRIUM 10XM MCPR$_p$		ATRIUM 11 MCPR$_p$	
Base case operation	100.0	1.39		1.39	
	90.0	1.41		1.40	
	50.0	1.72		1.67	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.86	1.74	1.87	1.66
	26.0	2.23	2.06	2.17	1.98
	26.0	2.42	2.31	2.37	2.19
	23.0	2.54	2.46	2.45	2.36
TBVOOS	100.0	1.46		1.48	
	90.0	1.47		1.49	
	50.0	1.75		1.82	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.89	1.77	1.91	1.74
	26.0	2.26	2.09	2.25	2.05
	26.0	3.27	3.27	3.12	3.12
	23.0	3.40	3.40	3.12	3.12

* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, MCPR$_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that reduced feedwater temperatures such as FFTR are not allowed in MELLLA+; however, the FFTR/Coastdown limits may be conservatively applied to operation in the MELLLA+ domain at these exposures.

Table 8.9 MCPR$_p$ Limits for TSSS Insertion Times FFTR/Coastdown*,†,‡

EOOS Condition	Power (% rated)	ATRIUM 10XM MCPR$_p$		ATRIUM 11 MCPR$_p$	
Base case operation	100.0	1.60		1.62	
	90.0	1.60		1.62	
	50.0	1.82		1.85	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.96	1.84	1.98	1.84
	26.0	2.33	2.16	2.28	2.09
	26.0	2.52	2.41	2.48	2.30
	23.0	2.64	2.56	2.56	2.47
TBVOOS	100.0	1.66		1.68	
	90.0	1.66		1.68	
	50.0	1.87		2.01	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.99	1.87	2.01	1.95
	26.0	2.36	2.19	2.53	2.31
	26.0	3.37	3.37	3.22	3.22
	23.0	3.50	3.50	3.22	3.22

* Limits support operation with any combination of 1 SRVOOS, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, MCPR$_p$ limits will be 0.02 higher. Note that operation in SLO is only supported up to a maximum power level of 71.1% of rated and is not allowed in MELLLA+.

† Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

‡ Note that reduced feedwater temperatures such as FFTR are not allowed in MELLLA+; however, the FFTR/Coastdown limits may be conservatively applied to operation in the MELLLA+ domain at these exposures.

Table 8.10 Flow-Dependent MCPR Limits
ATRIUM 10XM Fuel*

Core Flow (% of rated)	$MCPR_f$ MSIVIS	$MCPR_f$ MSIVOOS
0.0	1.48	1.66
31.0	1.48	1.66
60.0	1.42	1.50
75.0	1.30	--
81.0	--	1.30
107.0	1.30	1.30

Table 8.11 Flow-Dependent MCPR Limits
ATRIUM 11 Fuel*

Core Flow (% of rated)	$MCPR_f$ MSIVIS	$MCPR_f$ MSIVOOS
0.0	1.42	1.57
31.0	1.42	1.57
60.0	1.30	--
77.0	--	1.30
107.0	1.30	1.30

* Limits are only valid if control rods at a shallow position (i.e. greater than Notch 36) are no further withdrawn than their position specified in Reference 3. If not, the BEO-III acceptance criteria may not be met.

Table 8.12 Steady-State LHGR Limits

Peak Pellet Exposure (GWd/MTU)	ATRIUM 10XM LHGR (kW/ft)	Peak Pellet Exposure (GWd/MTU)	ATRIUM 11 LHGR (kW/ft)
0.0	15.1	0.0	13.6
6.0	14.1	--*	--
18.9	14.1	21.0	13.6
54.0	10.6	53.0	10.2
74.4	5.4	80.0	3.5

* "--" indicates that the ATRIUM 11 limit does not include any breakpoint at this exposure.

Table 8.13 LHGRFAC$_p$ Multipliers for NSS Insertion Times BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFAC$_p$		ATRIUM 11 LHGRFAC$_p$	
Base case operation	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	1.00		0.96	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.49	0.51	0.45	0.48
	23.0	0.49	0.51	0.45	0.48
TBVOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	1.00		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.45	0.51	0.41	0.48
	23.0	0.41	0.50	0.37	0.45
FHOOS*	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	1.00		0.90	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.47	0.49	0.43	0.46
	23.0	0.46	0.49	0.42	0.45
TBVOOS FHOOS*	100.0	1.00		0.98	
	90.0	1.00		0.97	
	50.0	0.96		0.87	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.42	0.49	0.37	0.46
	23.0	0.38	0.47	0.34	0.42

* Note that FHOOS is not allowed in MELLLA+.

Table 8.14 LHGRFAC$_p$ Multipliers for ESS Insertion Times BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFAC$_p$		ATRIUM 11 LHGRFAC$_p$	
Base case operation	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	1.00		0.96	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.49	0.51	0.45	0.48
	23.0	0.49	0.51	0.45	0.48
TBVOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	1.00		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.45	0.51	0.41	0.48
	23.0	0.41	0.50	0.37	0.45
FHOOS*	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	1.00		0.90	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.47	0.49	0.43	0.46
	23.0	0.46	0.49	0.42	0.45
TBVOOS FHOOS*	100.0	1.00		0.97	
	90.0	1.00		0.97	
	50.0	0.96		0.87	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.42	0.49	0.37	0.46
	23.0	0.38	0.47	0.34	0.42

* Note that FHOOS is not allowed in MELLLA+.

Table 8.15 $LHGRFAC_p$ Multipliers for TSSS Insertion Times BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM $LHGRFAC_p$		ATRIUM 11 $LHGRFAC_p$	
Base case operation	100.0	1.00		1.00	
	90.0	1.00		-	
	50.0	1.00		0.93	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.49	0.51	0.45	0.48
	23.0	0.49	0.51	0.45	0.48
TBVOOS	100.0	1.00		0.99	
	90.0	1.00		-	
	50.0	0.95		0.85	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.45	0.51	0.41	0.48
	23.0	0.41	0.50	0.37	0.45
FHOOS*	100.0	1.00		0.96	
	90.0	1.00		-	
	50.0	0.96		0.88	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.47	0.49	0.43	0.46
	23.0	0.46	0.49	0.42	0.45
TBVOOS FHOOS*	100.0	1.00		0.94	
	90.0	1.00		-	
	50.0	0.90		0.82	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.90	1.00	0.82	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.42	0.49	0.37	0.46
	23.0	0.38	0.47	0.34	0.42

* Note that FHOOS is not allowed in MELLLA+.

Table 8.16 LHGRFAC$_p$ Multipliers for NSS Insertion Times FFTR/Coastdown*

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFAC$_p$		ATRIUM 11 LHGRFAC$_p$	
Base case operation	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	1.00		0.90	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.47	0.49	0.43	0.46
	23.0	0.46	0.49	0.42	0.45
TBVOOS	100.0	1.00		0.98	
	90.0	1.00		0.97	
	50.0	0.96		0.87	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.42	0.49	0.37	0.46
	23.0	0.38	0.47	0.34	0.42

* Note that reduced feedwater temperatures such as FFTR are not allowed in MELLLA+; however, the FFTR/Coastdown limits may be conservatively applied to operation in the MELLLA+ domain at these exposures.

Table 8.17 LHGRFAC$_p$ Multipliers for ESS Insertion Times FFTR/Coastdown*

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFAC$_p$		ATRIUM 11 LHGRFAC$_p$	
Base case operation	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	1.00		0.90	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.47	0.49	0.43	0.46
	23.0	0.46	0.49	0.42	0.45
TBVOOS	100.0	1.00		0.97	
	90.0	1.00		0.97	
	50.0	0.96		0.87	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.42	0.49	0.37	0.46
	23.0	0.38	0.47	0.34	0.42

* Note that reduced feedwater temperatures such as FFTR are not allowed in MELLLA+; however, the FFTR/Coastdown limits may be conservatively applied to operation in the MELLLA+ domain at these exposures.

Table 8.18 LHGRFAC$_p$ Multipliers for TSSS Insertion Times FFTR/Coastdown*

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFAC$_p$		ATRIUM 11 LHGRFAC$_p$	
Base case operation	100.0	1.00		0.96	
	90.0	1.00		-	
	50.0	0.96		0.88	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.92	1.00	0.85	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.47	0.49	0.43	0.46
	23.0	0.46	0.49	0.42	0.45
TBVOOS	100.0	1.00		0.94	
	90.0	1.00		-	
	50.0	0.90		0.82	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.90	1.00	0.82	0.93
	26.0	0.75	0.86	0.67	0.79
	26.0	0.42	0.49	0.37	0.46
	23.0	0.38	0.47	0.34	0.42

* Note that reduced feedwater temperatures such as FFTR are not allowed in MELLLA+; however, the FFTR/Coastdown limits may be conservatively applied to operation in the MELLLA+ domain at these exposures.

Table 8.19 ATRIUM 10XM and ATRIUM 11 $LHGRFAC_f$ Multipliers
All Cycle 23 Exposures

Core Flow (% of rated)	$LHGRFAC_f$
0.0	0.52
31.0	0.52
75.0	1.00
107.0	1.00

Table 8.20 Framatome Fuel
MAPLHGR Limits

Average Planar Exposure (GWd/MTU)	ATRIUM 10XM MAPLHGR (kW/ft)	Average Planar Exposure (GWd/MTU)	ATRIUM 11 MAPLHGR (kW/ft)
0.0	13.1	0.0	12.0
15.0	13.1	20.0	12.0
67.0	7.7	60.0	9.0
--	--	69.0	7.2

Figure 8.1 [

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Figure 8.2 [

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ATRIUM 11 Fuel Rod Thermal-Mechanical Evaluation for Brunswick Unit 1 Cycle 23

ANP-3791NP
Revision 0

Licensing Report

October 2019

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Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	All	Initial Issue

Contents

List of Tables

List of Figures

Nomenclature

Acronym	Definition
3GFG	3rd generation FUELGUARD
AOO	anticipated operational occurrences
ASME	American Society of Mechanical Engineers
B&PV	Boiler and Pressure Vessel
BOL	beginning of life
BWR	boiling water reactor
CRWE	control rod withdrawal error
CUF	cumulative usage factor
EOL	end of life
FDL	fuel design limit
ID	inside diameter
LAR	License Amendment Request
LHGR	linear heat generation rate
LTP	lower tie plate
MWd/kgU	megawatt days per kilogram of initial uranium
MELLLA+	maximum extended load line limit analysis plus
NRC	Nuclear Regulatory Commission, U. S.
OD	outside diameter
PCI	pellet-to-cladding-interaction
PLFR	part length fuel rod
ppm	parts per million
SRA	stress relieved annealed
S-N	stress amplitude versus number of cycles
UTL	upper tolerance limit

1.0 INTRODUCTION

Results of the fuel rod thermal-mechanical analyses are presented to demonstrate that the applicable design criteria are satisfied. The analyses are for the Framatome Inc. ATRIUM 11 fuel that will be inserted for operation in Brunswick Unit 1 Cycle 23 as reload batch BRK1-23. These analyses assume the use of chromia additive in the enriched and natural urania portions of the fuel and assume operation in the Maximum Extended Load Line Limit Plus (MELLLA+) operation domain. Both the design criteria and the analysis methodology have been approved by the U. S. NRC (NRC).

The analysis results are evaluated according to the generic fuel rod thermal and mechanical design criteria contained in ANF-89-98(P)(A) Revision 1 and Supplement 1 (Reference 1) along with design criteria provided in the RODEX4 fuel rod thermal-mechanical topical report (Reference 2)*. Approved methodology for the inclusion of chromia additive in the fuel pellets is also used (Reference 3).

The RODEX4 fuel rod thermal-mechanical analysis code is used to analyze the fuel rod for fuel centerline temperature, cladding strain, rod internal pressure, cladding collapse, cladding fatigue and external oxidation. The code and application methodology are described in the RODEX4 topical report (Reference 2). The cladding steady-state stress and plenum spring design methodology are summarized in Reference 1.

The following sections describe the fuel rod design, design criteria and methodology with reference to the source topical reports. Results from the analyses are summarized for comparison to the design criteria.

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* (N.B., the cladding external oxidation limit from that topical report of **[ ]** was reduced to **[ ]** when the RODEX4 methodology was approved for application to the Brunswick units (Reference 4)).

2.0 SUMMARY AND CONCLUSIONS

Key results are compared against each design criterion in:

- Table 2-1 for MELLLA+ operating domain

Results are presented for the limiting cases. Additional RODEX4 results are given in Section 3.0.

The analyses support a maximum fuel rod discharge exposure of 62 MWd/kgU.

Fuel rod criteria applicable to the design are summarized in Section 3.0. Analyses show the criteria are satisfied when the fuel is operated at or below the LHGR (linear heat generation rate) limit (Fuel Design Limit – FDL) presented in Figure 2-1.

Table 2-1 Summary of Fuel Rod Design Evaluation Results (MELLLA+)

Criteria Section*	Description	Criteria	Result, Margin† or Comment
3.2	**Fuel Rod Criteria**		
3.2.1	Internal hydriding	**[**	**]**
(3.1.1)	Cladding collapse	**[**	**]**
(3.1.2)	Overheating of fuel pellets	No fuel melting margin to fuel melt > 0, °C	**[ ]**
3.2.5	Stress and strain limits		
(3.1.1) (3.1.2)	Pellet-cladding interaction	**[**	**]**
3.2.5.2	Cladding steady-state stresses	**[**	**]**
3.3	**Fuel System Criteria**		
(3.1.1)	Fatigue	**[**	**]**
(3.1.1)‡	Oxidation, hydriding, and crud buildup	**[**	**]**
(3.1.1) (3.1.2)	Rod internal pressure	**[**	**]**
3.3.9	Fuel rod plenum spring (fuel handling)	Plenum spring to **[**	**]**

* Numbers in the column refer to paragraph sections in the generic design criteria document, ANF-89-98(P)(A) Revision 1 and Supplement 1 (Reference 1). A number in parentheses is the paragraph section in the RODEX4 fuel rod topical report (Reference 2).

† Margin is defined as (limit – result).

‡ The cladding external oxidation limit is restricted to **[ ]** by Reference 4.

[

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Figure 2-1 LHGR Limit (Normal Operation)

3.0 FUEL ROD DESIGN EVALUATION

Summaries of the design criteria and methodology are provided in this section along with analysis results in comparison to criteria. Both the fuel rod criteria and fuel system criteria as directly related to the fuel rod analyses are covered.

The fuel rod analyses cover normal operating conditions and AOOs (anticipated operational occurrences). The fuel centerline temperature analysis (overheating of fuel) and cladding strain analysis take into account slow transients at rated operating conditions.

Other fuel rod-related topics on overheating of cladding, cladding rupture, fuel rod mechanical fracturing, rod bow, axial irradiation growth, cladding embrittlement, violent expulsion of fuel and fuel ballooning are evaluated as part of the respective fuel assembly structural analysis, thermal hydraulic analyses, or LOCA analyses and are reported elsewhere. The evaluation of fast transients and transients at off-rated conditions also are reported separately from this report.

3.1 *Fuel Rod Design*

The ATRIUM 11 fuel rod is conventional in design configuration and very similar to past designs such as the ATRIUM 10XM, ATRIUM-10 and ATRIUM-9 fuel rods.

[

] plenum spring on the upper end of the fuel column assists in maintaining a compact fuel column during shipment and initial reactor operation.

There are two Part-length Fuel Rod (PLFR) designs incorporated in the fuel assembly. The longer is **[** **]** long, while the shorter is **[** **]** long. **[**

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As on previous ATRIUM fuel designs that incorporated the 3rd generation FUELGUARD (3GFG) Lower Tie Plate (LTP), the PLFR's have a [

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Table 3-1 lists the main parameters for the fuel rod and components.

3.2 *RODEX4 and Statistical Methodology Summary*

RODEX4 evaluates the thermal-mechanical response of the fuel rod surrounded by coolant. The fuel rod model considers the fuel column, gap region, cladding, gas plena and the fill gas and released fission gases. The fuel rod is divided into axial and radial regions with conditions computed for each region. The operational conditions are controlled by the [

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The heat conduction in the fuel and clad is **[**

].

Mechanical processes include **[**

].

As part of the methodology, fuel rod power histories are generated **[**

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Since RODEX4 is a best-estimate code, uncertainties are taken into account by a [

]. Uncertainties taken into account in the analysis are summarized as:

- Power measurement and operational uncertainties – [
  ].
- Manufacturing uncertainties – [
  ].
- Model uncertainties – [
  ].

[

].

3.3 *Summary of Fuel Rod Design Evaluation*

Results from the analyses are listed in Table 3-2 and Table 3-3. Summaries of the methods and codes used in the evaluation are provided in the following paragraphs. The design criteria are also listed along with references to the sections of the design criteria topical reports (References 1 and 2).

The fuel rod thermal and mechanical design criteria are summarized as follows.

- **Internal Hydriding**. The fabrication limit **[** **]** to preclude cladding failure caused by internal sources of hydrogen (Section 3.2.1 of Reference 1).

- **Cladding Collapse**. Clad creep collapse shall be prevented. **[** **]** (Section 3.1.1 of Reference 2).

- **Overheating of Fuel Pellets**. The fuel pellet centerline temperature during anticipated transients shall remain below the melting temperature (Section 3.1.2 of Reference 2).

- **Stress and Strain Limits**. **[** **]** during normal operation and during anticipated transients (Sections 3.1.1 and 3.1.2 of Reference 2).

  Fuel rod cladding steady-state stresses are restricted to satisfy limits derived from the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel (B&PV) Code (Section 3.2.5.2 of Reference 1).

- **Cladding Fatigue**. The fatigue cumulative usage factor for clad stresses during normal operation and design cyclic maneuvers shall be below **[** **]** (Section 3.1.1 of Reference 2).

- **Cladding Oxidation, Hydriding and Crud Buildup**. Section 3.1.1 of Reference 2 limits the maximum cladding oxidation to less than **[** **]** to prevent clad corrosion failure. The oxidation limit is further reduced to **[** **]** (Reference 4).

- **Rod Internal Pressure**. The rod internal pressure is limited **[** **]** to ensure that significant outward clad creep does not occur and unfavorable hydride reorientation on cooldown does not occur (Section 3.1.1 of Reference 2).

- **Plenum Spring Design (Fuel Handling)**. The rod plenum spring must maintain a force against the fuel column stack **[** **]** (Section 3.3.9 of Reference 1).

Cladding collapse, overheating of fuel, cladding transient strain, cladding cyclic fatigue, cladding oxidation, and rod pressure are evaluated **[** **].** Cladding stress and the plenum spring are evaluated **[** **].**

3.3.1 Internal Hydriding

The absorption of hydrogen by the cladding can result in cladding failure due to reduced ductility and formation of hydride platelets. Careful moisture control during fuel fabrication reduces the potential for hydrogen absorption on the inside of the cladding. The fabrication limit **[** **]** is verified by quality control inspection during fuel manufacturing.

3.3.2 Cladding Collapse

Creep collapse of the cladding and the subsequent potential for fuel failure is avoided in the design by limiting the gap formation due to fuel densification subsequent to pellet-clad contact. The size of the axial gaps which may form due to densification following first pellet-clad contact shall be less than **[** **]**.

The evaluation is performed using the RODEX4 code and methodology. RODEX4 takes into account the **[** **]**.

Table 3-2 lists the results for an equilibrium cycle operating in the MELLLA+ operating domain. Table 3-3 lists the results for ATRIUM 11 BRK1-23 cycle operating in the MELLLA+ operating domain.

3.3.3 Overheating of Fuel Pellets

Fuel failure from the overheating of the fuel pellets is not allowed. The centerline temperature of the fuel pellets must remain below melting during normal operation and AOOs. The melting point of the fuel includes adjustments for **[** **]**. Framatome establishes an LHGR limit to protect against fuel centerline melting during steady-state operation and during AOOs.

Fuel centerline temperature is evaluated using the RODEX4 code and methodology for both normal operating conditions and AOOs.

Table 3-2 lists the results for an equilibrium cycle operating in the MELLLA+ operating domain. Table 3-3 lists the results for ATRIUM 11 BRK1-23 cycle operating in the MELLLA+ operating domain.

3.3.4 Stress and Strain Limits

3.3.4.1 Pellet/Cladding Interaction

Cladding strain caused by transient-induced deformations of the cladding is calculated using the RODEX4 code and methodology. **[**

]. The strain limit is 1%.

Table 3-2 lists the results for an equilibrium cycle operating in the MELLLA+ operating domain. Table 3-3 lists the results for ATRIUM 11 BRK1-23 cycle operating in the MELLLA+ operating domain.

3.3.4.2 Cladding Stress

Cladding stresses are calculated using solid mechanics elasticity solutions and finite element methods. The stresses are conservatively calculated for the individual loadings and are categorized as follows:

Category	Membrane	Bending
Primary	**[**	**]**
Secondary	**[**	**]**

Stresses are calculated at the cladding outer and inner diameter in the three principal directions for both beginning of life (BOL) and end of life (EOL) conditions. At EOL, the stresses due to mechanical bow and contact stress are decreased due to irradiation relaxation. The separate

stress components are then combined, and the stress intensities for each category are compared to their respective limits.

The cladding-to-end cap weld stresses are evaluated for loadings from differential pressure, differential thermal expansion, rod weight, and plenum spring force.

The design limits are derived from the ASME (American Society of Mechanical Engineers) Boiler and Pressure Vessel (B&PV) Code Section III (Reference 5) and the minimum specified material properties.

Table 3-4 lists the results in comparison to the limits for Beginning-of-Life (BOL) Hot conditions and End-of-Life (EOL) at both Hot and Cold conditions.

3.3.5 Fuel Densification and Swelling

Fuel densification and swelling are limited by the design criteria for fuel temperature, cladding strain, cladding collapse, and rod internal pressure criteria. Although there are no explicit criteria for fuel densification and swelling, the effect of these phenomena are included in the RODEX4 code and methodology.

3.3.6 Fatigue

Fuel rod cladding fatigue is calculated using the RODEX4 code and methodology. **[**

]. The CUF (cumulative usage factor) is summed for each of the axial regions of the fuel rod using Miner's rule. The axial region with the highest CUF is used in the subsequent **[**

]. The maximum CUF for the cladding must remain below **[** **]** to satisfy the design criterion.

Table 3-2 lists the results for an equilibrium cycle operating in the MELLLA+ operating domain. Table 3-3 lists the results for ATRIUM 11 BRK1-23 cycle operating in the MELLLA+ operating domain.

3.3.7 Oxidation, Hydriding, and Crud Buildup

Cladding external oxidation is calculated using the RODEX4 code and methodology. The corrosion model includes an enhancement factor that is derived from poolside measurement data to obtain a fit of the expected oxide thickness. An uncertainty value for the model enhancement factor also is determined from the data. The model uncertainty is included as part of the **[ ]**.

[

].

In the event abnormal crud is observed at a plant, a specific analysis is required to address the higher crud level. An abnormal level of crud is defined by a formation that increases the calculated fuel average temperature by 25°C above the design basis calculation. The formation of crud is not calculated within RODEX4. Instead, an upper bound of expected crud based on plant observations is input by the use of the crud heat transfer coefficient. The corrosion model also takes into consideration the effect of the higher thermal resistance from the crud on the corrosion rate. A higher corrosion rate is therefore included as part of the abnormal crud evaluation. A similar specific analysis is required if an abnormal corrosion layer is observed instead of crud.

In the case of the Brunswick units, no additional crud is taken into account in the calculations because an abnormal crud or corrosion layer (beyond the design basis) has not been observed at the Brunswick units.

[

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Currently, **[**

].

The oxide limit is evaluated such that greater than **[**

].

Table 3-2 lists the results for an equilibrium cycle operating in the MELLLA+ operating domain. Table 3-3 lists the results for ATRIUM 11 BRK1-23 cycle operating in the MELLLA+ operating domain.

3.3.8 Rod Internal Pressure

Fuel rod internal pressure is calculated using the RODEX4 code and methodology. The maximum rod pressure is calculated under steady-state conditions and also takes into account slow transients. Rod internal pressure is limited to **[**

]. The expected upper bound of rod pressure **[**

] is calculated for comparison to the limit.

Table 3-2 lists the results for an equilibrium cycle operating in the MELLLA+ operating domain. Table 3-3 lists the results for ATRIUM 11 BRK1-23 cycle operating in the MELLLA+ operating domain.

3.3.9 Plenum Spring Design (Fuel Assembly Handling)

The plenum spring must maintain a force against the fuel column to prevent **[**

]. This is accomplished by designing and verifying the spring force in relation to the fuel column weight. The plenum spring is designed such that the **[**

].

Table 3-1 Key Fuel Rod Design Parameters, ATRIUM 11 for BRK1-23

[

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* The theoretical density of enriched and naturally enriched UO_2-Cr pellets is 10.94 g/cm^3 while that for UO_2-Gd_2O_3 pellets is 10.96 g/cm^3.

Table 3-1 Key Fuel Rod Design Parameters, ATRIUM 11 for BRK1-23 (cont'd)

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]

Table 3-2 RODEX4 Fuel Rod Results Equilibrium Cycle—MELLLA+*

[

]

* Note that the results are provided up to fuel assembly discharge.

† Margin is defined as (limit – result).

Table 3-3 RODEX4 Fuel Rod Results for ATRIUM 11 BRK1-23 Cycle—MELLLA+*

[

]

* Note that the results are provided up to fuel assembly discharge.

† Margin is defined as (limit – result).

Table 3-4 Cladding and Cladding-End Cap Steady-State Stresses

Description, Stress Category	Criteria	Result		
		BOL Cold	BOL Hot	EOL Hot
Cladding stress				
P_m (primary membrane stress)	[			]
$P_m + P_b$ (primary membrane + bending)	[			]
P + Q (primary + secondary)	[			]
Cladding-End Cap stress				
$P_m + P_b$	[			]

4.0 REFERENCES

1. ANF-89-98(P)(A) Revision 1 and Supplement 1, *Generic Mechanical Design Criteria for BWR Fuel Designs*, Advanced Nuclear Fuels Corporation, May 1995.

2. BAW-10247PA Revision 0, *Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors*, AREVA NP Inc., February 2008.

3. ANP-10340P-A Revision 0. *Incorporation of Chromia-Doped Fuel Properties in AREVA Approved Methods*, Framatome Inc., May 2018.

4. Letter from Farideh E. Saba (NRC) to Michael J. Annacone (CP&L), “BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2 – ISSUANCE OF AMENDMENTS REGARDING ADDITION OF ANALYTICAL METHODOLOGY TOPICAL REPORT TO TECHNICAL SPECIFICATION 5.6.5 (TAC NOS. ME3858 AND ME3859), ML11101A043, NRC 1109968, dated April 8, 2011.

5. *ASME Boiler and Pressure Vessel Code*, Section III, “Rules for Construction of Nuclear Power Plant Components,” 1977.

6. O’Donnell, W.J., and B. F. Langer, “Fatigue Design Basis for Zircaloy Components,” *Nuclear Science and Engineering*, Vol. 20, 1964.

ANP-3759NP, *Brunswick Unit 1 Cycle 23 Fuel Cycle Design Report*, Revision 2

framatome

Brunswick Unit 1 Cycle 23

ANP-3759NP
Revision 2

Fuel Cycle Design Report

October 2019

Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	All	Signification modifications made throughout the document because of core redesign.
2	Section 2.0	Footnote added
3	Table 3.4	Negative hot excess reactivity values were removed.
4	Figure 3.1	Assembly placement error was corrected
5	Figure A.44	Erroneous Figure was replaced
6	Figures 3.4, A.42, A.45, A.53, A.55, A.65, & B.1	Less significant corrections were made

Contents

List of Tables

List of Figures

Nomenclature

Acronym	Definition
[ ]	Square brackets enclose information that is proprietary to Framatome.
ACE	Framatome critical power correlation **[ ]**
BOC	beginning of cycle
BOL	beginning of life
BWR	boiling water reactor
CSDM	cold shutdown margin
EOC	end of cycle
EOFP	end of full power capability
FFTR	final feedwater temperature reduction
GWd/MTU	gigawatt days per metric ton of initial uranium
HEXR	hot excess reactivity
LHGR	linear heat generation rate
MCPR	minimum critical power ratio
MICROBURN-B2	Framatome Inc. advanced BWR core simulator methodology with PPR capability
MWd/MTU	megawatt days per metric ton of initial uranium
NEOC	near end of cycle (MCPR limit exposure breakpoint)
NRC	(United States) Nuclear Regulatory Commission
PPR	Pin Power Reconstruction. The PPR methodology accounts for variation in local rod power distributions due to neighboring assemblies and control state. The local rod power distributions are reconstructed based on the actual flux solution for each statepoint.
R Value	the larger of zero or the shutdown margin at BOC minus the minimum calculated shutdown margin in the cycle
SLC	standby liquid control

1.0 INTRODUCTION

Framatome Inc. has performed a fuel cycle design evaluation for the Brunswick Unit 1 reactor. This design uses fresh ATRIUM 11 and co-resident ATRIUM 10XM fuel assemblies in the MELLLA+ operating domain. This analysis has been performed with the approved Framatome neutronic modeling methodology (Reference 1). This analysis has also used the References 2 - 3 critical power methodology. The CASMO-4 lattice depletion code was used to generate nuclear data including cross section libraries and local power peaking factors. The MICROBURN-B2 three dimensional core simulator code, combined with the ACE critical power correlation, was used to model the core. The MICROBURN-B2 pin power reconstruction (PPR) model was used to determine the thermal margins presented in this report. Design results including projected control rod patterns and evaluations of thermal and reactivity margins are presented in this report. The Cycle 23 results are based on Cycle 22 core operational history as summarized in Table 2.1.

The following MICROBURN-B2 version 2 modeling features were also used in the analyses supporting this document:

- Control Blade Boron (^{10}B) Depletion
- Explicit neutronic treatment of spacer grids
- Explicit modeling of PLFR plenums
- Explicit modeling of the water rod flow

2.0 SUMMARY

The Cycle 23 fresh batch size [ ] and batch average enrichment [ ] were determined to meet the energy requirements provided by Duke Energy* (Reference 4). For a complete description of the fresh reload assemblies, see Reference 5. The loading of the Cycle 23 fuel as described in this report results in a projected Cycle 23 full power energy capability (including FFTR) of 1,964±30 GWd (19,344±300 MWd/MTU). Beyond the full power capability, the cycle has been designed to achieve 41 GWd additional energy via Constant Pressure Power Coastdown operation.

In order to obtain optimum operating flexibility, the projected control rod patterns for Cycle 23 were developed to be consistent with a conservative margin to thermal limits (Reference 6). The cycle design calculations also demonstrate adequate hot excess reactivity and cold shutdown margin throughout the cycle. Key results from the design analysis are summarized in Table 2.1. Table 2.2 summarizes the assembly identification range by nuclear fuel type batch for the Cycle 23 design. Table 2.3, Table 2.4 and Table 2.5 contain the assumed thermal limits for this design. Figures 2.1 and 2.2 provide a summary of the cycle design step-through projection.

* This revised report reflects the revised design created by Duke Energy.

Table 2.1 Brunswick Unit 1 Cycle 23 Energy and Key Results Summary

Cycle Energy, GWd (Cycle Exposure, MWd/MTU)	
Cycle 22	
• Core follow through January 2019	(7,774)
• Best estimate depletion to Nominal EOC 22	(18,800)
• Short window EOC 22	(18,300)
• Long window EOC 22	(19,000)
Cycle 23	
• EOFP Energy (including FFTR)	1,964±30 (19,344±300)
• Constant Pressure Power Coastdown Energy	41 (403)
• EOC Energy (Nominal)	2,005±30 (19,747±300)

Key Results	
BOC CSDM, %Δk/k (based on short EOC 22)	1.07
Minimum CSDM, %Δk/k (based on short EOC 22)	1.07
Cycle Exposure of Minimum CSDM, MWd/MTU (short basis)	0
Moderator Temperature of Minimum CSDM, °F (short basis)	68
Cycle R Value, %Δk/k (short basis)	0.00
Minimum SLC SDM, %Δk/k (based on short EOC 22)	1.01
Cycle Exposure of Minimum SLC SDM, MWd/MTU (short basis)	0
BOC HEXR, %Δk/k (based on nominal EOC 22)	2.10
Maximum HEXR, %Δk/k (based on nominal EOC 22)	2.14
Cycle Exposure of Maximum HEXR, MWd/MTU (nominal basis)	4,000
Minimum MAPLHGR Margin, %	8.1
Exposure of Minimum MAPLHGR Margin, MWd/MTU	8,400
Minimum LHGR Margin, %	8.6
Exposure of Minimum LHGR Margin, MWd/MTU	0
Minimum CPR Margin, %	5
Exposure of Minimum CPR Margin, MWd/MTU	0

Table 2.2 Brunswick Unit 1 Cycle 23 Fuel Cycle Design Assembly ID Range by Nuclear Fuel Type

[ ]

Table 2.3 Assumed ATRIUM 11 MCPR Operating Limit

[ ]

Table 2.4 Assumed ATRIUM 11 LHGR Limit

[ ]

Table 2.5 Assumed ATRIUM 11 APLHGR Limit

[ ]

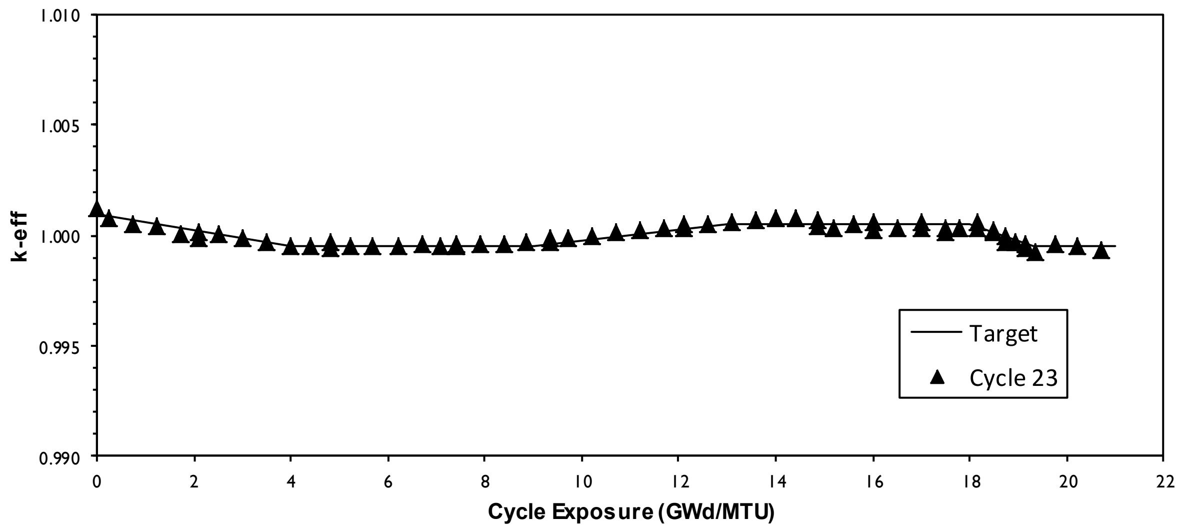

Figure 2.1 Brunswick Unit 1 Cycle 23 Design Step-through k-eff versus Cycle Exposure

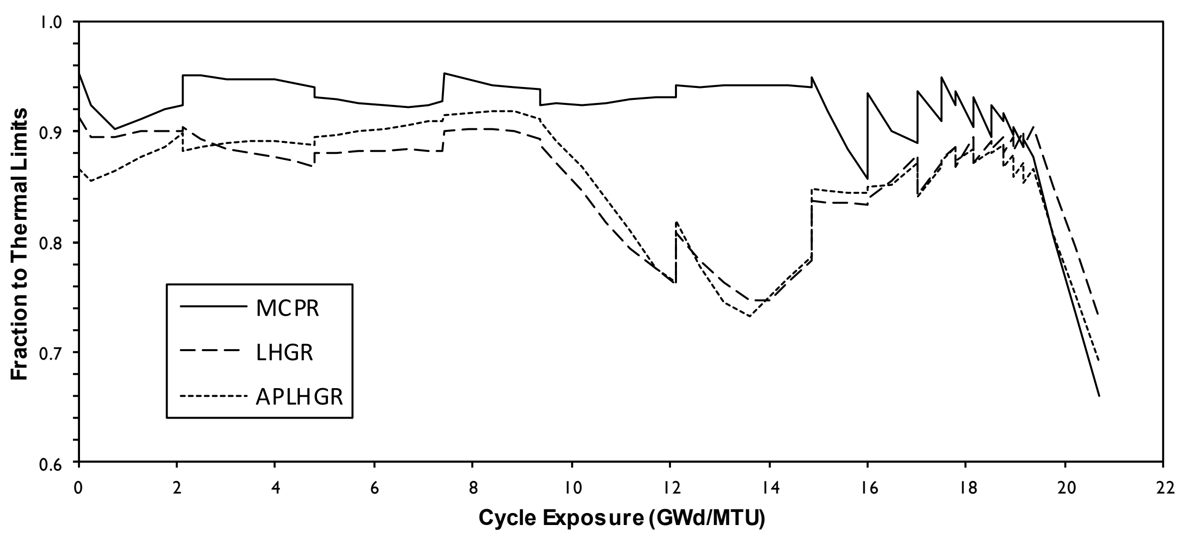

Figure 2.2 Brunswick Unit 1 Cycle 23 Design Margin to Thermal Limits versus Cycle Exposure

3.0 CYCLE 23 FUEL CYCLE DESIGN

3.1 *General Description*

The assembly design for the Cycle 23 BRK1-23 fresh reload fuel for Brunswick Unit 1 is described in detail in Reference 5. Elevation views of the fresh reload fuel design axial enrichment and gadolinia distributions are shown in Appendix B, Figures B.1 through B.3. The loading pattern generally maintains eighth core symmetry and uses a scatter load fuel management scheme. This loading in conjunction with the control rod patterns presented in Appendix A shows acceptable power peaking and associated margins to limits for projected Cycle 23 operation. The analyses supporting this fuel cycle design were based on the core parameters shown in Table 3.1. Figures 3.1 through 3.5, along with Table 3.1 define the reference loading pattern used in the fuel cycle design. The specific core location of the fresh assemblies in Cycle 23 is provided in Appendix C. Key results for the cycle are summarized in Table 2.1. Exposure limits have been checked using the long cycle N-1 and long cycle N energy window. It has been confirmed that no rod-averaged exposure exceeds 60 GWd/MTU.

3.2 *Control Rod Patterns and Thermal Limits*

Projected control rod patterns for Cycle 23 and resultant key operating parameters including thermal margins are shown in Appendix A. The thermal margins presented in this report were determined using the MICROBURN-B2 3D core simulator PPR model to provide adequate margin to thermal limits. A detailed summary of the core parameters resulting from the step-through projection analysis is provided in Tables A.1 and A.2. Limiting results from the step-through are summarized in Table 2.1 and in Figure 2.2. The thermal margins presented in this report are based on the assumed thermal limits shown in Table 2.3, Table 2.4, & Table 2.5 and are subject to revision pending the completion of the cycle thermal-mechanical and safety analyses. The hot operating target k-eff versus cycle exposure which was determined to be appropriate for Cycle 23 is shown in Table 3.2. The k-eff and margin to limits results from the design cycle depletion are presented graphically in Figure 2.1 and Figure 2.2. The k-eff values presented in Figure 2.1 and in Appendix A are not bias corrected. Selected exposure and radial power distributions from the design step-through are presented in Appendix D. The maximum core exit void fraction for the design step-through was determined to be 89.35%. The radial peaking factor does not exceed 1.60 for ATRIUM 11 fuel or 1.59 for ATRIUM 10XM fuel.

3.3 *Hot Excess Reactivity and Cold Shutdown Margin*

The cycle design calculations demonstrate adequate hot excess reactivity, SLC shutdown margin, and cold shutdown margin throughout the cycle. Key shutdown margin and R-Value results are presented in Table 2.1. The shutdown margin for Cycle 23 is in conformance with the Technical Specification limit of R + 0.38 %Δk/k at BOC. The cold target k-eff versus exposure determined to be appropriate for calculation of cold shutdown margin in Cycle 23 is shown in Table 3.3. The core hot excess reactivity was calculated at full power with all rods out, 77.0 Mlb/hr core flow, with equilibrium xenon. Table 3.4 summarizes the Cycle 23 reactivity margins versus cycle exposure, including the SLC shutdown margin for the cycle. Cold shutdown margin calculations have also been performed at temperatures above 68 °F to determine the shutdown margin at the most reactive temperature.

Table 3.1 Cycle 23 Core Composition and Design Parameters

[ ]

Number of Fuel Assemblies in Core	560
Total Number of Fresh Assemblies	[ ]
Total Core Mass, MTU	101.54
Rated Thermal Power Level, MW_t	2,923
Rated Core Flow, Mlb/hr	77.0
Reference Pressure, psia	1,045*
Reference Inlet Subcooling, Btu/lbm	21.3†

* Value is representative of MICROBURN-B2 input for dome pressure at rated conditions and varies depending on core state point.

† Value is typically determined by MICROBURN-B2 using a heat balance method based on nominal feedwater temperature and other parameters identified in the cycle specific plant parameters document.

Table 3.2 Brunswick Unit 1 Cycle 23 Hot Operating Target k-eff Versus Cycle Exposure

Cycle Exposure (MWd/MTU)	Hot Operating k-eff*
0.0	1.001
4,000.0	0.9995
9,000.0	0.9995
13,000.0	1.0005
18,000.0	1.0005
19,300.0	0.9995
EOC	0.9995

Table 3.3 Brunswick Unit 1 Cycle 23 Cold Critical Target k-eff Versus Cycle Exposure

Cycle Exposure (MWd/MTU)	Cold Critical k-eff*
0.0	0.9925
6,000.0	0.989
EOC	0.989

* Values are linearly interpolated between cycle exposure points.

Table 3.4 Brunswick Unit 1 Cycle 23 Reactivity Margin Summary

Cycle Exposure (MWd/MTU)	Cold Shutdown Margin* (% Δk/k)	SLC Cold Shutdown Margin† (% Δk/k)	Hot Excess Reactivity‡ (% Δk/k)
0	1.07	1.01	2.10
250	1.39	1.31	2.00
1,250	1.83	1.62	1.92
2,100	1.89	1.63	2.00
3,000	2.03	1.61	2.08
4,000	2.16	1.62	2.14
5,250	2.25	1.61	2.12
6,700	2.43	1.70	2.10
7,400	2.44	1.70	2.11
8,400	2.40	1.74	2.11
9,350	2.29	1.81	2.11
10,200	2.19	1.86	2.09
11,200	2.14	2.01	2.06
12,600	**2.04**	2.31	2.01
14,000	**1.78**	2.70	1.94
15,600	**1.72**	3.31	1.66
16,000	**1.56**	3.46	1.55
17,000	**1.29**	3.88	1.07
17,800	**1.23**	4.28	0.56
18,150	**1.26**	4.48	0.30
18,950	**1.39**	4.99	--
19,150	**1.44**	5.13	--
19,344	**1.50**	5.27	--
19,747	**1.68**	5.60	--
20,200	**1.95**	6.01	--

* Based on short window EOC 22. Values for cold shutdown margin are shown in bold font if the most reactive temperature is greater than 68 °F.
† Based on short window EOC 22, calculated at 360.8 °F ARO conditions.
‡ Based on nominal EOC 22.

Figure 3.1 Brunswick Unit 1 Cycle 23 Reference Loading Pattern

Figure 3.2 Brunswick Unit 1 Cycle 23 Upper Left Quarter Core Layout by Fuel Type

[ ]

Figure 3.3 Brunswick Unit 1 Cycle 23 Upper Right Quarter Core Layout by Fuel Type

[ ]

Figure 3.4 Brunswick Unit 1 Cycle 23 Lower Left Quarter Core Layout by Fuel Type

Figure 3.5 Brunswick Unit 1 Cycle 23 Lower Right Quarter Core Layout by Fuel Type

4.0 REFERENCES

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2. ANP-10298(P) Revision 1, ACE/ATRIUM 10XM Critical Power Correlation, AREVA, March 2014.

3. ANP-10335P-A, Revision 0, ACE/ATRIUM 11 Critical Power Correlation, Framatome Inc., May 2018

4. FS1-0040620 Revision 1.0, BRK1-23 RSD Transmittal Revision 1 NF18-73, October 2018.

5. ANP-3758P, Revision 1, Nuclear Fuel Design Report Brunswick Unit 1 Cycle 23 ATRIUM 11 Fuel, September 2019.

6. FS1-0040610, Revision 1.0, Brunswick Unit 1 Cycle 23 Target K-Effective and Thermal Limit Selection, October 2018.

Appendix A Brunswick Unit 1 Cycle 23 Step-through Depletion Summary, Control Rod Patterns and Core Average Axial Power and Exposure Distributions

Table A.1 Brunswick Unit 1 Cycle 23 Design Depletion Summary

Cycle Exposure (GWd/MT)	Calculated K-eff	Control Rod Density	Total Core Power MWt	Total Core Flow (Mlb/hr)	Ref. Pressure (psia)	Inlet Sub-Cooling (Btu/lb)	Void Fraction	Core Minimum CPR	Core Maximum LHGR (kW/ft)	Core Maximum APLHGR (kW/ft)
0.000	1.00125	6.20	2923.0	68.92	1044.70	24.16	0.532	1.446	12.43	10.24
0.250	1.00083	6.20	2923.0	70.84	1044.71	23.43	0.523	1.493	12.17	10.07
0.750	1.00055	6.20	2923.0	74.31	1044.75	22.21	0.513	1.527	12.19	10.08
1.250	1.00041	6.20	2923.0	73.15	1044.74	22.60	0.517	1.515	12.25	10.11
1.750	1.00010	6.20	2923.0	71.03	1044.72	23.36	0.523	1.500	12.24	10.12
2.100	0.99993	6.20	2923.0	69.68	1044.70	23.87	0.528	1.491	12.24	10.20
2.101	1.00019	6.57	2923.0	71.61	1044.72	23.15	0.511	1.449	12.30	9.89
2.500	1.00009	6.57	2923.0	70.46	1044.71	23.57	0.515	1.451	12.16	9.86
3.000	0.99991	6.57	2923.0	69.30	1044.70	24.02	0.519	1.457	12.03	9.82
3.500	0.99967	6.57	2923.0	68.14	1044.69	24.47	0.523	1.456	11.87	9.74
4.000	0.99949	6.57	2923.0	67.38	1044.68	24.78	0.526	1.456	11.86	9.64
4.400	0.99949	6.57	2923.0	67.38	1044.68	24.79	0.525	1.462	11.83	9.55
4.800	0.99946	6.57	2923.0	67.38	1044.68	24.79	0.524	1.468	11.77	9.48
4.801	0.99967	6.66	2923.0	69.68	1044.70	23.87	0.526	1.483	11.98	9.67
5.250	0.99957	6.66	2923.0	69.68	1044.70	23.87	0.525	1.485	11.85	9.61
5.700	0.99957	6.66	2923.0	69.88	1044.71	23.79	0.523	1.490	11.78	9.55
6.200	0.99957	6.66	2923.0	70.07	1044.71	23.72	0.521	1.493	11.70	9.57
6.700	0.99959	6.66	2923.0	70.26	1044.71	23.65	0.519	1.495	11.62	9.62
7.100	0.99953	6.66	2923.0	70.07	1044.71	23.72	0.519	1.492	11.57	9.65
7.400	0.99950	6.66	2923.0	69.88	1044.71	23.79	0.519	1.489	11.52	9.67
7.401	0.99966	6.39	2923.0	67.18	1044.68	24.86	0.532	1.448	11.89	9.65
7.900	0.99963	6.39	2923.0	67.38	1044.68	24.79	0.530	1.457	11.78	9.61
8.400	0.99965	6.39	2923.0	67.38	1044.68	24.79	0.529	1.463	11.69	9.65
8.850	0.99967	6.39	2923.0	67.38	1044.68	24.79	0.527	1.467	11.60	9.65
9.350	0.99971	6.39	2923.0	67.38	1044.68	24.79	0.525	1.471	11.41	9.57
9.351	0.99985	6.11	2923.0	66.61	1044.68	25.10	0.522	1.492	11.59	9.75
9.700	0.99986	6.11	2923.0	66.61	1044.68	25.11	0.519	1.491	11.35	9.61
10.200	1.00000	6.11	2923.0	66.99	1044.68	24.94	0.514	1.492	10.90	9.31
10.700	1.00015	6.11	2923.0	67.38	1044.68	24.79	0.507	1.490	10.37	8.89
11.200	1.00025	6.11	2923.0	67.57	1044.68	24.71	0.499	1.486	9.81	8.42
11.700	1.00037	6.11	2923.0	67.76	1044.69	24.63	0.491	1.481	9.20	7.96
12.100	1.00048	6.11	2923.0	68.14	1044.69	24.47	0.483	1.482	8.84	7.75
12.101	1.00036	5.44	2923.0	68.14	1044.69	24.47	0.501	1.463	10.54	9.04
12.600	1.00048	5.44	2923.0	68.92	1044.70	24.17	0.489	1.469	9.71	8.31
13.100	1.00059	5.44	2923.0	69.45	1044.70	23.96	0.478	1.465	9.05	7.78
13.600	1.00069	5.44	2923.0	70.07	1044.71	23.72	0.467	1.463	9.16	7.60
14.000	1.00080	5.44	2923.0	70.84	1044.71	23.43	0.458	1.463	9.21	7.66
14.400	1.00077	5.44	2923.0	71.61	1044.72	23.15	0.449	1.464	9.30	7.77
14.850	1.00074	5.44	2923.0	72.76	1044.73	22.74	0.438	1.468	9.37	7.91
14.851	1.00043	5.38	2923.0	72.38	1044.73	22.87	0.437	1.454	9.69	8.53
15.200	1.00037	5.38	2923.0	74.31	1044.75	22.21	0.427	1.504	9.60	8.55
15.600	1.00048	5.38	2923.0	77.00	1044.77	21.33	0.415	1.560	9.54	8.58
16.000	1.00060	5.38	2923.0	80.46	1044.80	20.29	0.401	1.609	9.52	8.59
16.001	1.00024	4.81	2923.0	68.92	1044.70	24.15	0.415	1.477	9.85	8.81
16.500	1.00035	4.81	2923.0	73.92	1044.74	22.34	0.397	1.533	10.03	8.98
17.000	1.00059	4.81	2923.0	80.46	1044.80	20.29	0.377	1.574	10.21	9.15
17.001	1.00030	3.65	2923.0	72.76	1044.73	22.73	0.400	1.494	9.78	8.82
17.500	1.00034	3.65	2923.0	80.46	1044.80	20.29	0.377	1.539	10.08	9.02
17.501	1.00017	2.55	2923.0	74.31	1044.75	22.20	0.397	1.473	10.41	8.81
17.800	1.00038	2.55	2923.0	80.46	1044.80	20.29	0.381	1.513	10.45	8.91
17.801	1.00038	1.46	2923.0	73.15	1044.74	22.59	0.400	1.495	10.38	8.79
18.150	1.00036	1.46	2923.0	80.46	1044.80	20.29	0.381	1.548	10.41	8.93
18.151	1.00057	0.64	2923.0	73.92	1044.74	22.33	0.393	1.502	10.29	8.81
18.500	1.00012	0.64	2923.0	80.46	1044.80	20.29	0.376	1.564	10.24	8.87
18.501	1.00029	0.00	2923.0	76.23	1044.76	21.56	0.386	1.516	10.35	8.87
18.739	0.99974	0.00	2923.0	80.46	1044.80	20.29	0.375	1.550	10.34	8.94
18.740	0.99995	0.00	2923.0	76.23	1044.70	25.15	0.372	1.538	10.11	8.73
18.950	0.99973	0.00	2923.0	80.46	1044.70	23.68	0.361	1.570	10.13	8.81
18.951	0.99970	0.00	2923.0	76.23	1044.70	28.45	0.359	1.560	9.93	8.61
19.150	0.99958	0.00	2923.0	80.46	1044.70	26.80	0.348	1.590	9.98	8.71
19.151	0.99942	0.00	2923.0	76.23	1044.70	31.50	0.347	1.579	9.78	8.51
19.344	0.99926	0.00	2923.0	80.46	1044.70	29.69	0.337	1.608	9.84	8.61
19.747	0.99964	0.00	2649.7	80.46	1044.70	26.71	0.315	1.751	9.00	7.99
20.200	0.99955	0.00	2389.7	80.46	1044.70	23.87	0.293	1.916	8.20	7.40
20.697	0.99931	0.00	2111.8	80.46	1044.70	20.83	0.269	2.138	7.52	6.72

Table A.2 Brunswick Unit 1 Cycle 23 Design Depletion Thermal Margin Summary

Cycle Exposure (GWd/MT)	Calculated K-eff	Control Rod Density	Core Limiting CPR	Fraction of Limiting CPR	Core Limiting LHGR (kW/ft)	Fraction of Limiting LHGR	Core Limiting APLHGR (kW/ft)	Fraction of Limiting APLHGR
0.000	1.00125	6.204	1.446	0.954	12.43	0.914	10.24	0.867
0.250	1.00083	6.204	1.493	0.925	12.17	0.895	10.06	0.856
0.750	1.00055	6.204	1.527	0.903	12.19	0.896	10.08	0.865
1.250	1.00041	6.204	1.515	0.911	12.25	0.900	10.11	0.877
1.750	1.00010	6.204	1.500	0.920	12.24	0.900	10.12	0.886
2.100	0.99993	6.204	1.491	0.925	12.24	0.900	10.20	0.899
2.101	1.00019	6.569	1.449	0.952	12.30	0.905	9.89	0.882
2.500	1.00009	6.569	1.451	0.951	12.16	0.894	9.86	0.886
3.000	0.99991	6.569	1.457	0.947	12.03	0.884	9.82	0.890
3.500	0.99967	6.569	1.456	0.948	10.52	0.881	9.74	0.892
4.000	0.99949	6.569	1.456	0.948	10.38	0.877	9.64	0.891
4.400	0.99949	6.569	1.462	0.944	10.26	0.873	9.55	0.890
4.800	0.99946	6.569	1.468	0.940	10.13	0.869	9.46	0.888
4.801	0.99967	6.661	1.483	0.931	11.98	0.881	9.50	0.896
5.250	0.99957	6.661	1.485	0.929	10.56	0.880	9.44	0.897
5.700	0.99957	6.661	1.490	0.926	10.49	0.882	9.39	0.901
6.200	0.99957	6.661	1.493	0.924	10.41	0.883	9.33	0.903
6.700	0.99959	6.661	1.495	0.923	10.33	0.884	9.27	0.906
7.100	0.99953	6.661	1.492	0.925	10.24	0.883	9.22	0.909
7.400	0.99950	6.661	1.489	0.927	10.16	0.882	9.18	0.910
7.401	0.99966	6.387	1.448	0.953	10.38	0.901	9.45	0.916
7.900	0.99963	6.387	1.457	0.947	10.29	0.902	9.37	0.917
8.400	0.99965	6.387	1.463	0.943	10.20	0.902	9.29	0.919
8.850	0.99967	6.387	1.467	0.940	10.10	0.900	9.20	0.918
9.350	0.99971	6.387	1.471	0.938	9.93	0.894	9.05	0.912
9.351	0.99985	6.113	1.492	0.925	10.00	0.888	9.14	0.909
9.700	0.99986	6.113	1.491	0.926	9.74	0.871	8.90	0.892
10.200	1.00000	6.113	1.492	0.925	9.38	0.846	8.58	0.868
10.700	1.00015	6.113	1.490	0.926	8.98	0.818	8.23	0.840
11.200	1.00025	6.113	1.486	0.929	8.02	0.794	7.86	0.810
11.700	1.00037	6.113	1.481	0.932	7.68	0.776	7.48	0.776
12.100	1.00048	6.113	1.482	0.931	7.40	0.761	7.48	0.764
12.101	1.00036	5.444	1.463	0.943	7.76	0.809	7.85	0.820
12.600	1.00048	5.444	1.469	0.940	7.45	0.783	7.30	0.778
13.100	1.00059	5.444	1.465	0.942	7.19	0.764	6.98	0.745
13.600	1.00069	5.444	1.463	0.943	6.90	0.748	7.45	0.733
14.000	1.00080	5.444	1.463	0.943	7.54	0.748	7.58	0.750
14.400	1.00077	5.444	1.464	0.943	8.54	0.763	7.70	0.767
14.850	1.00074	5.444	1.468	0.940	8.70	0.784	7.87	0.786
14.851	1.00043	5.383	1.454	0.949	9.19	0.838	8.44	0.849
15.200	1.00037	5.383	1.504	0.918	9.10	0.836	8.31	0.846
15.600	1.00048	5.383	1.560	0.885	9.03	0.835	8.25	0.845
16.000	1.00060	5.383	1.609	0.858	9.15	0.834	8.38	0.844
16.001	1.00024	4.805	1.477	0.935	9.28	0.840	8.48	0.851
16.500	1.00035	4.805	1.533	0.900	10.03	0.856	8.42	0.852
17.000	1.00059	4.805	1.574	0.889	10.21	0.879	9.00	0.872
17.001	1.00030	3.650	1.494	0.937	9.78	0.843	8.82	0.841
17.500	1.00034	3.650	1.539	0.910	10.00	0.871	9.02	0.868
17.501	1.00017	2.555	1.473	0.950	9.59	0.875	8.69	0.874
17.800	1.00038	2.555	1.513	0.925	9.66	0.886	8.76	0.887
17.801	1.00038	1.460	1.495	0.936	8.84	0.868	8.63	0.873
18.150	1.00036	1.460	1.548	0.904	8.97	0.896	8.69	0.885
18.151	1.00057	0.639	1.502	0.932	9.44	0.871	8.55	0.871
18.500	1.00012	0.639	1.564	0.895	8.78	0.891	8.60	0.882
18.501	1.00029	0.000	1.516	0.924	8.62	0.884	8.64	0.881
18.739	0.99974	0.000	1.550	0.910	8.63	0.896	8.64	0.888
18.740	0.99995	0.000	1.538	0.917	8.49	0.881	8.44	0.868
18.950	0.99973	0.000	1.570	0.898	8.63	0.895	8.51	0.879
18.951	0.99970	0.000	1.560	0.904	8.51	0.883	8.33	0.860
19.150	0.99958	0.000	1.590	0.887	8.60	0.900	8.42	0.872
19.151	0.99942	0.000	1.579	0.893	8.47	0.887	8.24	0.853
19.344	0.99926	0.000	1.608	0.877	8.57	0.905	8.33	0.866
19.747	0.99964	0.000	1.751	0.805	7.90	0.851	7.74	0.807
20.200	0.99955	0.000	1.916	0.736	7.22	0.796	7.25	0.753
20.697	0.99931	0.000	2.138	0.660	6.46	0.731	6.59	0.692

```
Cycle:                              23                 Core Average Exposure: MWd/MTU    16658.3
Exposure: MWd/MTU (GWd)            0.0 (    0.00 )
Delta E: MWd/MTU, (GWd)            0.0 (    0.00 )          Axial Profile    Edit   Radial Power
Power: MWt                      2923.0 (100.00 %)       N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia             1044.7                 Top 25  0.128   3.306    37  0.758 0.791    3 24
Inlet Subcooling: Btu/lbm       -24.16                     24  0.298   9.241    38  0.462 0.690   47 16
Flow: Mlb/hr                     68.92 ( 89.50 %)          23  0.476  11.702    39  0.486 0.848   17 48
                                                           22  0.569  13.900    40  0.558 1.008    5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50               21  0.628  15.411    41  0.907 1.250   39 38
   51            -- -- -- -- -- --            51           20  0.677  16.527    42  1.174 1.358   31 24
   47       -- -- -- -- -- -- -- -- -- --       47         19  0.719  17.124    43  1.278 1.398   27 22
   43    -- -- -- -- -- --  8 -- -- -- -- --    43         18  0.771  17.814    44  1.091 1.293   39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --    39         17  0.824  18.294    45  1.136 1.329   39 22
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 35         16  0.890  18.544
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31         15  0.975  18.678
   27 -- --  8 -- 40 --  0 -- 40 --  8 -- -- 27            14  1.034  18.678
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23         13  1.147  18.774
   19 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 19         12  1.219  19.393
   15    -- -- -- -- -- -- -- -- -- -- -- --    15         11  1.275  19.788
   11    -- -- -- -- -- --  8 -- -- -- -- --    11         10  1.353  19.488
    7       -- -- -- -- -- -- -- -- -- --        7          9  1.376  19.810
    3            -- -- -- -- -- --               3          8  1.403  19.962
      2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.437  20.038
                                                            6  1.473  20.357*
                                                            5  1.515  20.283
                                                            4  1.550  19.602
Control Rod Density: %            6.20                      3  1.591* 18.162
                                                            2  1.326  14.002
k-effective:                   1.00125               Bottom  1  0.346   4.024
Void Fraction:                   0.532
Core Delta-P: psia              20.394            % AXIAL TILT -33.013  -9.236
Core Plate Delta-P: psia        15.840        AVG BOT 8ft/12ft  1.2007  1.0560
Coolant Temp: Deg-F              548.6
In Channel Flow: Mlb/hr          59.90   Active Channel Flow: Mlb/hr        57.64
Total Bypass Flow (%):            13.1   (of total core flow)
Total Water Rod Flow (%):          3.3   (of total core flow)
Source Convergence             0.00040
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.398	43	27	22	1.446	0.954	43	21	28	10.24	0.867	27.4	42	19	26	6	12.43	0.914	0.0	43	17	28	6
1.395	43	31	26	1.455	0.948	43	19	30	10.15	0.863	27.9	42	27	20	6	12.36	0.909	0.0	43	27	18	6
1.391	43	33	24	1.456	0.948	43	27	22	9.56	0.799	25.9	41	13	38	3	12.14	0.893	0.0	43	21	28	6
1.391	43	29	20	1.468	0.940	43	29	20	9.43	0.797	27.2	41	37	14	3	12.08	0.888	0.0	43	19	30	6
1.384	43	29	24	1.472	0.938	45	39	22	9.41	0.796	27.3	42	21	24	6	12.08	0.888	0.0	44	13	36	3
1.374	43	31	22	1.478	0.934	43	23	24	9.37	0.794	27.5	42	23	22	6	12.07	0.888	0.0	43	27	22	6
1.358	42	31	24	1.482	0.931	45	31	14	9.42	0.786	25.7	42	13	34	3	12.07	0.888	0.0	44	39	14	3
1.356	42	29	22	1.486	0.929	43	21	22	9.25	0.781	27.2	42	17	30	6	12.02	0.884	0.0	44	35	40	3
1.354	43	37	24	1.503	0.918	45	39	26	9.11	0.779	28.6	42	29	18	6	12.01	0.883	0.0	43	29	20	6
1.353	42	35	24	1.507	0.916	44	35	14	9.28	0.778	26.3	42	33	14	3	11.96	0.879	0.0	45	13	32	3

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.1 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 0.0 MWd/MTU

```
Cycle:                           23                 Core Average Exposure: MWd/MTU    16908.2
Exposure: MWd/MTU (GWd)       250.0 (  25.39 )
Delta E: MWd/MTU, (GWd)       250.0 (  25.39 )         Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)     N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7               Top 25  0.134   3.341    37  0.764 0.798   3 24
Inlet Subcooling: Btu/lbm    -23.43                   24  0.312   9.324    38  0.465 0.693  47 16
Flow: Mlb/hr                  70.84 ( 92.00 %)        23  0.498  11.834    39  0.489 0.852  17 48
                                                      22  0.594  14.058    40  0.561 1.013   5 34
    2  6 10 14 18 22 26 30 34 38 42 46 50             21  0.654  15.586    41  0.911 1.250  39 38
  51             -- -- -- -- --             51        20  0.702  16.715    42  1.175 1.357  31 24
  47       -- -- -- -- -- -- -- -- -- --       47     19  0.743  17.323    43  1.272 1.391  27 22
  43    -- -- -- -- -- --  8 -- -- -- -- --    43     18  0.792  18.027    44  1.089 1.287  39 18
  39    -- -- -- -- -- -- -- -- -- -- -- --    39     17  0.844  18.521    45  1.133 1.323  39 22
  35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 35     16  0.906  18.786
  31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31     15  0.988  18.936
  27 -- --  8 -- 40 --  0 -- 40 --  8 -- -- 27        14  1.044  18.951
  23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23     13  1.154  19.052
  19 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 19     12  1.223  19.687
  15    -- -- -- -- -- -- -- -- -- -- -- --    15     11  1.276  20.096
  11    -- -- -- -- -- --  8 -- -- -- -- --    11     10  1.351  19.800
   7       -- -- -- -- -- -- -- -- -- --        7      9  1.373  20.127
   3             -- -- -- -- --                 3      8  1.396  20.285
    2  6 10 14 18 22 26 30 34 38 42 46 50              7  1.427  20.368
                                                       6  1.457  20.695*
                                                       5  1.491  20.630
                                                       4  1.511  19.955
Control Rod Density: %         6.20                    3  1.532* 18.522
                                                       2  1.267  14.301
k-effective:                1.00083           Bottom  1  0.330   4.108
Void Fraction:                0.523
Core Delta-P: psia           21.119              % AXIAL TILT -31.124  -9.474
Core Plate Delta-P: psia     16.563          AVG BOT 8ft/12ft  1.1900  1.0574
Coolant Temp: Deg-F           548.6
In Channel Flow: Mlb/hr       61.65   Active Channel Flow: Mlb/hr        59.34
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.2   (of total core flow)
Source Convergence          0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.391	43	27	22	1.493	0.925	43	21	28	10.06	0.856	28.0	42	19	28	6	12.17	0.895	0.8	43	17	28	6
1.388	43	21	28	1.497	0.922	43	27	22	9.97	0.852	28.4	42	27	20	6	12.08	0.889	0.8	43	27	18	6
1.384	43	33	24	1.501	0.919	45	39	22	9.30	0.790	27.8	42	21	24	6	11.91	0.876	0.8	43	21	28	6
1.384	43	29	20	1.502	0.919	43	19	30	9.26	0.788	28.0	42	23	22	6	11.86	0.872	0.8	43	19	30	6
1.377	43	29	24	1.507	0.916	43	29	20	9.15	0.776	27.6	42	17	30	6	11.83	0.870	0.8	43	27	22	6
1.366	43	31	22	1.510	0.914	45	31	14	9.23	0.774	26.4	41	13	38	3	11.78	0.866	0.8	43	29	20	6
1.357	42	31	24	1.524	0.905	43	23	24	9.00	0.773	29.0	42	29	18	6	11.00	0.862	32.4	42	19	28	6
1.355	42	29	22	1.529	0.903	45	39	26	9.09	0.771	27.7	41	37	14	3	10.91	0.858	32.7	42	27	20	6
1.351	42	35	24	1.533	0.900	43	21	22	9.10	0.763	26.2	42	13	34	3	11.53	0.848	0.8	44	13	36	3
1.347	43	37	24	1.535	0.899	44	35	14	8.82	0.762	29.7	42	23	28	6	11.51	0.846	0.8	44	39	40	3

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.2 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 250.0 MWd/MTU

Cycle:	23
Exposure: MWd/MTU (GWd)	750.0 (76.16)
Delta E: MWd/MTU, (GWd)	500.0 (50.77)
Power: MWt	2923.0 (100.00 %)
Core Pressure: psia	1044.7
Inlet Subcooling: Btu/lbm	-22.21
Flow: Mlb/hr	74.31 (96.50 %)

Core Average Exposure: MWd/MTU 17408.2

```
      2  6 10 14 18 22 26 30 34 38 42 46 50
   51             -- -- -- -- -- --             51
   47       -- -- -- -- -- -- -- -- -- --       47
   43    -- -- -- -- -- --  8 -- -- -- -- --    43
   39    -- -- -- -- -- -- -- -- -- -- -- --    39
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 35
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31
   27 -- --  8 -- 40 --  0 -- 40 --  8 -- -- 27
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23
   19 -- -- -- --  6 -- 40 --  6 -- -- -- -- -- 19
   15    -- -- -- -- -- -- -- -- -- -- -- --    15
   11    -- -- -- -- -- --  8 -- -- -- -- --    11
    7       -- -- -- -- -- -- -- -- -- --        7
    3             -- -- -- -- -- --              3
      2  6 10 14 18 22 26 30 34 38 42 46 50
```

	Axial Profile	
N(PRA)	Power	Exposure
Top 25	0.140	3.415
24	0.326	9.495
23	0.518	12.110
22	0.614	14.386
21	0.672	15.947
20	0.717	17.101
19	0.754	17.731
18	0.799	18.460
17	0.847	18.982
16	0.906	19.275
15	0.984	19.455
14	1.037	19.499
13	1.146	19.607
12	1.214	20.275
11	1.267	20.709
10	1.343	20.424
9	1.370	20.759
8	1.397	20.928
7	1.430	21.027
6	1.464	21.368*
5	1.494	21.318
4	1.502	20.650
3	1.502*	19.221
2	1.232	14.876
Bottom 1	0.326	4.271
% AXIAL TILT	-30.296	-9.889
AVG BOT 8ft/12ft	1.1834	1.0598

Edit	Radial Power			
Zone	Avg.	Max.	IR	JR
37	0.761	0.795	3	24
38	0.460	0.688	47	16
39	0.484	0.849	17	48
40	0.557	1.010	5	34
41	0.908	1.253	37	14
42	1.176	1.357	31	24
43	1.277	1.396	27	22
44	1.090	1.292	39	18
45	1.135	1.328	39	22

Control Rod Density: %	6.20	
k-effective:	1.00055	
Void Fraction:	0.513	
Core Delta-P: psia	22.554	
Core Plate Delta-P: psia	17.996	
Coolant Temp: Deg-F	548.6	
In Channel Flow: Mlb/hr	64.76	Active Channel Flow: Mlb/hr 62.38
Total Bypass Flow (%):	12.8	(of total core flow)
Total Water Rod Flow (%):	3.2	(of total core flow)
Source Convergence	0.00045	

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.396	43	27	22	1.527	0.903	43	21	28	10.08	0.865	29.0	42	19	26	6	12.19	0.896	2.3	43	17	28	6
1.392	43	21	28	1.534	0.899	43	19	30	9.98	0.861	29.5	42	27	20	6	12.10	0.890	2.3	43	27	36	6
1.390	43	33	24	1.535	0.899	43	27	22	9.33	0.800	28.8	42	21	24	6	11.94	0.878	2.3	43	21	28	6
1.390	43	29	20	1.536	0.898	45	39	22	9.29	0.798	29.0	42	23	22	6	11.90	0.875	2.3	43	19	30	6
1.380	43	29	24	1.544	0.894	43	29	20	9.19	0.786	28.6	42	17	30	6	11.87	0.873	2.3	43	27	22	6
1.372	43	31	22	1.545	0.893	45	31	14	9.05	0.784	30.0	42	29	18	6	11.83	0.870	2.3	43	29	20	6
1.357	42	31	24	1.558	0.886	43	23	24	8.83	0.769	30.6	42	23	28	6	10.98	0.868	33.5	42	19	28	6
1.356	42	29	22	1.563	0.883	45	39	26	8.89	0.768	29.7	42	15	28	6	10.88	0.863	33.9	42	27	20	6
1.353	42	35	24	1.566	0.881	43	21	22	9.08	0.768	27.3	41	13	38	3	11.34	0.834	2.2	43	23	30	5
1.353	43	37	24	1.570	0.879	44	35	14	8.92	0.766	29.0	42	27	16	6	11.32	0.832	2.2	43	21	22	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.3 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 750.0 MWd/MTU

```
Cycle:                            23                       Core Average Exposure: MWd/MTU    17908.3
Exposure: MWd/MTU (GWd)       1250.0 ( 126.93 )
Delta E: MWd/MTU, (GWd)        500.0 (  50.77 )                 Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)           N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                     Top 25  0.142   3.490    37  0.756 0.787   3 24
Inlet Subcooling: Btu/lbm     -22.60                         24  0.331   9.672    38  0.455 0.684  47 16
Flow: Mlb/hr                   73.15 ( 95.00 %)              23  0.521  12.392    39  0.479 0.842  17 48
                                                             22  0.616  14.720    40  0.551 1.003   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                  21  0.671  16.312    41  0.903 1.252  37 14
   51          -- -- -- -- -- --              51             20  0.712  17.490    42  1.174 1.353  31 24
   47       -- -- -- -- -- -- -- -- -- --     47             19  0.747  18.139    43  1.284 1.402  27 22
   43    -- -- -- -- -- --  8 -- -- -- -- --  43             18  0.790  18.893    44  1.094 1.302  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --  39             17  0.835  19.439    45  1.142 1.336  39 22
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 35           16  0.890  19.759
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31              15  0.966  19.968
   27 -- --  8 -- 40 --  0 -- 40 --  8 -- -- 27              14  1.018  20.039
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23              13  1.125  20.155
   19 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 19           12  1.193  20.856
   15    -- -- -- -- -- -- -- -- -- -- -- --  15             11  1.248  21.316
   11    -- -- -- -- -- --  8 -- -- -- -- --  11             10  1.327  21.042
    7       -- -- -- -- -- -- -- -- -- --      7              9  1.363  21.389
    3          -- -- -- -- -- --               3              8  1.399  21.573
      2  6 10 14 18 22 26 30 34 38 42 46 50                   7  1.442  21.689
                                                              6  1.487  22.049*
                                                              5  1.525  22.014
                                                              4  1.535* 21.350
Control Rod Density: %          6.20                          3  1.528  19.919
                                                              2  1.253  15.448
k-effective:                 1.00041                   Bottom 1  0.336   4.435
Void Fraction:                 0.517
Core Delta-P: psia            22.092             % AXIAL TILT -30.988 -10.280
Core Plate Delta-P: psia      17.535          AVG BOT 8ft/12ft  1.1849  1.0620
Coolant Temp: Deg-F            548.6
In Channel Flow: Mlb/hr        63.71   Active Channel Flow: Mlb/hr        61.36
Total Bypass Flow (%):          12.9   (of total core flow)
Total Water Rod Flow (%):        3.2   (of total core flow)
Source Convergence           0.00046


                         Top Ten Thermal Limits Summary - Sorted by Margin

     Power                  MCPR                          APLHGR                              LHGR
Value FT  IR JR    Value Margin FT  IR JR   Value Margin Exp. FT  IR JR  K   Value Margin Exp. FT  IR JR  K
1.402 43  27 22    1.515  0.911 43  21 28   10.11  0.877 30.1 42  19 26  6   12.25  0.900  3.9 43  17 28  6
1.399 43  31 26    1.519  0.908 43  19 30   10.02  0.872 30.5 42  27 20  6   12.17  0.895  3.9 43  27 36  6
1.397 43  33 24    1.526  0.904 43  27 22    9.37  0.810 29.8 42  21 24  6   12.00  0.882  3.8 43  21 28  6
1.397 43  29 20    1.533  0.900 45  39 22    9.33  0.808 29.9 42  23 22  6   11.97  0.880  3.8 43  19 30  6
1.386 43  29 24    1.534  0.900 43  29 20    9.25  0.799 29.6 42  17 30  6   11.92  0.877  3.8 43  27 22  6
1.379 43  31 22    1.542  0.895 45  31 14    9.11  0.796 30.9 42  29 18  6   10.97  0.876 34.7 42  19 28  6
1.361 43  37 24    1.544  0.894 43  23 24    9.20  0.785 28.3 41  13 38  3   11.90  0.875  3.8 43  29 20  6
1.357 43  29 16    1.551  0.890 43  21 22    9.06  0.782 29.6 41  37 14  3   10.88  0.871 35.0 42  27 20  6
1.356 43  35 26    1.563  0.883 45  39 26    8.96  0.781 30.7 42  15 28  6   11.45  0.842  3.6 43  29 30  5
1.354 43  27 18    1.566  0.881 44  35 14    8.99  0.779 29.9 42  27 16  6   11.44  0.841  3.6 43  21 22  5

  * LHGR calculated with pin-power reconstruction
  * CPR calculated with pin-power reconstruction & CPR limit type 3
```

Figure A.4 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 1,250.0 MWd/MTU

```
Cycle:                           23              Core Average Exposure: MWd/MTU    18408.2
Exposure: MWd/MTU (GWd)      1750.0 ( 177.70 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )          Axial Profile     Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)      N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                Top 25  0.144   3.567    37  0.751 0.780   3 24
Inlet Subcooling: Btu/lbm    -23.36                    24  0.334   9.851    38  0.451 0.680  47 16
Flow: Mlb/hr                  71.03 ( 92.25 %)         23  0.523  12.676    39  0.475 0.836  17 48
                                                       22  0.617  15.054    40  0.546 0.996   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50            21  0.668  16.677    41  0.897 1.250  37 14
   51          -- -- -- -- -- --            51         20  0.707  17.876    42  1.170 1.347  31 24
   47       -- -- -- -- -- -- -- -- -- --   47         19  0.739  18.543    43  1.290 1.406  27 22
   43    -- -- -- -- -- --  8 -- -- -- -- --   43      18  0.779  19.320    44  1.099 1.311  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --   39      17  0.821  19.890    45  1.149 1.344  39 22
   35 -- -- -- --  6 -- 40 --  6 -- -- -- -- 35        16  0.874  20.235
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31        15  0.947  20.471
   27 -- --  8 -- 40 --  0 -- 40 --  8 -- -- 27        14  0.997  20.569
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23        13  1.103  20.692
   19 -- -- -- --  6 -- 40 --  6 -- -- -- -- 19        12  1.171  21.426
   15    -- -- -- -- -- -- -- -- -- -- -- --   15      11  1.228  21.913
   11    -- -- -- -- -- --  8 -- -- -- -- --   11      10  1.310  21.652
    7       -- -- -- -- -- -- -- -- -- --    7          9  1.355  22.015
    3          -- -- -- -- -- --             3          8  1.400  22.218
      2  6 10 14 18 22 26 30 34 38 42 46 50             7  1.454  22.356
                                                        6  1.512  22.740*
                                                        5  1.559  22.725
                                                        4  1.574* 22.067
Control Rod Density: %         6.20                     3  1.560  20.631
                                                        2  1.279  16.032
k-effective:                1.00010             Bottom  1  0.346   4.604
Void Fraction:                0.523
Core Delta-P: psia           21.234            % AXIAL TILT -31.781 -10.671
Core Plate Delta-P: psia     16.679        AVG BOT 8ft/12ft  1.1869  1.0641
Coolant Temp: Deg-F           548.6
In Channel Flow: Mlb/hr       61.81   Active Channel Flow: Mlb/hr        59.50
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.2   (of total core flow)
Source Convergence          0.00049
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.406	43	27	22	1.500	0.920	43	21	28	10.12	0.886	31.1	42	19	26	6	12.24	0.900	5.4	43	17	28	6
1.403	43	31	26	1.503	0.918	43	19	30	10.03	0.881	31.6	42	27	20	6	12.18	0.896	5.4	43	27	36	6
1.403	43	33	24	1.511	0.913	43	27	22	9.42	0.821	30.6	42	21	24	5	10.94	0.882	35.8	42	19	28	6
1.403	43	29	20	1.516	0.910	43	29	20	9.40	0.819	30.7	42	23	22	5	11.99	0.881	5.4	43	21	28	6
1.390	43	29	24	1.524	0.905	45	39	22	9.29	0.809	30.5	42	17	30	6	11.99	0.881	5.4	43	19	30	6
1.385	43	31	22	1.529	0.903	43	23	24	9.16	0.807	31.9	42	29	18	6	10.86	0.877	36.1	42	27	20	6
1.368	43	37	24	1.533	0.900	45	31	14	9.35	0.805	29.3	41	13	38	3	11.92	0.876	5.3	43	27	22	6
1.364	43	29	16	1.535	0.899	43	21	22	9.21	0.802	30.6	41	37	14	3	11.91	0.876	5.3	43	29	20	6
1.361	43	35	26	1.557	0.886	44	35	14	9.26	0.795	29.1	42	13	34	3	11.62	0.854	5.1	44	13	36	3
1.359	43	27	18	1.558	0.886	45	39	26	9.02	0.793	31.6	42	15	28	6	11.55	0.849	5.1	43	21	22	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.5 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 1,750.0 MWd/MTU

```
Cycle:                          23                  Core Average Exposure: MWd/MTU    18758.3
Exposure: MWd/MTU (GWd)      2100.0 ( 213.24 )
Delta E: MWd/MTU, (GWd)       350.0 (  35.54 )              Axial Profile     Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)        N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                  Top 25  0.145   3.621    37  0.748 0.776   3 24
Inlet Subcooling: Btu/lbm    -23.87                      24  0.335   9.977    38  0.448 0.677  47 16
Flow: Mlb/hr                  69.68 ( 90.50 %)           23  0.524  12.875    39  0.472 0.833  17 48
                                                         22  0.616  15.288    40  0.543 0.991   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50              21  0.666  16.931    41  0.894 1.249  37 14
   51             -- -- -- -- --             51          20  0.703  18.145    42  1.168 1.342  31 24
   47       -- -- -- -- -- -- -- -- -- --       47       19  0.733  18.824    43  1.294 1.409  27 22
   43    -- -- -- -- -- --  8 -- -- -- -- --    43       18  0.771  19.615    44  1.103 1.317  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --    39       17  0.812  20.201    45  1.153 1.349  39 22
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 35       16  0.863  20.563
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31       15  0.934  20.817
   27 -- --  8 -- 40 --  0 -- 40 --  8 -- -- 27          14  0.983  20.934
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23       13  1.087  21.062
   19 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 19       12  1.155  21.819
   15    -- -- -- -- -- -- -- -- -- -- -- --    15       11  1.213  22.325
   11    -- -- -- -- -- --  8 -- -- -- -- --    11       10  1.299  22.075
    7       -- -- -- -- -- -- -- -- -- --        7        9  1.349  22.451
    3             -- -- -- -- --                 3        8  1.401  22.669
      2  6 10 14 18 22 26 30 34 38 42 46 50               7  1.463  22.827
                                                          6  1.530  23.231
                                                          5  1.584  23.232*
                                                          4  1.602* 22.579
Control Rod Density: %         6.20                       3  1.583  21.138
                                                          2  1.297  16.447
k-effective:                0.99993              Bottom  1  0.353   4.725
Void Fraction:                0.528
Core Delta-P: psia           20.699          % AXIAL TILT -32.383 -10.946
Core Plate Delta-P: psia     16.145        AVG BOT 8ft/12ft  1.1886  1.0655
Coolant Temp: Deg-F           548.6
In Channel Flow: Mlb/hr       60.60   Active Channel Flow: Mlb/hr       58.32
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.409	43	27	22	1.491	0.925	43	21	28	10.20	0.899	31.9	42	19	26	6	12.24	0.900	6.5	43	17	28	6
1.407	43	29	20	1.492	0.925	43	19	30	10.12	0.894	32.2	42	25	20	6	12.16	0.894	6.5	43	27	36	6
1.406	43	33	24	1.502	0.919	43	27	22	9.54	0.836	31.3	42	21	24	5	11.00	0.892	36.6	42	19	28	6
1.406	43	31	26	1.506	0.916	43	29	20	9.52	0.835	31.4	42	23	22	5	10.91	0.887	36.9	42	27	20	6
1.392	43	29	24	1.519	0.908	45	39	22	9.45	0.819	30.0	41	13	38	3	12.01	0.883	6.4	43	19	30	6
1.389	43	31	22	1.522	0.907	43	23	24	9.34	0.818	31.2	42	17	24	6	12.01	0.883	6.4	43	21	28	6
1.373	43	37	24	1.528	0.903	43	21	22	9.31	0.816	31.2	41	37	14	3	11.94	0.878	6.4	43	27	22	6
1.369	43	29	16	1.529	0.903	45	31	14	9.20	0.816	32.6	42	29	18	6	11.94	0.878	6.4	43	29	20	6
1.364	43	35	26	1.552	0.889	44	35	14	9.19	0.810	31.9	42	13	34	4	11.75	0.864	6.2	44	13	36	3
1.362	43	27	18	1.554	0.888	45	39	26	9.10	0.804	32.2	42	33	14	4	11.67	0.858	6.1	45	13	32	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.6 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 2,100.0 MWd/MTU

```
Cycle:                           23                     Core Average Exposure: MWd/MTU    18759.3
Exposure: MWd/MTU (GWd)      2101.0 ( 213.35 )
Delta E: MWd/MTU, (GWd)         1.0 (    0.10 )               Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                    Top 25  0.171   3.621    37  0.763 0.803   3 24
Inlet Subcooling: Btu/lbm    -23.15                        24  0.395   9.977    38  0.461 0.691  37  6
Flow: Mlb/hr                  71.61 ( 93.00 %)             23  0.619  12.875    39  0.481 0.875  17 48
                                                           22  0.728  15.289    40  0.559 0.985   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                21  0.786  16.932    41  0.917 1.232  37 14
   51           -- -- -- -- --              51             20  0.816  18.146    42  1.157 1.423  27 26
   47       -- -- -- -- -- -- -- -- -- --       47         19  0.829  18.825    43  1.240 1.471  25 26
   43    -- -- -- -- 40 -- 40 -- -- -- --    43            18  0.843  19.616    44  1.112 1.322  35 14
   39    -- -- -- -- -- -- -- -- -- -- --    39            17  0.863  20.202    45  1.167 1.393  27 14
   35 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 35            16  0.898  20.564
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31            15  0.956  20.818
   27 -- -- --  8 -- 40 -- 40 --  8 -- -- -- 27            14  0.993  20.935
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23            13  1.087  21.063
   19 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 19            12  1.146  21.820
   15    -- -- -- -- -- -- -- -- -- -- --    15            11  1.196  22.326
   11    -- -- -- -- 40 -- 40 -- -- -- --    11            10  1.274  22.076
    7       -- -- -- -- -- -- -- -- -- --        7          9  1.317  22.452
    3           -- -- -- -- --               3              8  1.360  22.671
      2  6 10 14 18 22 26 30 34 38 42 46 50                 7  1.412  22.828
                                                            6  1.465  23.232
                                                            5  1.497* 23.234*
                                                            4  1.477  22.580
Control Rod Density: %         6.57                         3  1.425  21.139
                                                            2  1.142  16.448
k-effective:                1.00019               Bottom  1  0.307   4.725
Void Fraction:                0.511
Core Delta-P: psia           21.240              % AXIAL TILT -25.600 -10.947
Core Plate Delta-P: psia     16.684          AVG BOT 8ft/12ft  1.1449  1.0655
Coolant Temp: Deg-F           548.5
In Channel Flow: Mlb/hr       62.42  Active Channel Flow: Mlb/hr        60.13
Total Bypass Flow (%):         12.8  (of total core flow)
Total Water Rod Flow (%):       3.2  (of total core flow)
Source Convergence          0.00048
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.471	43	25	26	1.449	0.952	45	27	10	9.89	0.882	33.1	42	23	28	6	12.30	0.905	4.9	43	27	28	6
1.423	43	29	24	1.465	0.942	45	27	14	9.66	0.851	31.9	42	25	28	6	12.02	0.884	6.2	43	21	28	6
1.423	42	27	26	1.476	0.935	43	25	26	9.28	0.819	32.0	42	25	30	5	10.80	0.881	37.4	42	23	28	6
1.393	45	27	14	1.487	0.928	45	31	14	8.81	0.793	34.1	42	31	12	6	10.50	0.854	37.1	42	25	28	6
1.380	42	27	24	1.499	0.920	45	29	12	9.01	0.791	31.4	42	21	24	6	11.53	0.847	6.1	43	29	30	6
1.374	43	31	26	1.528	0.903	45	33	12	8.86	0.781	31.9	42	19	26	6	11.52	0.847	5.1	45	29	12	6
1.373	43	27	22	1.565	0.882	43	29	24	8.66	0.778	34.0	42	25	12	6	11.46	0.843	5.1	45	31	10	6
1.369	45	31	14	1.570	0.879	44	35	14	9.13	0.772	27.4	42	29	10	6	10.19	0.828	37.0	42	25	30	5
1.365	43	33	24	1.572	0.878	45	31	10	8.44	0.765	34.9	42	29	14	6	11.17	0.822	3.2	45	27	10	6
1.346	45	27	10	1.583	0.872	45	35	12	8.51	0.748	31.5	42	25	16	5	11.11	0.817	6.2	43	27	22	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.7 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 2,101.0 MWd/MTU

```
Cycle:                          23                   Core Average Exposure: MWd/MTU    19158.3
Exposure: MWd/MTU (GWd)     2500.0 ( 253.86 )
Delta E: MWd/MTU, (GWd)      399.0 (  40.52 )             Axial Profile    Edit   Radial Power
Power: MWt                  2923.0 (100.00 %)        N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia         1044.7                  Top 25  0.173   3.695    37  0.760 0.797   3 24
Inlet Subcooling: Btu/lbm   -23.57                      24  0.397  10.147    38  0.457 0.687  37  6
Flow: Mlb/hr                 70.46 ( 91.50 %)           23  0.621  13.144    39  0.477 0.869  17 48
                                                        22  0.728  15.605    40  0.555 0.981   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50             21  0.784  17.273    41  0.913 1.231  37 14
   51             -- -- -- -- -- --          51         20  0.811  18.499    42  1.155 1.411  27 26
   47       -- -- -- -- -- -- -- -- -- --    47         19  0.823  19.184    43  1.245 1.469  25 26
   43    -- -- -- -- 40 -- 40 -- -- -- --    43         18  0.834  19.980    44  1.117 1.330  35 14
   39    -- -- -- -- -- -- -- -- -- -- --    39         17  0.852  20.575    45  1.173 1.398  27 14
   35 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 35         16  0.885  20.948
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31         15  0.940  21.216
   27 -- -- --  8 -- 40 -- 40 --  8 -- -- -- 27         14  0.976  21.348
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23         13  1.069  21.478
   19 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 19         12  1.128  22.258
   15    -- -- -- -- -- -- -- -- -- -- --    15         11  1.180  22.783
   11    -- -- -- -- 40 -- 40 -- -- -- --    11         10  1.261  22.544
    7       -- -- -- -- -- -- -- -- -- --     7          9  1.311  22.936
    3             -- -- -- -- -- --           3          8  1.362  23.171
      2  6 10 14 18 22 26 30 34 38 42 46 50              7  1.422  23.350
                                                         6  1.485  23.775
                                                         5  1.525* 23.790*
                                                         4  1.509  23.130
Control Rod Density: %        6.57                       3  1.450  21.668
                                                         2  1.161  16.871
k-effective:               1.00009              Bottom  1  0.314   4.848
Void Fraction:               0.515
Core Delta-P: psia          20.791               % AXIAL TILT -26.257 -11.117
Core Plate Delta-P: psia    16.235           AVG BOT 8ft/12ft  1.1465  1.0662
Coolant Temp: Deg-F          548.5
In Channel Flow: Mlb/hr      61.38   Active Channel Flow: Mlb/hr        59.11
Total Bypass Flow (%):        12.9   (of total core flow)
Total Water Rod Flow (%):      3.2   (of total core flow)
Source Convergence         0.00048
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.469	43	25	26	1.451	0.951	45	27	10	9.86	0.886	33.9	42	23	28	6	12.16	0.894	6.1	43	27	28	6
1.425	43	29	24	1.465	0.942	45	27	14	9.62	0.854	32.7	42	25	28	6	10.74	0.882	38.3	42	23	28	6
1.411	42	27	26	1.478	0.933	43	27	28	9.30	0.826	32.8	42	25	30	5	11.95	0.879	7.4	43	21	28	6
1.398	45	27	14	1.487	0.928	45	31	14	8.91	0.807	34.8	42	31	12	6	10.43	0.855	37.9	42	25	28	6
1.376	43	31	26	1.502	0.919	45	29	12	9.06	0.799	32.0	42	21	24	5	11.63	0.855	5.8	45	29	12	6
1.376	43	27	22	1.527	0.904	45	33	12	8.74	0.791	34.7	42	25	12	6	11.57	0.851	6.3	45	31	10	6
1.374	45	31	14	1.559	0.885	43	29	24	8.94	0.791	32.3	42	19	26	5	11.49	0.845	7.2	43	29	30	6
1.371	42	27	24	1.568	0.880	44	35	14	9.22	0.786	28.1	42	29	10	6	10.17	0.833	37.8	42	25	30	5
1.370	43	33	24	1.573	0.878	45	31	10	8.52	0.778	35.6	42	29	14	6	11.26	0.828	4.3	45	27	10	6
1.351	45	27	10	1.581	0.873	45	35	12	8.54	0.764	33.5	42	33	14	5	11.12	0.817	6.9	45	25	14	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.8 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 2,500.0 MWd/MTU

```
Cycle:                            23                    Core Average Exposure: MWd/MTU    19658.3
Exposure: MWd/MTU (GWd)       3000.0 ( 304.63 )
Delta E: MWd/MTU, (GWd)        500.0 (  50.77 )               Axial Profile     Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                    Top 25  0.174   3.788    37  0.755 0.791   3 24
Inlet Subcooling: Btu/lbm     -24.02                        24  0.398  10.362    38  0.452 0.683  37  6
Flow: Mlb/hr                   69.30 ( 90.00 %)             23  0.622  13.481    39  0.473 0.864  17 48
                                                            22  0.727  16.000    40  0.550 0.975   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50               21  0.780  17.699    41  0.908 1.230  37 14
   51             -- -- -- -- -- --           51            20  0.804  18.939    42  1.151 1.397  27 26
   47       -- -- -- -- -- -- -- -- -- --        47         19  0.813  19.629    43  1.249 1.467  25 26
   43    -- -- -- -- 40 -- 40 -- -- -- --    43             18  0.822  20.431    44  1.122 1.338  35 14
   39    -- -- -- -- -- -- -- -- -- -- -- --    39          17  0.839  21.035    45  1.180 1.404  27 14
   35 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 35             16  0.869  21.421
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31             15  0.922  21.706
   27 -- -- --  8 -- 40 -- 40 --  8 -- -- -- 27             14  0.956  21.856
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23             13  1.048  21.989
   19 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 19             12  1.108  22.797
   15    -- -- -- -- -- -- -- -- -- -- -- --    15          11  1.162  23.348
   11    -- -- -- -- 40 -- 40 -- -- -- --    11             10  1.247  23.124
    7       -- -- -- -- -- -- -- -- -- --        7           9  1.306  23.539
    3             -- -- -- -- -- --            3             8  1.366  23.800
       2  6 10 14 18 22 26 30 34 38 42 46 50                 7  1.437  24.008
                                                             6  1.511  24.466
                                                             5  1.559* 24.500*
                                                             4  1.545  23.834
Control Rod Density: %          6.57                         3  1.478  22.343
                                                             2  1.182  17.411
k-effective:                 0.99991                Bottom   1  0.321   5.006
Void Fraction:                 0.519
Core Delta-P: psia            20.352                 % AXIAL TILT -27.120 -11.340
Core Plate Delta-P: psia      15.798             AVG BOT 8ft/12ft  1.1491  1.0671
Coolant Temp: Deg-F            548.5
In Channel Flow: Mlb/hr        60.33   Active Channel Flow: Mlb/hr       58.09
Total Bypass Flow (%):          12.9   (of total core flow)
Total Water Rod Flow (%):        3.2   (of total core flow)
Source Convergence           0.00038
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.467	43	25	26	1.457	0.947	45	27	10	9.82	0.890	35.0	42	23	28	6	12.03	0.884	7.6	43	27	28	6
1.425	43	29	24	1.467	0.940	45	27	14	9.56	0.857	33.7	42	25	28	6	10.65	0.883	39.4	42	23	28	6
1.404	45	27	14	1.484	0.930	43	27	28	9.31	0.835	33.8	42	25	30	5	11.85	0.871	8.9	43	21	28	6
1.397	42	27	26	1.488	0.927	45	31	14	9.03	0.825	35.8	42	31	12	6	11.77	0.865	7.3	45	29	12	6
1.382	45	31	14	1.506	0.916	45	29	12	9.11	0.811	33.0	42	21	24	5	11.68	0.859	7.8	45	31	10	6
1.378	43	27	22	1.526	0.904	45	33	12	8.85	0.807	35.6	42	25	12	6	10.35	0.856	39.0	42	25	28	6
1.377	43	31	26	1.555	0.887	43	29	24	9.36	0.804	29.1	42	29	10	6	11.42	0.840	8.7	43	29	30	6
1.374	43	33	24	1.565	0.882	44	35	14	9.00	0.803	33.2	42	19	26	5	11.40	0.838	5.8	45	27	10	6
1.360	42	27	24	1.574	0.877	45	31	10	8.62	0.793	36.5	42	29	14	6	10.15	0.838	38.9	42	25	30	5
1.358	45	27	10	1.578	0.874	45	35	12	8.68	0.783	34.5	42	33	14	5	11.19	0.823	8.2	45	25	14	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.9 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 3,000.0 MWd/MTU

```
Cycle:                          23                    Core Average Exposure: MWd/MTU    20158.2
Exposure: MWd/MTU (GWd)      3500.0 ( 355.41 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )            Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)         N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia          1044.7                   Top 25  0.175   3.881    37  0.751 0.785   3 24
Inlet Subcooling: Btu/lbm    -24.47                       24  0.401  10.577    38  0.448 0.679  37  6
Flow: Mlb/hr                  68.14 ( 88.50 %)            23  0.625  13.820    39  0.470 0.859  17 48
                                                          22  0.728  16.395    40  0.545 0.969   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50               21  0.778  18.123    41  0.903 1.228  37 14
   51             -- -- -- -- -- --            51         20  0.800  19.375    42  1.147 1.383  27 26
   47       -- -- -- -- -- -- -- -- -- -- --   47         19  0.807  20.070    43  1.254 1.464  25 26
   43    -- -- -- -- 40 -- 40 -- -- -- -- --   43         18  0.814  20.877    44  1.128 1.346  35 14
   39    -- -- -- -- -- -- -- -- -- -- -- --   39         17  0.828  21.489    45  1.187 1.409  27 14
   35 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 35           16  0.856  21.886
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31           15  0.907  22.187
   27 -- -- --  8 -- 40 -- 40 --  8 -- -- -- 27           14  0.940  22.354
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23           13  1.031  22.491
   19 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 19           12  1.092  23.328
   15    -- -- -- -- -- -- -- -- -- -- -- --   15         11  1.148  23.905
   11    -- -- -- -- 40 -- 40 -- -- -- -- --   11         10  1.236  23.699
    7       -- -- -- -- -- -- -- -- -- -- --    7          9  1.303  24.140
    3             -- -- -- -- -- --             3          8  1.370  24.431
      2  6 10 14 18 22 26 30 34 38 42 46 50                7  1.448  24.673
                                                           6  1.531  25.167
                                                           5  1.585* 25.225*
                                                           4  1.573  24.553
Control Rod Density: %         6.57                        3  1.500  23.029
                                                           2  1.198  17.959
k-effective:                0.99967               Bottom  1  0.328   5.166
Void Fraction:                0.523
Core Delta-P: psia           19.908              % AXIAL TILT -27.758 -11.571
Core Plate Delta-P: psia     15.355          AVG BOT 8ft/12ft  1.1508  1.0681
Coolant Temp: Deg-F           548.5
In Channel Flow: Mlb/hr       59.29   Active Channel Flow: Mlb/hr        57.07
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00039
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.464	43	25	26	1.456	0.948	45	27	10	9.74	0.892	36.0	42	23	28	6	10.52	0.881	40.5	42	23	28	6
1.425	43	29	24	1.468	0.940	45	27	14	9.48	0.857	34.7	42	25	28	6	11.87	0.873	9.1	43	27	28	5
1.409	45	27	14	1.480	0.932	43	27	28	9.10	0.839	36.7	42	31	12	6	11.84	0.870	8.8	45	29	12	6
1.388	45	31	14	1.489	0.927	45	31	14	9.27	0.839	34.8	42	25	30	5	11.73	0.863	9.2	45	31	10	6
1.383	42	27	26	1.509	0.914	45	29	12	8.93	0.822	36.5	42	25	12	6	11.69	0.860	10.4	43	21	28	6
1.380	43	27	22	1.525	0.905	45	33	12	9.45	0.820	30.1	42	29	10	6	10.24	0.855	40.1	42	25	28	6
1.379	43	31	26	1.549	0.891	43	29	24	9.12	0.819	33.9	42	21	24	5	11.50	0.846	5.6	45	27	10	5
1.378	43	33	24	1.554	0.888	44	35	14	9.02	0.812	34.2	42	19	26	5	10.07	0.839	39.9	42	25	30	5
1.367	45	27	10	1.574	0.877	45	31	10	8.67	0.805	37.4	42	29	14	6	10.04	0.833	39.5	42	31	12	6
1.360	45	33	12	1.576	0.876	45	35	12	8.76	0.798	35.4	42	33	14	5	11.30	0.831	10.1	43	29	30	6

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.10 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 3,500.0 MWd/MTU

```
Cycle:                          23                  Core Average Exposure: MWd/MTU    20658.3
Exposure: MWd/MTU (GWd)      4000.0 ( 406.18 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )          Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)      N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                 Top 25  0.177   3.976    37  0.747 0.780   3 24
Inlet Subcooling: Btu/lbm    -24.78                     24  0.403  10.793    38  0.445 0.676  37  6
Flow: Mlb/hr                  67.38 ( 87.50 %)          23  0.628  14.160    39  0.466 0.854  17 48
                                                        22  0.730  16.791    40  0.541 0.964   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50             21  0.778  18.546    41  0.899 1.227  37 14
   51             -- -- -- -- -- --           51        20  0.797  19.810    42  1.144 1.370  27 26
   47       -- -- -- -- -- -- -- -- -- -- --     47     19  0.803  20.508    43  1.258 1.462  25 26
   43    -- -- -- -- 40 -- 40 -- -- -- -- --    43      18  0.808  21.318    44  1.134 1.352  35 14
   39    -- -- -- -- -- -- -- -- -- -- -- --    39      17  0.821  21.938    45  1.193 1.414  27 14
   35 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 35         16  0.847  22.345
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31         15  0.896  22.661
   27 -- -- --  8 -- 40 -- 40 --  8 -- -- -- 27         14  0.929  22.846
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23         13  1.020  22.986
   19 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 19         12  1.081  23.852
   15    -- -- -- -- -- -- -- -- -- -- -- --    15      11  1.139  24.457
   11    -- -- -- -- 40 -- 40 -- -- -- -- --    11      10  1.229  24.270
    7       -- -- -- -- -- -- -- -- -- -- --     7       9  1.301  24.741
    3             -- -- -- -- -- --            3         8  1.374  25.063
      2  6 10 14 18 22 26 30 34 38 42 46 50              7  1.457  25.343
                                                         6  1.545  25.876
                                                         5  1.601* 25.960*
                                                         4  1.589  25.282
Control Rod Density: %         6.57                      3  1.511  23.723
                                                         2  1.204  18.512
k-effective:                0.99949             Bottom  1  0.331   5.330
Void Fraction:                0.526
Core Delta-P: psia           19.610          % AXIAL TILT -28.128 -11.804
Core Plate Delta-P: psia     15.057       AVG BOT 8ft/12ft  1.1514  1.0690
Coolant Temp: Deg-F           548.4
In Channel Flow: Mlb/hr       58.60   Active Channel Flow: Mlb/hr        56.40
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00029
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.462	43	25	26	1.456	0.948	45	27	10	9.64	0.891	37.0	42	23	28	6	10.38	0.877	41.6	42	23	28	6
1.426	43	29	24	1.471	0.938	45	27	14	9.40	0.857	35.5	42	25	28	5	11.86	0.872	10.3	45	29	12	6
1.414	45	27	14	1.480	0.933	43	27	28	9.13	0.850	37.7	42	31	12	6	11.70	0.861	10.7	45	31	10	6
1.393	45	31	14	1.492	0.925	45	31	14	9.20	0.841	35.7	42	25	30	5	11.68	0.859	10.6	43	27	28	5
1.382	43	33	24	1.515	0.911	45	29	12	8.97	0.833	37.5	42	25	12	6	10.12	0.852	41.2	42	25	28	6
1.381	43	27	22	1.526	0.904	45	33	12	9.50	0.831	31.1	42	29	10	6	11.56	0.850	7.1	45	27	10	5
1.381	43	31	26	1.546	0.893	43	29	24	9.10	0.824	34.9	42	21	24	5	11.55	0.849	11.3	43	21	26	6
1.374	45	27	10	1.547	0.892	44	35	14	9.00	0.817	35.1	42	19	26	5	10.06	0.842	40.5	42	31	12	6
1.370	42	27	26	1.575	0.876	45	31	10	8.69	0.814	38.3	42	29	14	6	9.96	0.837	41.0	42	25	30	5
1.367	45	33	12	1.575	0.876	45	35	12	8.80	0.808	36.3	42	33	14	5	10.60	0.832	32.6	42	29	10	6

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.11 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 4,000.0 MWd/MTU

```
Cycle:                          23                  Core Average Exposure: MWd/MTU    21058.3
Exposure: MWd/MTU (GWd)      4400.0 ( 446.80 )
Delta E: MWd/MTU, (GWd)       400.0 (  40.62 )            Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)       N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia          1044.7                 Top 25  0.179   4.052    37  0.744 0.776   3 24
Inlet Subcooling: Btu/lbm    -24.79                     24  0.407  10.967    38  0.441 0.673  37  6
Flow: Mlb/hr                  67.38 ( 87.50 %)          23  0.634  14.433    39  0.463 0.850  17 48
                                                        22  0.736  17.109    40  0.537 0.960   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50             21  0.782  18.886    41  0.896 1.226  37 14
   51             -- -- -- -- -- --            51       20  0.800  20.158    42  1.142 1.362  27 26
   47       -- -- -- -- -- -- -- -- -- -- --   47       19  0.803  20.858    43  1.262 1.461  25 26
   43    -- -- -- -- 40 -- 40 -- -- -- -- --   43       18  0.807  21.670    44  1.137 1.357  35 14
   39    -- -- -- -- -- -- -- -- -- -- -- --   39       17  0.819  22.295    45  1.198 1.417  27 14
   35 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 35        16  0.844  22.710
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31        15  0.891  23.037
   27 -- -- --  8 -- 40 -- 40 --  8 -- -- -- 27        14  0.923  23.236
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23        13  1.013  23.378
   19 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 19        12  1.075  24.268
   15    -- -- -- -- -- -- -- -- -- -- -- --   15       11  1.134  24.895
   11    -- -- -- -- 40 -- 40 -- -- -- -- --   11       10  1.225  24.724
    7       -- -- -- -- -- -- -- -- -- -- --    7        9  1.300  25.220
    3             -- -- -- -- -- --             3        8  1.375  25.570
      2  6 10 14 18 22 26 30 34 38 42 46 50              7  1.460  25.881
                                                         6  1.549  26.446
                                                         5  1.606* 26.551*
                                                         4  1.593  25.869
Control Rod Density: %         6.57                      3  1.511  24.280
                                                         2  1.202  18.955
k-effective:                0.99949              Bottom  1  0.331   5.461
Void Fraction:                0.525
Core Delta-P: psia           19.608             % AXIAL TILT -28.088 -11.986
Core Plate Delta-P: psia     15.056         AVG BOT 8ft/12ft  1.1503  1.0697
Coolant Temp: Deg-F           548.4
In Channel Flow: Mlb/hr       58.60   Active Channel Flow: Mlb/hr       56.40
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00028
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.461	43	25	26	1.462	0.944	45	27	10	9.55	0.890	37.8	42	23	28	6	10.26	0.873	42.5	42	23	28	6
1.427	43	29	24	1.480	0.933	45	27	14	9.13	0.856	38.5	42	31	12	6	11.83	0.870	11.5	45	29	12	6
1.417	45	27	14	1.485	0.929	43	27	28	9.31	0.855	36.3	42	25	28	5	11.63	0.855	11.8	45	31	10	6
1.397	45	31	14	1.500	0.920	45	31	14	9.13	0.840	36.5	42	25	30	5	10.01	0.849	42.0	42	25	28	6
1.386	43	33	24	1.524	0.905	45	29	12	8.97	0.839	38.2	42	25	12	6	11.53	0.848	8.2	45	27	10	5
1.384	43	27	22	1.533	0.900	45	33	12	9.50	0.838	31.9	42	29	10	6	10.05	0.847	41.4	42	31	12	6
1.383	43	31	26	1.547	0.892	44	35	14	9.05	0.826	35.7	42	21	24	5	11.51	0.846	11.8	43	27	28	5
1.380	45	27	10	1.548	0.891	43	29	24	8.96	0.820	35.9	42	19	26	5	11.45	0.842	12.5	43	21	26	6
1.372	45	33	12	1.580	0.873	45	31	10	8.68	0.819	39.1	42	29	14	6	10.52	0.837	34.2	42	29	10	6
1.369	45	29	12	1.580	0.873	45	35	12	8.80	0.814	37.0	42	33	14	5	9.85	0.834	41.8	42	25	30	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.12 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 4,400.0 MWd/MTU

```
Cycle:                              23               Core Average Exposure: MWd/MTU    21458.3
Exposure: MWd/MTU (GWd)         4800.0 ( 487.42 )
Delta E: MWd/MTU, (GWd)          400.0 (  40.62 )          Axial Profile    Edit   Radial Power
Power: MWt                      2923.0 (100.00 %)      N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia             1044.7                Top 25  0.181   4.129    37  0.741 0.771   3 24
Inlet Subcooling: Btu/lbm       -24.79                    24  0.411  11.143    38  0.438 0.670  37  6
Flow: Mlb/hr                     67.38 ( 87.50 %)         23  0.640  14.710    39  0.460 0.846  17 48
                                                          22  0.742  17.430    40  0.534 0.956   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50              21  0.787  19.228    41  0.893 1.225  37 14
   51             -- -- -- -- --             51           20  0.803  20.507    42  1.140 1.354  27 26
   47       -- -- -- -- -- -- -- -- --       47           19  0.806  21.208    43  1.266 1.461  25 26
   43    -- -- -- -- 40 -- 40 -- -- -- --    43           18  0.808  22.022    44  1.141 1.362  35 14
   39    -- -- -- -- -- -- -- -- -- -- --    39           17  0.818  22.651    45  1.202 1.420  27 14
   35 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 35           16  0.842  23.074
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31           15  0.888  23.411
   27 -- -- --  8 -- 40 -- 40 --  8 -- -- -- 27           14  0.920  23.624
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23           13  1.009  23.768
   19 -- -- -- 12 --  8 --  8 -- 12 -- -- -- 19           12  1.071  24.682
   15    -- -- -- -- -- -- -- -- -- -- --    15           11  1.130  25.332
   11    -- -- -- -- 40 -- 40 -- -- -- --    11           10  1.222  25.177
    7       -- -- -- -- -- -- -- -- --        7            9  1.299  25.699
    3             -- -- -- -- --              3            8  1.375  26.078
       2  6 10 14 18 22 26 30 34 38 42 46 50               7  1.461  26.420
                                                           6  1.551  27.018
                                                           5  1.607* 27.143*
                                                           4  1.593  26.456
Control Rod Density: %            6.57                     3  1.508  24.836
                                                           2  1.197  19.397
k-effective:                   0.99946             Bottom  1  0.331   5.592
Void Fraction:                   0.524
Core Delta-P: psia              19.602            % AXIAL TILT -27.915 -12.159
Core Plate Delta-P: psia        15.049          AVG BOT 8ft/12ft  1.1485  1.0703
Coolant Temp: Deg-F              548.4
In Channel Flow: Mlb/hr          58.61   Active Channel Flow: Mlb/hr        56.41
Total Bypass Flow (%):            13.0   (of total core flow)
Total Water Rod Flow (%):          3.3   (of total core flow)
Source Convergence             0.00030
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.461	43	25	26	1.468	0.940	45	27	10	9.46	0.888	38.6	42	23	28	6	10.13	0.869	43.3	42	23	28	6
1.429	43	29	24	1.488	0.927	45	27	14	9.10	0.860	39.2	42	31	12	6	11.77	0.865	12.7	45	29	12	6
1.420	45	27	14	1.489	0.927	43	27	28	9.21	0.852	37.1	42	25	28	5	10.01	0.850	42.2	42	31	12	6
1.400	45	31	14	1.507	0.916	45	31	14	8.94	0.843	39.0	42	25	12	6	11.54	0.849	13.0	45	31	10	6
1.390	43	33	24	1.533	0.900	45	29	12	9.48	0.842	32.7	42	29	10	6	9.89	0.845	42.9	42	25	28	6
1.387	43	31	26	1.539	0.897	45	33	12	9.05	0.838	37.3	42	25	30	5	11.46	0.843	9.4	45	27	10	5
1.386	43	27	22	1.546	0.893	44	35	14	9.00	0.827	36.4	42	21	24	5	10.49	0.840	35.1	42	29	10	6
1.384	45	27	10	1.549	0.891	43	29	24	8.66	0.822	39.8	42	29	14	6	11.36	0.835	13.6	43	21	26	6
1.376	45	33	12	1.585	0.871	45	35	12	8.92	0.822	36.6	42	19	26	5	11.33	0.833	12.9	43	27	28	5
1.373	45	29	12	1.585	0.870	45	31	10	8.78	0.818	37.8	42	33	14	5	9.73	0.830	42.6	42	25	30	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.13 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 4,800.0 MWd/MTU

```
Cycle:                          23                Core Average Exposure: MWd/MTU    21459.3
Exposure: MWd/MTU (GWd)      4801.0 ( 487.52 )
Delta E: MWd/MTU, (GWd)         1.0 (   0.10 )        Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)     N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7               Top 25  0.162   4.129    37  0.742 0.775   3 24
Inlet Subcooling: Btu/lbm    -23.87                   24  0.368  11.144    38  0.434 0.662  47 16
Flow: Mlb/hr                  69.68 ( 90.50 %)        23  0.572  14.711    39  0.454 0.815  17 48
                                                      22  0.662  17.431    40  0.527 0.966   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50           21  0.700  19.228    41  0.891 1.232  39 38
   51            -- -- -- -- -- --           51       20  0.735  20.507    42  1.139 1.346  27 26
   47      -- -- -- -- -- -- -- -- -- --     47       19  0.760  21.209    43  1.297 1.465  25 26
   43   -- -- -- -- -- -- -- -- -- -- -- --  43       18  0.790  22.023    44  1.161 1.352  39 36
   39   -- -- 42 --  6 --  6 -- 42 -- --     39       17  0.819  22.652    45  1.175 1.302  41 18
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35       16  0.854  23.075
   31 -- -- --  0 -- 20 -- 40 --  6 -- -- -- 31       15  0.904  23.412
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27       14  0.932  23.625
   23 -- -- --  6 -- 40 -- 20 --  6 -- -- -- 23       13  1.020  23.769
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19       12  1.080  24.683
   15   -- -- 42 --  6 --  6 -- 42 -- --     15       11  1.140  25.333
   11   -- -- -- -- -- -- -- -- -- -- -- --  11       10  1.233  25.178
    7      -- -- -- -- -- -- -- -- -- --      7        9  1.312  25.701
    3            -- -- -- -- -- --            3        8  1.392  26.079
      2  6 10 14 18 22 26 30 34 38 42 46 50            7  1.484  26.421
                                                       6  1.583  27.020
                                                       5  1.656  27.145*
                                                       4  1.666* 26.458
Control Rod Density: %         6.66                    3  1.576  24.837
                                                       2  1.254  19.398
k-effective:                0.99967             Bottom 1  0.347   5.592
Void Fraction:                0.526
Core Delta-P: psia           20.671           % AXIAL TILT -31.128 -12.159
Core Plate Delta-P: psia     16.115         AVG BOT 8ft/12ft  1.1735  1.0703
Coolant Temp: Deg-F           548.5
In Channel Flow: Mlb/hr       60.61  Active Channel Flow: Mlb/hr        58.34
Total Bypass Flow (%):         13.0  (of total core flow)
Total Water Rod Flow (%):       3.3  (of total core flow)
Source Convergence          0.00045
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.465	43	25	26	1.483	0.931	43	27	28	9.50	0.896	39.0	41	13	16	5	11.98	0.881	12.7	44	39	40	5
1.445	43	25	22	1.518	0.909	44	39	36	9.51	0.894	38.7	41	37	40	5	10.65	0.880	39.0	42	21	24	6
1.444	43	31	28	1.535	0.899	43	25	22	9.67	0.889	36.4	42	23	22	6	10.66	0.880	38.8	42	23	22	6
1.429	43	23	20	1.539	0.897	43	23	20	9.65	0.889	36.5	42	21	24	6	11.93	0.877	10.1	44	39	36	5
1.424	43	33	30	1.540	0.896	43	31	28	9.48	0.854	34.3	42	37	36	5	10.08	0.874	44.7	41	13	16	5
1.422	43	19	20	1.562	0.883	43	29	30	9.39	0.852	35.1	42	21	20	5	10.05	0.869	44.3	41	37	14	5
1.420	43	23	24	1.577	0.875	43	19	24	9.34	0.852	35.6	42	19	22	5	11.77	0.865	11.5	43	37	38	5
1.403	43	21	22	1.578	0.875	44	35	40	9.33	0.852	35.7	42	17	16	5	11.65	0.856	10.6	43	15	20	4
1.401	43	35	36	1.586	0.870	43	19	20	9.35	0.845	34.6	42	17	20	4	11.61	0.854	13.2	43	21	22	6
1.354	43	35	28	1.596	0.865	43	35	36	9.32	0.842	34.6	42	19	18	4	11.60	0.853	10.6	43	35	36	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.14 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 4,801.0 MWd/MTU

```
Cycle:                          23                    Core Average Exposure: MWd/MTU    21908.3
Exposure: MWd/MTU (GWd)      5250.0 ( 533.11 )
Delta E: MWd/MTU, (GWd)       449.0 (  45.59 )              Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)        N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                  Top 25  0.164   4.208    37  0.739 0.770   3 24
Inlet Subcooling: Btu/lbm    -23.87                      24  0.372  11.323    38  0.431 0.659  47 16
Flow: Mlb/hr                  69.68 ( 90.50 %)           23  0.579  14.991    39  0.451 0.811  17 48
                                                         22  0.670  17.755    40  0.524 0.960   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50              21  0.706  19.572    41  0.887 1.229  39 38
   51             -- -- -- -- -- --         51           20  0.740  20.868    42  1.137 1.340  27 26
   47       -- -- -- -- -- -- -- -- -- --      47        19  0.763  21.581    43  1.302 1.467  25 26
   43    -- -- -- -- -- -- -- -- -- -- -- --    43       18  0.793  22.410    44  1.164 1.356  39 36
   39    -- -- 42 --  6 --  6 -- 42 -- --    39          17  0.820  23.053    45  1.180 1.307  41 18
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35          16  0.854  23.488
   31 -- -- --  0 -- 20 -- 40 --  6 -- -- -- 31          15  0.904  23.839
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27          14  0.930  24.065
   23 -- -- --  6 -- 40 -- 20 --  6 -- -- -- 23          13  1.018  24.211
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19          12  1.078  25.151
   15    -- -- 42 --  6 --  6 -- 42 -- --    15          11  1.137  25.826
   11    -- -- -- -- -- -- -- -- -- -- -- --    11       10  1.230  25.690
    7       -- -- -- -- -- -- -- -- -- --       7         9  1.310  26.243
    3             -- -- -- -- -- --             3         8  1.391  26.655
      2  6 10 14 18 22 26 30 34 38 42 46 50               7  1.483  27.035
                                                          6  1.582  27.675
                                                          5  1.653  27.830*
                                                          4  1.662* 27.147
Control Rod Density: %         6.66                       3  1.569  25.488
                                                          2  1.246  19.915
k-effective:                0.99957              Bottom  1  0.346   5.747
Void Fraction:                0.525
Core Delta-P: psia           20.659            % AXIAL TILT -30.824 -12.409
Core Plate Delta-P: psia     16.103        AVG BOT 8ft/12ft  1.1713  1.0715
Coolant Temp: Deg-F           548.5
In Channel Flow: Mlb/hr       60.62   Active Channel Flow: Mlb/hr        58.35
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.467	43	25	26	1.485	0.929	43	27	28	9.44	0.897	39.8	41	13	16	5	10.56	0.880	40.0	42	21	24	6
1.450	43	25	22	1.534	0.899	43	25	22	9.45	0.896	39.6	41	37	40	5	10.57	0.879	39.8	42	23	22	6
1.450	43	31	28	1.536	0.899	44	39	36	9.58	0.890	37.4	42	21	24	6	9.98	0.873	45.6	41	13	16	5
1.433	43	23	20	1.539	0.897	43	31	28	9.59	0.889	37.3	42	23	22	6	11.85	0.871	13.7	44	39	40	5
1.430	43	33	30	1.540	0.896	43	23	20	9.41	0.856	35.2	42	37	36	5	11.84	0.871	11.5	44	39	36	5
1.426	43	19	20	1.561	0.884	43	29	30	9.28	0.854	36.6	42	17	16	5	9.96	0.868	45.2	41	37	14	5
1.425	43	23	24	1.578	0.875	43	19	24	9.27	0.854	36.5	42	19	22	5	11.62	0.855	12.8	43	37	38	5
1.409	43	21	22	1.584	0.871	44	35	14	9.31	0.853	36.0	42	21	20	5	10.04	0.851	42.0	42	35	38	5
1.405	43	35	36	1.600	0.862	43	19	20	9.28	0.846	35.5	42	17	20	4	10.06	0.848	41.3	42	37	36	5
1.360	43	35	28	1.607	0.859	43	21	22	9.25	0.843	35.5	42	19	18	4	11.50	0.846	14.3	44	35	40	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.15 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 5,250.0 MWd/MTU

```
Cycle:                           23              Core Average Exposure: MWd/MTU    22358.3
Exposure: MWd/MTU (GWd)      5700.0 ( 578.81 )
Delta E: MWd/MTU, (GWd)       450.0 (  45.70 )          Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)       N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                 Top 25  0.166   4.287    37  0.735 0.765   3 24
Inlet Subcooling: Btu/lbm    -23.79                     24  0.375  11.504    38  0.427 0.655  47 16
Flow: Mlb/hr                  69.88 ( 90.75 %)          23  0.584  15.275    39  0.448 0.807  17 48
                                                        22  0.675  18.084    40  0.519 0.955   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50              21  0.710  19.919    41  0.883 1.227  39 38
 51             -- -- -- -- --             51           20  0.743  21.231    42  1.135 1.333  27 26
 47       -- -- -- -- -- -- -- -- --       47           19  0.766  21.956    43  1.307 1.469  25 26
 43    -- -- -- -- -- -- -- -- -- -- --    43           18  0.795  22.799    44  1.168 1.360  39 36
 39    -- -- 42 --  6 --  6 -- 42 -- --    39           17  0.822  23.455    45  1.184 1.312  41 18
 35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35           16  0.855  23.903
 31 -- -- --  0 -- 20 -- 40 --  6 -- -- -- 31           15  0.904  24.267
 27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27           14  0.930  24.505
 23 -- -- --  6 -- 40 -- 20 --  6 -- -- -- 23           13  1.018  24.653
 19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19           12  1.078  25.619
 15    -- -- 42 --  6 --  6 -- 42 -- --    15           11  1.137  26.320
 11    -- -- -- -- -- -- -- -- -- -- --    11           10  1.229  26.202
  7       -- -- -- -- -- -- -- -- --        7            9  1.309  26.787
  3             -- -- -- -- --              3            8  1.390  27.232
     2  6 10 14 18 22 26 30 34 38 42 46 50               7  1.482  27.650
                                                         6  1.581  28.331
                                                         5  1.651  28.516*
                                                         4  1.658* 27.835
Control Rod Density: %         6.66                      3  1.563  26.138
                                                         2  1.238  20.430
k-effective:                0.99957              Bottom  1  0.344   5.901
Void Fraction:                0.523
Core Delta-P: psia           20.728           % AXIAL TILT -30.589 -12.643
Core Plate Delta-P: psia     16.173        AVG BOT 8ft/12ft  1.1696  1.0725
Coolant Temp: Deg-F           548.5
In Channel Flow: Mlb/hr       60.80   Active Channel Flow: Mlb/hr        58.52
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00023
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.469	43	25	26	1.490	0.926	43	27	28	9.39	0.901	40.7	41	13	16	5	10.49	0.882	41.0	42	21	24	6
1.455	43	25	22	1.536	0.898	43	25	22	9.40	0.900	40.5	41	37	40	5	10.49	0.880	40.8	42	23	22	6
1.455	43	31	28	1.541	0.896	43	31	28	9.52	0.892	38.3	42	21	24	6	9.90	0.873	46.6	41	13	16	5
1.437	43	23	20	1.546	0.893	44	39	36	9.52	0.891	38.2	42	23	22	6	9.88	0.868	46.2	41	37	14	5
1.436	43	33	30	1.549	0.891	43	23	20	9.37	0.859	36.1	42	37	36	5	11.78	0.866	15.1	44	39	40	5
1.431	43	19	20	1.561	0.884	43	29	30	9.24	0.858	37.4	42	17	16	5	11.76	0.864	12.9	44	39	36	5
1.430	43	23	24	1.578	0.875	43	33	30	9.23	0.857	37.4	42	19	22	5	9.99	0.854	42.9	42	35	38	5
1.415	43	21	22	1.590	0.868	44	35	14	9.26	0.855	36.9	42	21	20	5	10.01	0.850	42.3	42	37	36	5
1.410	43	35	36	1.601	0.862	43	19	20	9.23	0.848	36.4	42	17	20	4	11.52	0.847	14.3	43	37	38	5
1.366	43	35	28	1.606	0.859	43	21	22	9.20	0.845	36.4	42	19	18	4	9.82	0.845	43.7	42	19	22	6

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.16 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 5,700.0 MWd/MTU

```
Cycle:                          23                Core Average Exposure: MWd/MTU    22858.3
Exposure: MWd/MTU (GWd)      6200.0 ( 629.58 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )           Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)       N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                 Top 25  0.168   4.377    37  0.731 0.759   3 24
Inlet Subcooling: Btu/lbm    -23.72                     24  0.380  11.707    38  0.423 0.651  47 16
Flow: Mlb/hr                  70.07 ( 91.00 %)          23  0.593  15.595    39  0.444 0.803  17 48
                                                        22  0.684  18.452    40  0.515 0.949   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50              21  0.718  20.307    41  0.879 1.224  39 38
  51             -- -- -- -- -- --            51        20  0.750  21.637    42  1.133 1.326  27 26
  47       -- -- -- -- -- -- -- -- -- -- --       47    19  0.771  22.374    43  1.313 1.472  25 26
  43    -- -- -- -- -- -- -- -- -- -- -- -- --    43    18  0.799  23.232    44  1.171 1.365  39 36
  39    -- -- 42 --  6 --  6 -- 42 -- --          39    17  0.825  23.904    45  1.188 1.317  41 18
  35 -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- 35    16  0.856  24.364
  31 -- -- --  0 -- 20 -- 40 --  6 -- -- -- -- 31       15  0.904  24.742
  27 -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- 27    14  0.929  24.994
  23 -- -- --  6 -- 40 -- 20 --  6 -- -- -- 23          13  1.016  25.143
  19 -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- 19    12  1.076  26.139
  15    -- -- 42 --  6 --  6 -- 42 -- --          15    11  1.134  26.868
  11    -- -- -- -- -- -- -- -- -- -- -- -- --    11    10  1.224  26.770
   7       -- -- -- -- -- -- -- -- -- -- --        7     9  1.304  27.389
   3             -- -- -- -- -- --                 3     8  1.385  27.871
     2  6 10 14 18 22 26 30 34 38 42 46 50               7  1.477  28.332
                                                         6  1.576  29.059
                                                         5  1.647  29.276*
                                                         4  1.653* 28.599
Control Rod Density: %         6.66                      3  1.557  26.857
                                                         2  1.231  20.998
k-effective:                0.99957              Bottom  1  0.343   6.071
Void Fraction:                0.521
Core Delta-P: psia           20.792           % AXIAL TILT -30.139 -12.885
Core Plate Delta-P: psia     16.236        AVG BOT 8ft/12ft  1.1666  1.0736
Coolant Temp: Deg-F           548.5
In Channel Flow: Mlb/hr       60.98  Active Channel Flow: Mlb/hr        58.70
Total Bypass Flow (%):         13.0  (of total core flow)
Total Water Rod Flow (%):       3.2  (of total core flow)
Source Convergence          0.00049
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.472	43	25	26	1.493	0.924	43	27	28	9.33	0.903	41.7	41	13	16	5	10.41	0.883	42.1	42	21	24	6
1.462	43	31	28	1.536	0.899	43	25	22	9.34	0.902	41.5	41	37	40	5	10.40	0.881	41.9	42	23	22	6
1.462	43	25	22	1.539	0.897	43	31	28	9.45	0.894	39.3	42	21	24	6	9.80	0.872	47.6	41	13	16	5
1.444	43	33	30	1.552	0.889	43	23	20	9.45	0.892	39.2	42	23	22	6	10.04	0.868	44.4	41	37	40	5
1.443	43	23	20	1.555	0.887	44	39	36	9.31	0.861	37.1	42	37	36	5	11.70	0.860	16.6	44	39	40	5
1.438	43	23	24	1.559	0.885	43	29	30	9.19	0.861	38.4	42	17	16	5	11.64	0.856	14.3	44	39	36	5
1.437	43	19	20	1.574	0.877	43	33	30	9.18	0.860	38.4	42	19	22	5	9.92	0.855	44.0	42	35	38	5
1.422	43	21	22	1.597	0.864	44	35	14	9.20	0.857	37.9	42	21	20	5	9.93	0.851	43.3	42	37	36	5
1.417	43	35	36	1.602	0.861	43	19	20	9.17	0.850	37.4	42	17	20	4	9.75	0.846	44.7	42	19	22	6
1.374	43	35	28	1.603	0.861	43	21	22	9.14	0.848	37.3	42	19	18	4	9.75	0.844	44.5	42	21	20	6

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.17 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 6,200.0 MWd/MTU

```
Cycle:                            23                   Core Average Exposure: MWd/MTU    23358.3
Exposure: MWd/MTU (GWd)       6700.0 ( 680.35 )
Delta E: MWd/MTU, (GWd)        500.0 (  50.77 )              Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)        N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                  Top 25  0.170   4.467    37  0.727 0.754   3 24
Inlet Subcooling: Btu/lbm     -23.65                      24  0.385  11.913    38  0.419 0.647  47 16
Flow: Mlb/hr                   70.26 ( 91.25 %)           23  0.600  15.918    39  0.440 0.797  17 48
                                                          22  0.692  18.826    40  0.510 0.943   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50               21  0.724  20.700    41  0.875 1.222  39 38
   51             -- -- -- -- -- --          51           20  0.756  22.047    42  1.132 1.320  27 26
   47       -- -- -- -- -- -- -- -- -- --    47           19  0.776  22.795    43  1.320 1.476  25 26
   43    -- -- -- -- -- -- -- -- -- -- -- -- 43           18  0.803  23.669    44  1.174 1.370  39 36
   39    -- -- 42 --  6 --  6 -- 42 -- --    39           17  0.828  24.354    45  1.192 1.323  41 18
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35           16  0.858  24.827
   31 -- -- --  0 -- 20 -- 40 --  6 -- -- -- 31           15  0.904  25.218
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27           14  0.929  25.483
   23 -- -- --  6 -- 40 -- 20 --  6 -- -- -- 23           13  1.015  25.633
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19           12  1.074  26.657
   15    -- -- 42 --  6 --  6 -- 42 -- --    15           11  1.131  27.414
   11    -- -- -- -- -- -- -- -- -- -- -- -- 11           10  1.220  27.336
    7       -- -- -- -- -- -- -- -- -- --     7            9  1.299  27.989
    3             -- -- -- -- -- --           3            8  1.379  28.508
      2  6 10 14 18 22 26 30 34 38 42 46 50                7  1.471  29.012
                                                           6  1.570  29.784
                                                           5  1.642  30.034*
                                                           4  1.650* 29.360
Control Rod Density: %          6.66                       3  1.554  27.574
                                                           2  1.227  21.564
k-effective:                 0.99959             Bottom  1  0.342   6.241
Void Fraction:                 0.519
Core Delta-P: psia            20.857            % AXIAL TILT -29.741 -13.107
Core Plate Delta-P: psia      16.302        AVG BOT 8ft/12ft  1.1638  1.0746
Coolant Temp: Deg-F            548.5
In Channel Flow: Mlb/hr        61.16  Active Channel Flow: Mlb/hr        58.88
Total Bypass Flow (%):          13.0  (of total core flow)
Total Water Rod Flow (%):        3.2  (of total core flow)
Source Convergence           0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.476	43	25	26	1.495	0.923	43	27	28	9.27	0.906	42.7	41	13	16	5	10.33	0.884	43.2	42	21	24	6
1.470	43	31	28	1.534	0.900	43	25	22	9.28	0.905	42.5	41	37	40	5	10.32	0.882	43.0	42	23	22	6
1.470	43	25	22	1.537	0.898	43	31	28	9.38	0.896	40.3	42	21	24	6	9.98	0.872	45.6	41	13	16	5
1.453	43	33	30	1.557	0.886	43	29	30	9.38	0.894	40.2	42	23	22	6	9.96	0.870	45.4	41	37	40	5
1.450	43	23	20	1.560	0.885	43	23	20	9.15	0.865	39.4	42	17	16	5	9.86	0.857	45.0	42	35	38	5
1.445	43	23	24	1.564	0.882	44	39	36	9.26	0.865	38.0	42	37	36	5	11.62	0.854	18.0	44	39	40	5
1.445	43	19	20	1.570	0.879	43	33	30	9.13	0.864	39.3	42	19	22	5	9.87	0.853	44.3	42	37	36	5
1.431	43	21	22	1.599	0.863	43	21	22	9.14	0.860	38.8	42	21	20	5	11.54	0.849	15.8	44	39	36	5
1.424	43	35	36	1.600	0.863	44	35	14	9.12	0.854	38.3	42	17	20	4	9.69	0.848	45.7	42	19	22	6
1.382	43	35	28	1.602	0.862	43	19	20	9.09	0.851	38.3	42	19	18	4	9.67	0.845	45.5	42	21	20	6

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.18 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 6,700.0 MWd/MTU

```
Cycle:                          23                      Core Average Exposure: MWd/MTU    23758.2
Exposure: MWd/MTU (GWd)     7100.0 ( 720.97 )
Delta E: MWd/MTU, (GWd)      400.0 (  40.62 )                  Axial Profile    Edit   Radial Power
Power: MWt                  2923.0 (100.00 %)           N(PRA) Power Exposure   Zone  Avg.   Max.  IR JR
Core Pressure: psia         1044.7                     Top 25  0.172   4.541    37  0.723 0.749   3 24
Inlet Subcooling: Btu/lbm   -23.72                         24  0.388  12.080    38  0.416 0.644  47 16
Flow: Mlb/hr                 70.07 ( 91.00 %)              23  0.606  16.180    39  0.437 0.794  17 48
                                                           22  0.698  19.128    40  0.507 0.938   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50                 21  0.729  21.016    41  0.871 1.220  39 38
  51             -- -- -- -- --              51            20  0.760  22.377    42  1.130 1.316  27 26
  47       -- -- -- -- -- -- -- -- --        47            19  0.780  23.135    43  1.326 1.480  25 26
  43    -- -- -- -- -- -- -- -- -- -- --     43            18  0.807  24.019    44  1.176 1.374  39 36
  39    -- -- 42 --  6 --  6 -- 42 -- --     39            17  0.831  24.715    45  1.196 1.328  41 18
  35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35            16  0.859  25.197
  31 -- -- --  0 -- 20 -- 40 --  6 -- -- -- 31            15  0.904  25.598
  27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27            14  0.928  25.873
  23 -- -- --  6 -- 40 -- 20 --  6 -- -- -- 23            13  1.013  26.025
  19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19            12  1.071  27.071
  15    -- -- 42 --  6 --  6 -- 42 -- --     15            11  1.128  27.850
  11    -- -- -- -- -- -- -- -- -- -- --     11            10  1.215  27.786
   7       -- -- -- -- -- -- -- -- --         7             9  1.293  28.467
   3             -- -- -- -- --               3             8  1.373  29.015
     2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.465  29.553
                                                            6  1.565  30.362
                                                            5  1.640  30.639*
                                                            4  1.650* 29.969
Control Rod Density: %        6.66                          3  1.556  28.147
                                                            2  1.228  22.017
k-effective:               0.99953                  Bottom  1  0.343   6.377
Void Fraction:               0.519
Core Delta-P: psia          20.766                  % AXIAL TILT -29.451 -13.272
Core Plate Delta-P: psia    16.211              AVG BOT 8ft/12ft  1.1618  1.0753
Coolant Temp: Deg-F          548.5
In Channel Flow: Mlb/hr      60.99   Active Channel Flow: Mlb/hr        58.72
Total Bypass Flow (%):        13.0   (of total core flow)
Total Water Rod Flow (%):      3.2   (of total core flow)
Source Convergence         0.00043
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.480	43	25	26	1.492	0.925	43	27	28	9.22	0.909	43.5	41	13	16	5	10.24	0.883	44.0	42	21	24	6
1.476	43	31	28	1.529	0.903	43	25	22	9.23	0.908	43.3	41	37	40	5	10.23	0.881	43.8	42	23	22	6
1.476	43	25	22	1.532	0.901	43	31	28	9.31	0.897	41.1	42	21	24	6	9.92	0.873	46.4	41	13	16	5
1.460	43	33	30	1.552	0.889	43	29	30	9.30	0.894	41.0	42	23	22	6	9.91	0.871	46.3	41	37	40	5
1.456	43	23	20	1.554	0.888	43	23	20	9.11	0.868	40.1	42	17	16	5	9.81	0.859	45.8	42	35	38	5
1.451	43	23	24	1.563	0.883	43	33	30	9.21	0.867	38.8	42	37	36	5	9.81	0.854	45.1	42	37	36	5
1.451	43	33	34	1.569	0.879	44	39	36	9.08	0.865	40.1	42	19	22	5	11.57	0.851	19.2	44	39	40	5
1.437	43	21	22	1.592	0.867	43	21	22	9.09	0.862	39.6	42	21	20	5	9.92	0.848	43.0	42	19	22	5
1.429	43	35	36	1.595	0.865	43	19	20	9.08	0.857	39.1	42	17	20	4	9.61	0.845	46.3	42	21	20	6
1.389	43	35	28	1.599	0.863	44	35	14	9.05	0.854	39.1	42	19	18	4	9.45	0.845	48.1	42	11	38	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.19 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 7,100.0 MWd/MTU

```
Cycle:                           23                   Core Average Exposure: MWd/MTU    24058.3
Exposure: MWd/MTU (GWd)      7400.0 ( 751.43 )
Delta E: MWd/MTU, (GWd)       300.0 (  30.46 )              Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)        N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia          1044.7                  Top 25  0.173   4.596    37  0.720 0.746   3 24
Inlet Subcooling: Btu/lbm    -23.79                      24  0.391  12.205    38  0.413 0.642  47 16
Flow: Mlb/hr                  69.88 ( 90.75 %)           23  0.610  16.378    39  0.435 0.791  17 48
                                                         22  0.703  19.356    40  0.504 0.934   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50              21  0.734  21.255    41  0.868 1.219  39 38
   51             -- -- -- -- --              51         20  0.764  22.626    42  1.129 1.313  27 26
   47       -- -- -- -- -- -- -- -- -- --     47         19  0.784  23.390    43  1.330 1.483  25 26
   43    -- -- -- -- -- -- -- -- -- -- -- --  43         18  0.809  24.283    44  1.178 1.377  39 36
   39    -- -- 42 --  6 --  6 -- 42 -- --     39         17  0.833  24.987    45  1.198 1.331  41 18
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35         16  0.860  25.475
   31 -- -- --  0 -- 20 -- 40 --  6 -- -- -- 31         15  0.904  25.884
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27         14  0.927  26.166
   23 -- -- --  6 -- 40 -- 20 --  6 -- -- -- 23         13  1.012  26.318
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19         12  1.069  27.381
   15    -- -- 42 --  6 --  6 -- 42 -- --     15         11  1.125  28.176
   11    -- -- -- -- -- -- -- -- -- -- -- --  11         10  1.210  28.123
    7       -- -- -- -- -- -- -- -- -- --      7          9  1.287  28.824
    3             -- -- -- -- --               3          8  1.367  29.394
      2  6 10 14 18 22 26 30 34 38 42 46 50               7  1.459  29.957
                                                          6  1.561  30.795
                                                          5  1.637  31.093*
                                                          4  1.650* 30.425
Control Rod Density: %         6.66                       3  1.558  28.577
                                                          2  1.229  22.356
k-effective:                0.99950             Bottom  1  0.344   6.479
Void Fraction:                0.519
Core Delta-P: psia           20.679              % AXIAL TILT -29.192 -13.388
Core Plate Delta-P: psia     16.124          AVG BOT 8ft/12ft  1.1600  1.0758
Coolant Temp: Deg-F           548.5
In Channel Flow: Mlb/hr       60.82  Active Channel Flow: Mlb/hr       58.56
Total Bypass Flow (%):         13.0  (of total core flow)
Total Water Rod Flow (%):       3.2  (of total core flow)
Source Convergence          0.00049


                      Top Ten Thermal Limits Summary - Sorted by Margin

    Power               MCPR                        APLHGR                            LHGR
Value FT  IR JR   Value Margin FT  IR JR   Value Margin Exp. FT  IR JR  K   Value Margin Exp. FT  IR JR  K
1.483 43  25 26   1.489  0.927 43  27 28    9.18  0.910 44.1 41  13 16  5   10.16  0.882 44.7 42  21 24  6
1.481 43  31 28   1.524  0.906 43  25 22    9.19  0.910 43.8 41  37 40  5   10.16  0.879 44.5 42  23 22  6
1.480 43  25 22   1.527  0.904 43  31 28    9.25  0.896 41.7 42  21 24  6    9.87  0.874 47.0 41  13 16  5
1.465 43  33 30   1.547  0.892 43  29 30    9.24  0.893 41.5 42  23 22  6    9.86  0.872 46.9 41  37 40  5
1.460 43  23 20   1.548  0.891 43  23 20    9.07  0.870 40.7 42  17 16  5    9.77  0.860 46.4 42  35 38  5
1.455 43  33 34   1.556  0.887 43  33 30    9.18  0.869 39.4 42  37 36  5    9.77  0.855 45.7 42  37 36  5
1.455 43  23 24   1.573  0.877 44  39 36    9.03  0.866 40.7 42  19 22  5    9.86  0.847 43.6 42  19 22  5
1.441 43  21 22   1.587  0.870 43  21 22    9.04  0.862 40.2 42  21 20  5   11.52  0.847 20.1 44  39 40  5
1.434 43  35 36   1.588  0.869 43  19 20    9.05  0.859 39.7 42  17 20  4    9.40  0.845 48.7 42  11 38  5
1.394 43  35 28   1.598  0.864 44  35 14    9.02  0.856 39.6 42  19 18  4    9.54  0.844 46.9 42  21 20  6

   * LHGR calculated with pin-power reconstruction
   * CPR calculated with pin-power reconstruction & CPR limit type 3
```

Figure A.20 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 7,400.0 MWd/MTU

```
Cycle:                           23                          Core Average Exposure: MWd/MTU    24059.3
Exposure: MWd/MTU (GWd)      7401.0 ( 751.53 )
Delta E: MWd/MTU, (GWd)         1.0 (   0.10 )                    Axial Profile     Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)              N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia          1044.7                        Top 25  0.147   4.596    37  0.742 0.776   3 24
Inlet Subcooling: Btu/lbm    -24.86                            24  0.332  12.206    38  0.424 0.658  47 16
Flow: Mlb/hr                  67.18 ( 87.25 %)                 23  0.522  16.379    39  0.446 0.809  17 48
                                                               22  0.609  19.356    40  0.517 0.975   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                    21  0.651  21.256    41  0.892 1.273  39 38
   51             -- -- -- -- -- --           51               20  0.687  22.627    42  1.099 1.297  15 18
   47       -- -- -- -- -- -- -- -- -- --       47             19  0.715  23.391    43  1.215 1.448  37 16
   43    -- -- -- -- -- -- -- -- -- -- -- --    43             18  0.751  24.284    44  1.215 1.445  39 18
   39    -- -- -- 40 --  6 -- 40 -- -- -- --    39             17  0.787  24.988    45  1.269 1.418  41 20
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35                16  0.830  25.476
   31 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 31                15  0.894  25.885
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27                14  0.941  26.167
   23 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 23                13  1.047  26.319
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19                12  1.121  27.382
   15    -- -- -- 40 --  6 -- 40 -- -- -- --    15             11  1.189  28.177
   11    -- -- -- -- -- -- -- -- -- -- -- --    11             10  1.286  28.124
    7       -- -- -- -- -- -- -- -- -- --        7              9  1.369  28.825
    3             -- -- -- -- -- --              3              8  1.451  29.396
      2  6 10 14 18 22 26 30 34 38 42 46 50                     7  1.540  29.959
                                                                6  1.631  30.796
                                                                5  1.684* 31.094*
                                                                4  1.660  30.426
Control Rod Density: %         6.39                             3  1.568  28.579
                                                                2  1.241  22.357
k-effective:                0.99966                   Bottom  1  0.348   6.479
Void Fraction:                0.532
Core Delta-P: psia           19.719              % AXIAL TILT -34.325 -13.389
Core Plate Delta-P: psia     15.166          AVG BOT 8ft/12ft  1.1950  1.0758
Coolant Temp: Deg-F           548.4
In Channel Flow: Mlb/hr       58.36   Active Channel Flow: Mlb/hr        56.14
Total Bypass Flow (%):         13.1   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00034
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.448	43	37	16	1.448	0.953	44	39	18	9.45	0.916	41.8	42	33	14	6	10.38	0.901	44.7	42	19	14	6
1.445	44	39	18	1.474	0.937	45	39	22	9.62	0.915	40.0	42	35	16	6	10.50	0.899	43.1	42	35	16	6
1.426	43	35	18	1.504	0.917	45	31	14	9.07	0.898	43.9	42	11	32	6	10.21	0.886	44.8	42	11	22	6
1.418	45	41	20	1.506	0.916	45	43	26	9.11	0.897	43.4	41	43	24	6	11.89	0.874	18.2	44	13	36	4
1.417	45	39	22	1.512	0.913	45	41	20	9.25	0.893	41.4	41	13	38	4	9.91	0.872	46.3	41	43	24	6
1.405	43	37	20	1.515	0.911	45	39	26	9.00	0.888	43.6	41	37	14	5	10.18	0.868	42.8	42	13	20	4
1.398	45	31	14	1.522	0.907	45	41	18	9.26	0.886	40.5	42	37	18	5	10.31	0.868	41.1	42	15	36	5
1.397	45	41	18	1.544	0.894	44	35	14	9.23	0.884	40.6	42	13	34	5	11.79	0.867	19.1	44	35	14	6
1.396	45	33	12	1.546	0.892	45	33	12	8.94	0.870	42.2	42	11	28	6	9.68	0.866	48.1	42	11	38	4
1.392	45	39	26	1.550	0.890	45	35	12	8.87	0.868	42.7	42	11	38	4	9.64	0.861	48.0	41	13	38	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.21 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 7,401.0 MWd/MTU

```
Cycle:                          23                    Core Average Exposure: MWd/MTU    24558.3
Exposure: MWd/MTU (GWd)     7900.0 ( 802.20 )
Delta E: MWd/MTU, (GWd)      499.0 (  50.67 )              Axial Profile    Edit   Radial Power
Power: MWt                  2923.0 (100.00 %)        N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia         1044.7                  Top 25  0.149   4.675    37  0.738 0.771   3 24
Inlet Subcooling: Btu/lbm   -24.79                      24  0.336  12.385    38  0.420 0.654  47 16
Flow: Mlb/hr                 67.38 ( 87.50 %)           23  0.528  16.663    39  0.442 0.804  17 48
                                                        22  0.617  19.688    40  0.513 0.969   5 34
    2  6 10 14 18 22 26 30 34 38 42 46 50               21  0.658  21.611    41  0.887 1.270  39 38
 51           -- -- -- -- -- --            51           20  0.693  23.002    42  1.097 1.294  15 18
 47       -- -- -- -- -- -- -- -- -- --    47           19  0.721  23.781    43  1.221 1.454  37 16
 43    -- -- -- -- -- -- -- -- -- -- -- -- 43           18  0.755  24.693    44  1.219 1.450  39 18
 39    -- -- -- 40 --  6 -- 40 -- -- -- -- 39           17  0.791  25.416    45  1.273 1.424  41 20
 35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35           16  0.833  25.924
 31 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 31           15  0.895  26.354
 27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27           14  0.941  26.661
 23 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 23           13  1.046  26.823
 19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19           12  1.119  27.921
 15    -- -- -- 40 --  6 -- 40 -- -- -- -- 15           11  1.186  28.749
 11    -- -- -- -- -- -- -- -- -- -- -- -- 11           10  1.280  28.717
  7       -- -- -- -- -- -- -- -- -- --     7            9  1.362  29.453
  3             -- -- -- -- -- --           3            8  1.442  30.061
    2  6 10 14 18 22 26 30 34 38 42 46 50                7  1.531  30.665
                                                         6  1.624  31.545
                                                         5  1.679* 31.868*
                                                         4  1.658  31.190
Control Rod Density: %        6.39                       3  1.568  29.300
                                                         2  1.240  22.928
k-effective:               0.99963                Bottom 1  0.348   6.651
Void Fraction:               0.530
Core Delta-P: psia          19.783             % AXIAL TILT -33.902 -13.676
Core Plate Delta-P: psia    15.230         AVG BOT 8ft/12ft  1.1922  1.0772
Coolant Temp: Deg-F          548.4
In Channel Flow: Mlb/hr      58.54  Active Channel Flow: Mlb/hr        56.31
Total Bypass Flow (%):        13.1  (of total core flow)
Total Water Rod Flow (%):      3.3  (of total core flow)
Source Convergence         0.00037
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.454	43	37	16	1.457	0.947	44	39	18	9.37	0.917	42.8	42	33	14	6	10.29	0.902	45.8	42	19	14	6
1.450	44	39	18	1.486	0.929	45	39	22	9.54	0.917	41.0	42	35	16	6	10.41	0.899	44.2	42	35	16	6
1.433	43	35	18	1.514	0.912	45	31	14	8.99	0.899	44.9	42	11	32	6	10.10	0.885	45.8	42	11	22	6
1.424	45	41	20	1.516	0.910	45	43	26	9.04	0.899	44.3	41	43	24	6	9.82	0.872	47.4	41	43	24	6
1.419	45	39	22	1.522	0.907	45	41	20	9.19	0.896	42.3	41	13	38	4	10.11	0.871	43.8	42	13	20	4
1.411	43	37	20	1.529	0.903	45	39	26	8.95	0.892	44.5	41	37	14	5	10.23	0.869	42.2	42	15	36	5
1.403	45	41	18	1.529	0.902	45	41	18	9.20	0.889	41.5	42	37	18	5	9.61	0.867	49.2	42	11	38	4
1.403	45	33	12	1.553	0.889	44	35	14	9.17	0.887	41.6	42	13	34	5	11.78	0.866	17.3	44	13	36	4
1.401	45	31	14	1.554	0.888	45	33	12	8.84	0.873	43.6	42	11	38	4	9.57	0.862	49.0	41	13	38	4
1.394	45	39	26	1.556	0.887	45	35	12	8.85	0.870	43.1	42	11	28	6	9.50	0.859	49.4	41	37	14	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.22 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 7,900.0 MWd/MTU

```
Cycle:                          23                       Core Average Exposure: MWd/MTU    25058.3
Exposure: MWd/MTU (GWd)      8400.0 ( 852.98 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )                 Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)           N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                     Top 25  0.151   4.756    37  0.734 0.765   3 24
Inlet Subcooling: Btu/lbm    -24.79                         24  0.340  12.567    38  0.416 0.651  47 16
Flow: Mlb/hr                  67.38 ( 87.50 %)              23  0.534  16.951    39  0.439 0.800  17 48
                                                            22  0.623  20.025    40  0.509 0.964   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                 21  0.664  21.971    41  0.883 1.267  39 38
   51           -- -- -- -- -- --           51              20  0.699  23.380    42  1.095 1.290  15 18
   47        -- -- -- -- -- -- -- -- -- --        47        19  0.726  24.175    43  1.226 1.459  37 16
   43     -- -- -- -- -- -- -- -- -- -- -- --     43        18  0.760  25.106    44  1.224 1.456  39 18
   39     -- -- -- 40 --  6 -- 40 -- -- -- --     39        17  0.795  25.848    45  1.278 1.430  41 20
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35              16  0.836  26.374
   31 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 31              15  0.897  26.825
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27              14  0.942  27.156
   23 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 23              13  1.046  27.328
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19              12  1.118  28.461
   15     -- -- -- 40 --  6 -- 40 -- -- -- --     15        11  1.184  29.321
   11     -- -- -- -- -- -- -- -- -- -- -- --     11        10  1.275  29.308
    7        -- -- -- -- -- -- -- -- -- --         7         9  1.355  30.080
    3           -- -- -- -- -- --            3               8  1.434  30.724
      2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.523  31.369
                                                             6  1.616  32.292
                                                             5  1.673* 32.641*
                                                             4  1.655  31.954
Control Rod Density: %         6.39                          3  1.567  30.023
                                                             2  1.239  23.498
k-effective:                0.99965                  Bottom  1  0.347   6.823
Void Fraction:                0.529
Core Delta-P: psia           19.768              % AXIAL TILT -33.476 -13.944
Core Plate Delta-P: psia     15.215          AVG BOT 8ft/12ft  1.1896  1.0786
Coolant Temp: Deg-F           548.4
In Channel Flow: Mlb/hr       58.54   Active Channel Flow: Mlb/hr        56.32
Total Bypass Flow (%):         13.1   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00031
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.459	43	37	16	1.463	0.943	44	39	18	9.29	0.919	43.8	42	33	14	6	10.20	0.902	46.9	42	19	14	6
1.456	44	39	18	1.497	0.922	45	39	22	9.45	0.917	42.0	42	35	16	6	10.30	0.898	45.3	42	35	16	6
1.439	43	35	18	1.522	0.907	45	31	14	8.98	0.902	45.3	41	43	24	6	10.01	0.885	46.9	42	11	22	6
1.430	45	41	20	1.523	0.906	45	43	26	8.93	0.901	45.8	42	11	32	6	9.75	0.873	48.4	41	43	24	6
1.422	45	39	22	1.528	0.903	45	41	20	9.13	0.899	43.3	41	13	38	4	10.03	0.872	44.9	42	13	20	4
1.416	43	37	20	1.533	0.900	45	41	18	8.89	0.895	45.5	41	37	14	5	10.14	0.869	43.3	42	15	36	5
1.409	45	41	18	1.540	0.896	45	39	26	9.12	0.890	42.4	42	37	18	5	9.54	0.869	50.2	42	11	38	4
1.409	45	33	12	1.558	0.886	44	35	14	9.11	0.889	42.5	42	13	34	5	9.50	0.864	50.0	41	13	38	4
1.405	45	31	14	1.558	0.886	45	33	12	8.82	0.879	44.5	42	11	38	4	9.43	0.861	50.4	41	37	14	5
1.396	45	39	26	1.559	0.885	45	35	12	8.71	0.871	44.9	42	11	28	5	11.69	0.859	19.8	44	13	36	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.23 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 8,400.0 MWd/MTU

```
Cycle:                          23                Core Average Exposure: MWd/MTU    25508.3
Exposure: MWd/MTU (GWd)     8850.0 ( 898.67 )
Delta E: MWd/MTU, (GWd)      450.0 (  45.70 )            Axial Profile    Edit   Radial Power
Power: MWt                  2923.0 (100.00 %)         N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia         1044.7                   Top 25  0.152   4.829    37  0.731 0.761   3 24
Inlet Subcooling: Btu/lbm   -24.79                       24  0.343  12.733    38  0.413 0.648  47 16
Flow: Mlb/hr                 67.38 ( 87.50 %)            23  0.540  17.214    39  0.436 0.797  17 48
                                                         22  0.629  20.331    40  0.505 0.959   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50               21  0.670  22.298    41  0.880 1.265  39 16
  51             -- -- -- -- -- --           51          20  0.704  23.724    42  1.093 1.286  15 18
  47       -- -- -- -- -- -- -- -- -- --     47          19  0.731  24.532    43  1.228 1.464  37 16
  43    -- -- -- -- -- -- -- -- -- -- -- --  43          18  0.766  25.480    44  1.228 1.461  39 18
  39    -- -- -- 40 --  6 -- 40 -- -- -- --  39          17  0.800  26.239    45  1.283 1.435  41 20
  35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35          16  0.840  26.781
  31 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 31          15  0.901  27.251
  27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27          14  0.946  27.603
  23 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 23          13  1.049  27.783
  19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19          12  1.120  28.947
  15    -- -- -- 40 --  6 -- 40 -- -- -- --  15          11  1.185  29.835
  11    -- -- -- -- -- -- -- -- -- -- -- --  11          10  1.273  29.838
   7       -- -- -- -- -- -- -- -- -- --      7           9  1.351  30.641
   3             -- -- -- -- -- --            3           8  1.428  31.318
     2  6 10 14 18 22 26 30 34 38 42 46 50                7  1.515  32.000
                                                          6  1.607  32.960
                                                          5  1.663* 33.333*
                                                          4  1.646  32.638
Control Rod Density: %        6.39                        3  1.561  30.671
                                                          2  1.234  24.011
k-effective:               0.99967                Bottom  1  0.346   6.978
Void Fraction:               0.527
Core Delta-P: psia          19.750             % AXIAL TILT -33.023 -14.169
Core Plate Delta-P: psia    15.197         AVG BOT 8ft/12ft  1.1872  1.0797
Coolant Temp: Deg-F          548.4
In Channel Flow: Mlb/hr      58.55   Active Channel Flow: Mlb/hr       56.34
Total Bypass Flow (%):        13.1   (of total core flow)
Total Water Rod Flow (%):      3.3   (of total core flow)
Source Convergence         0.00022


                         Top Ten Thermal Limits Summary - Sorted by Margin

     Power                   MCPR                          APLHGR                                LHGR
Value FT   IR JR     Value Margin FT   IR JR    Value Margin Exp. FT   IR JR   K     Value Margin Exp. FT   IR JR   K
1.464 43   37 16     1.467  0.940 44   39 18     9.20  0.918 44.6 42   33 14   6     10.10  0.900 47.9 42   19 14   6
1.461 44   39 18     1.505  0.917 45   39 22     9.35  0.916 42.9 42   35 16   6     10.19  0.896 46.2 42   35 16   6
1.443 43   35 18     1.528  0.903 45   43 26     8.92  0.904 46.1 41   43 24   6      9.93  0.885 47.8 42   11 22   6
1.435 45   41 20     1.529  0.903 45   31 14     8.86  0.903 46.6 42   11 32   6      9.68  0.874 49.3 41   43 24   6
1.425 45   39 22     1.533  0.900 45   41 20     9.05  0.898 44.2 41   13 38   4      9.86  0.870 46.7 42   13 20   5
1.421 43   37 20     1.536  0.899 45   41 18     8.81  0.895 46.3 41   37 14   5      9.46  0.868 51.1 42   11 38   4
1.416 45   41 18     1.549  0.891 45   39 26     9.03  0.890 43.4 42   13 34   5      9.84  0.867 46.5 42   37 18   5
1.415 45   33 12     1.558  0.886 44   35 14     9.03  0.889 43.3 42   37 18   5      9.42  0.863 50.9 41   13 38   4
1.409 45   31 14     1.561  0.884 45   35 12     8.78  0.882 45.4 42   11 38   4      9.35  0.860 51.3 41   37 14   5
1.400 43   33 16     1.562  0.884 45   33 12     8.65  0.873 45.7 42   11 28   5     11.60  0.853 21.1 44   13 36   4

  * LHGR calculated with pin-power reconstruction
  * CPR calculated with pin-power reconstruction & CPR limit type 3
```

Figure A.24 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 8,850.0 MWd/MTU

```
Cycle:                           23
Exposure: MWd/MTU (GWd)      9350.0 ( 949.44 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )
Power: MWt                   2923.0 (100.00 %)
Core Pressure: psia          1044.7
Inlet Subcooling: Btu/lbm    -24.79
Flow: Mlb/hr                  67.38 ( 87.50 %)

      2  6 10 14 18 22 26 30 34 38 42 46 50
   51             -- -- -- -- --             51
   47       -- -- -- -- -- -- -- -- --       47
   43    -- -- -- -- -- -- -- -- -- -- --    43
   39    -- -- -- 40 --  6 -- 40 -- -- --    39
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35
   31 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 31
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27
   23 -- -- 40 --  0 --  8 --  0 -- 40 -- -- 23
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19
   15    -- -- -- 40 --  6 -- 40 -- -- --    15
   11    -- -- -- -- -- -- -- -- -- -- --    11
    7       -- -- -- -- -- -- -- -- --        7
    3             -- -- -- -- --              3
      2  6 10 14 18 22 26 30 34 38 42 46 50

Control Rod Density: %         6.39

k-effective:                0.99971
Void Fraction:                0.525
Core Delta-P: psia           19.716
Core Plate Delta-P: psia     15.163
Coolant Temp: Deg-F           548.4
In Channel Flow: Mlb/hr       58.57   Active Channel Flow: Mlb/hr       56.36
Total Bypass Flow (%):         13.1   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00049
```

Core Average Exposure: MWd/MTU 26008.2

N(PRA)	Axial Profile Power	Axial Profile Exposure
Top 25	0.155	4.911
24	0.349	12.919
23	0.551	17.510
22	0.642	20.676
21	0.682	22.666
20	0.716	24.111
19	0.743	24.933
18	0.776	25.899
17	0.810	26.677
16	0.849	27.237
15	0.908	27.726
14	0.952	28.102
13	1.054	28.290
12	1.124	29.488
11	1.186	30.407
10	1.271	30.427
9	1.345	31.262
8	1.419	31.974
7	1.503	32.695
6	1.591	33.698
5	1.644*	34.095*
4	1.626	33.393
3	1.543	31.387
2	1.220	24.576
Bottom 1	0.342	7.149

Edit Zone	Radial Power Avg.	Radial Power Max.	IR	JR
37	0.728	0.757	3	24
38	0.410	0.645	47	16
39	0.434	0.793	17	48
40	0.502	0.955	5	34
41	0.877	1.262	39	16
42	1.090	1.282	15	18
43	1.230	1.466	37	16
44	1.233	1.466	39	18
45	1.288	1.441	41	20

% AXIAL TILT -32.083 -14.395
AVG BOT 8ft/12ft 1.1819 1.0808

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.466	43	37	16	1.471	0.938	44	39	18	9.05	0.912	45.6	42	33	14	6	9.93	0.894	48.9	42	19	14	6
1.466	44	39	18	1.515	0.911	45	39	22	9.18	0.909	43.8	42	35	16	6	10.01	0.888	47.3	42	35	16	6
1.446	43	35	18	1.532	0.901	45	31	14	8.84	0.905	47.0	41	43	24	6	9.80	0.882	48.9	42	11	22	6
1.441	45	41	20	1.533	0.900	45	43	26	8.77	0.902	47.6	42	11	32	6	9.57	0.873	50.3	41	43	24	6
1.429	45	39	22	1.538	0.897	45	41	20	8.89	0.891	45.1	41	13	38	4	9.72	0.865	47.7	42	13	20	5
1.425	43	37	20	1.540	0.896	45	41	18	8.67	0.889	47.2	41	37	14	5	9.30	0.862	52.1	42	11	38	4
1.421	45	41	18	1.558	0.886	44	35	14	8.90	0.886	44.4	42	13	34	5	9.66	0.859	47.5	42	37	18	5
1.420	45	33	12	1.558	0.886	45	39	26	8.86	0.881	44.3	42	37	18	5	9.26	0.857	51.9	41	13	38	4
1.412	45	31	14	1.564	0.882	44	39	14	8.67	0.880	46.3	42	11	38	4	9.21	0.855	52.3	41	37	14	5
1.405	43	33	16	1.565	0.882	45	35	12	9.22	0.872	39.2	42	29	10	4	9.89	0.850	43.6	42	29	10	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.25 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 9,350.0 MWd/MTU

```
Cycle:                              23                     Core Average Exposure: MWd/MTU    26009.3
Exposure: MWd/MTU (GWd)         9351.0 ( 949.55 )
Delta E: MWd/MTU, (GWd)            1.0 (   0.10 )               Axial Profile    Edit   Radial Power
Power: MWt                      2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia             1044.7                    Top 25  0.178   4.912    37  0.687 0.695   3 24
Inlet Subcooling: Btu/lbm       -25.10                        24  0.399  12.919    38  0.390 0.622  47 16
Flow: Mlb/hr                     66.61 ( 86.50 %)             23  0.624  17.510    39  0.418 0.764  17 48
                                                              22  0.718  20.677    40  0.478 0.908   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50                 21  0.742  22.667    41  0.831 1.218  37 14
   51             -- -- -- -- --              51              20  0.758  24.111    42  1.136 1.320  35 24
   47       -- -- -- -- -- -- -- -- --        47              19  0.769  24.934    43  1.374 1.504  33 24
   43    -- -- -- -- --  8 -- -- -- -- --     43              18  0.789  25.900    44  1.160 1.407  39 18
   39    -- -- -- -- -- -- -- -- -- -- --     39              17  0.810  26.678    45  1.226 1.432  39 22
   35 -- -- -- --  6 -- 40 --  6 -- -- -- -- 35              16  0.838  27.238
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31              15  0.886  27.727
   27 -- --  8 -- 40 --  6 -- 40 --  8 -- -- 27              14  0.921  28.103
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23              13  1.013  28.291
   19 -- -- -- --  6 -- 40 --  6 -- -- -- -- 19              12  1.074  29.489
   15    -- -- -- -- -- -- -- -- -- -- --     15              11  1.130  30.408
   11    -- -- -- -- --  8 -- -- -- -- --     11              10  1.208  30.428
    7       -- -- -- -- -- -- -- -- --         7               9  1.278  31.264
    3             -- -- -- -- --               3               8  1.351  31.975
       2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.438  32.697
                                                               6  1.538  33.699
                                                               5  1.616  34.097*
                                                               4  1.648* 33.394
Control Rod Density: %           6.11                          3  1.606  31.388
                                                               2  1.298  24.577
k-effective:                   0.99985                 Bottom  1  0.369   7.149
Void Fraction:                   0.522
Core Delta-P: psia              19.354                % AXIAL TILT -29.694 -14.395
Core Plate Delta-P: psia        14.806            AVG BOT 8ft/12ft  1.1610  1.0808
Coolant Temp: Deg-F              548.4
In Channel Flow: Mlb/hr          57.92   Active Channel Flow: Mlb/hr        55.74
Total Bypass Flow (%):            13.0   (of total core flow)
Total Water Rod Flow (%):          3.3   (of total core flow)
Source Convergence             0.00044
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.504	43	33	24	1.492	0.925	43	29	20	9.14	0.909	44.3	42	19	28	6	10.00	0.888	47.4	42	19	28	6
1.496	43	29	20	1.494	0.924	43	33	24	9.13	0.908	44.3	42	27	20	6	9.96	0.885	47.5	42	27	20	6
1.494	43	27	22	1.498	0.921	43	27	22	8.78	0.893	46.4	41	37	14	4	9.81	0.867	46.9	42	13	34	4
1.485	43	31	26	1.507	0.916	45	39	22	9.04	0.891	43.5	42	13	34	4	9.69	0.866	48.0	42	19	14	4
1.479	43	31	22	1.520	0.908	45	31	14	8.88	0.890	45.1	41	13	38	4	11.57	0.860	22.4	44	35	14	3
1.467	43	37	24	1.530	0.902	43	31	26	8.93	0.889	44.5	42	33	14	4	9.28	0.860	52.1	42	11	38	4
1.467	43	29	24	1.550	0.890	43	37	24	8.65	0.878	46.3	42	11	38	4	9.32	0.859	51.6	41	37	14	4
1.462	43	29	16	1.553	0.888	43	31	22	8.67	0.876	45.8	42	37	12	4	11.59	0.858	21.8	44	13	36	3
1.453	43	35	26	1.555	0.887	43	29	16	8.60	0.869	45.8	42	9	34	4	9.20	0.855	52.4	42	37	12	4
1.447	43	27	18	1.568	0.880	44	39	18	8.83	0.865	42.8	42	17	30	5	9.24	0.855	51.9	41	13	38	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.26 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 9,351.0 MWd/MTU

```
Cycle:                           23                Core Average Exposure: MWd/MTU    26358.2
Exposure: MWd/MTU (GWd)      9700.0 ( 984.98 )
Delta E: MWd/MTU, (GWd)       349.0 (  35.44 )              Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                    Top 25  0.181   4.979    37  0.687 0.694   3 24
Inlet Subcooling: Btu/lbm    -25.11                        24  0.406  13.070    38  0.389 0.621  47 16
Flow: Mlb/hr                  66.61 ( 86.50 %)             23  0.636  17.749    39  0.417 0.763  17 48
                                                           22  0.731  20.951    40  0.476 0.906   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50                 21  0.756  22.951    41  0.831 1.217  37 14
   51             -- -- -- -- -- --          51            20  0.772  24.402    42  1.134 1.316  35 24
   47       -- -- -- -- -- -- -- -- -- --       47            19  0.782  25.228    43  1.373 1.501  33 24
   43    -- -- -- -- -- --  8 -- -- -- -- --    43            18  0.802  26.203    44  1.164 1.410  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --    39            17  0.823  26.988    45  1.230 1.434  39 22
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- -- 35          16  0.849  27.555
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31            15  0.897  28.055
   27 -- --  8 -- 40 --  6 -- 40 --  8 -- -- 27            14  0.930  28.443
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23            13  1.022  28.634
   19 -- -- -- --  6 -- 40 --  6 -- -- -- -- 19            12  1.082  29.853
   15    -- -- -- -- -- -- -- -- -- -- -- --    15            11  1.135  30.789
   11    -- -- -- -- -- --  8 -- -- -- -- --    11            10  1.210  30.819
    7       -- -- -- -- -- -- -- -- -- --        7             9  1.276  31.674
    3             -- -- -- -- -- --           3             8  1.344  32.409
     2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.426  33.157
                                                            6  1.520  34.191
                                                            5  1.593  34.613*
                                                            4  1.619* 33.920
Control Rod Density: %         6.11                         3  1.575  31.900
                                                            2  1.272  24.990
k-effective:                0.99986                 Bottom  1  0.361   7.275
Void Fraction:                0.519
Core Delta-P: psia           19.313             % AXIAL TILT -28.560 -14.502
Core Plate Delta-P: psia     14.765         AVG BOT 8ft/12ft  1.1551  1.0812
Coolant Temp: Deg-F           548.4
In Channel Flow: Mlb/hr       57.94   Active Channel Flow: Mlb/hr       55.76
Total Bypass Flow (%):         13.0   (of total core flow)
Total Water Rod Flow (%):       3.3   (of total core flow)
Source Convergence          0.00049
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.501	43	33	24	1.491	0.926	43	29	20	8.90	0.892	45.0	42	19	28	6	9.74	0.871	48.2	42	19	28	6
1.495	43	29	20	1.494	0.923	43	33	24	8.90	0.891	45.0	42	27	20	6	9.71	0.868	48.2	42	27	20	6
1.490	43	27	22	1.500	0.920	43	27	22	8.61	0.881	47.1	41	37	14	4	9.61	0.855	47.6	42	13	34	4
1.482	43	31	26	1.502	0.919	45	39	22	8.86	0.879	44.2	42	13	34	4	9.47	0.851	48.7	42	19	14	4
1.477	43	31	22	1.517	0.910	45	31	14	8.71	0.879	45.8	41	13	38	4	9.11	0.849	52.8	42	11	38	4
1.469	43	37	24	1.531	0.901	43	31	26	8.72	0.874	45.1	42	33	14	4	9.14	0.848	52.3	41	37	14	4
1.463	43	29	24	1.546	0.893	43	37	24	8.52	0.870	46.9	42	11	38	4	11.35	0.846	22.8	44	13	36	3
1.462	43	29	16	1.552	0.889	43	29	16	8.53	0.867	46.4	42	37	12	4	11.27	0.845	23.4	44	35	14	3
1.455	43	35	26	1.552	0.889	43	31	22	8.47	0.862	46.5	42	9	34	4	9.07	0.844	52.6	41	13	38	4
1.449	43	27	18	1.562	0.884	44	39	18	8.40	0.855	46.5	42	33	10	4	9.02	0.844	53.1	42	37	12	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.27 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 9,700.0 MWd/MTU

```
Cycle:                            23                 Core Average Exposure: MWd/MTU    26858.3
Exposure: MWd/MTU (GWd)      10200.0 (1035.76 )
Delta E: MWd/MTU, (GWd)        500.0 (  50.77 )            Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)       N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                  Top 25  0.186   5.077    37  0.686 0.692   3 24
Inlet Subcooling: Btu/lbm    -24.94                      24  0.416  13.291    38  0.387 0.619  47 16
Flow: Mlb/hr                   66.99 ( 87.00 %)          23  0.654  18.099    39  0.415 0.761  17 48
                                                         22  0.752  21.354    40  0.474 0.903   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50              21  0.776  23.368    41  0.829 1.216  37 14
   51             -- -- -- -- -- --             51       20  0.792  24.828    42  1.132 1.311  35 24
   47       -- -- -- -- -- -- -- -- -- --       47       19  0.803  25.660    43  1.373 1.499  33 24
   43    -- -- -- -- -- --  8 -- -- -- -- --    43       18  0.823  26.645    44  1.169 1.415  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --    39       17  0.843  27.441    45  1.234 1.437  39 22
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 35       16  0.869  28.019
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31       15  0.916  28.531
   27 -- --  8 -- 40 --  6 -- 40 --  8 -- -- 27          14  0.948  28.937
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23       13  1.039  29.131
   19 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 19       12  1.097  30.378
   15    -- -- -- -- -- -- -- -- -- -- -- --    15       11  1.147  31.339
   11    -- -- -- -- -- --  8 -- -- -- -- --    11       10  1.215  31.380
    7       -- -- -- -- -- -- -- -- -- --        7        9  1.275  32.262
    3             -- -- -- -- -- --              3        8  1.336  33.027
      2  6 10 14 18 22 26 30 34 38 42 46 50               7  1.410  33.811
                                                          6  1.492  34.885
                                                          5  1.554  35.338*
                                                          4  1.568* 34.655
Control Rod Density: %         6.11                       3  1.517  32.612
                                                          2  1.224  25.565
k-effective:                 1.00000              Bottom  1  0.347   7.451
Void Fraction:                 0.514
Core Delta-P: psia            19.400            % AXIAL TILT -26.731 -14.621
Core Plate Delta-P: psia      14.851         AVG BOT 8ft/12ft  1.1458  1.0817
Coolant Temp: Deg-F            548.3
In Channel Flow: Mlb/hr        58.31  Active Channel Flow: Mlb/hr        56.14
Total Bypass Flow (%):          13.0  (of total core flow)
Total Water Rod Flow (%):        3.2  (of total core flow)
Source Convergence           0.00046
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.499	43	33	24	1.492	0.925	43	29	20	8.58	0.868	45.9	42	19	28	6	9.38	0.846	49.1	42	19	28	6
1.494	43	29	20	1.499	0.921	43	33	24	8.58	0.867	45.9	42	27	20	6	9.36	0.845	49.2	42	27	20	6
1.486	43	27	22	1.501	0.919	45	39	22	8.30	0.858	48.0	41	37	14	4	9.28	0.833	48.6	42	13	34	4
1.479	43	31	26	1.505	0.917	43	27	22	8.42	0.858	46.7	41	13	38	4	8.81	0.829	53.7	42	11	38	4
1.476	43	31	22	1.517	0.910	45	31	14	8.55	0.857	45.1	42	13	34	4	8.82	0.826	53.2	41	37	14	4
1.470	43	37	24	1.535	0.899	43	31	26	8.27	0.853	47.8	42	11	38	4	9.10	0.825	49.7	42	19	14	4
1.462	43	29	16	1.545	0.893	43	37	24	8.38	0.848	46.0	42	33	14	4	8.95	0.824	51.4	42	43	20	4
1.460	43	29	24	1.553	0.889	43	29	16	8.26	0.848	47.3	42	37	12	4	8.77	0.824	53.5	41	13	38	4
1.457	43	35	26	1.555	0.887	43	31	22	8.24	0.846	47.4	42	9	34	4	8.71	0.823	54.1	42	37	12	4
1.451	43	27	18	1.559	0.885	44	39	18	8.15	0.837	47.4	42	33	10	4	10.84	0.822	24.9	44	13	36	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.28 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 10,200.0 MWd/MTU

```
Cycle:                             23                  Core Average Exposure: MWd/MTU    27358.2
Exposure: MWd/MTU (GWd)       10700.0 (1086.53 )
Delta E: MWd/MTU, (GWd)         500.0 (  50.77 )              Axial Profile    Edit   Radial Power
Power: MWt                     2923.0 (100.00 %)         N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia            1044.7                   Top 25  0.192   5.178    37  0.684 0.690   3 24
Inlet Subcooling: Btu/lbm      -24.79                       24  0.428  13.518    38  0.385 0.618  47 16
Flow: Mlb/hr                    67.38 ( 87.50 %)            23  0.675  18.460    39  0.413 0.760  17 48
                                                            22  0.778  21.769    40  0.472 0.901   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                 21  0.802  23.798    41  0.828 1.215  37 14
   51             -- -- -- -- -- --          51             20  0.818  25.266    42  1.130 1.307  35 24
   47       -- -- -- -- -- -- -- -- -- -- --       47       19  0.829  26.104    43  1.373 1.498  33 24
   43    -- -- -- -- -- --  8 -- -- -- -- -- --    43       18  0.849  27.100    44  1.173 1.418  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- -- --    39       17  0.869  27.908    45  1.237 1.439  39 22
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- -- 35       16  0.894  28.494
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31       15  0.940  29.019
   27 -- --  8 -- 40 --  6 -- 40 --  8 -- -- 27             14  0.971  29.442
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23       13  1.061  29.638
   19 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- -- 19       12  1.117  30.912
   15    -- -- -- -- -- -- -- -- -- -- -- -- --    15       11  1.161  31.896
   11    -- -- -- -- -- --  8 -- -- -- -- -- --    11       10  1.224  31.944
    7       -- -- -- -- -- -- -- -- -- -- --        7        9  1.276  32.850
    3             -- -- -- -- -- --              3           8  1.327  33.641
      2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.389  34.456
                                                             6  1.457  35.565
                                                             5  1.504* 36.043*
                                                             4  1.503  35.363
Control Rod Density: %           6.11                        3  1.444  33.295
                                                             2  1.163  26.115
k-effective:                  1.00015                Bottom  1  0.329   7.619
Void Fraction:                  0.507
Core Delta-P: psia             19.467             % AXIAL TILT -24.436 -14.697
Core Plate Delta-P: psia       14.919           AVG BOT 8ft/12ft  1.1343  1.0819
Coolant Temp: Deg-F             548.3
In Channel Flow: Mlb/hr         58.69   Active Channel Flow: Mlb/hr        56.52
Total Bypass Flow (%):           12.9   (of total core flow)
Total Water Rod Flow (%):         3.2   (of total core flow)
Source Convergence            0.00041
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.498	43	33	24	1.490	0.926	43	29	20	8.23	0.840	46.8	42	27	20	6	8.98	0.818	50.1	42	19	28	6
1.495	43	29	20	1.499	0.920	43	33	24	8.23	0.840	46.8	42	19	28	6	8.97	0.817	50.1	42	27	20	6
1.484	43	27	22	1.500	0.920	45	39	22	8.05	0.828	47.5	41	13	38	4	8.44	0.808	54.6	42	11	38	4
1.477	43	31	26	1.506	0.916	43	27	22	7.95	0.827	48.7	42	11	38	4	8.22	0.807	55.7	42	37	12	5
1.476	43	31	22	1.516	0.911	45	31	14	7.93	0.827	48.8	41	37	14	4	8.86	0.803	49.6	42	13	34	4
1.471	43	37	24	1.537	0.898	43	31	26	8.17	0.827	46.0	42	13	34	4	8.40	0.801	54.4	41	13	38	4
1.463	43	29	16	1.543	0.894	43	37	24	7.93	0.822	48.2	42	9	34	4	8.60	0.799	52.3	42	43	20	4
1.461	43	35	26	1.551	0.890	43	29	16	7.93	0.821	48.2	42	37	12	4	8.32	0.799	54.8	41	37	14	5
1.459	43	29	24	1.551	0.890	43	31	22	7.98	0.815	46.9	42	33	14	4	10.37	0.794	26.0	44	39	18	4
1.455	43	27	18	1.554	0.888	44	39	18	7.83	0.812	48.2	42	33	10	4	8.65	0.791	50.6	42	19	14	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.29 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 10,700.0 MWd/MTU

```
Cycle:                          23                       Core Average Exposure: MWd/MTU    27858.3
Exposure: MWd/MTU (GWd)     11200.0 (1137.30 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )              Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                    Top 25  0.198   5.283    37  0.684 0.689   3 24
Inlet Subcooling: Btu/lbm    -24.71                        24  0.442  13.753    38  0.384 0.617  47 16
Flow: Mlb/hr                  67.57 ( 87.75 %)             23  0.700  18.833    39  0.412 0.758  17 48
                                                           22  0.807  22.199    40  0.470 0.898   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50               21  0.832  24.242    41  0.827 1.213  37 14
   51             -- -- -- -- -- --            51          20  0.849  25.719    42  1.128 1.304  35 24
   47       -- -- -- -- -- -- -- -- -- --      47          19  0.860  26.563    43  1.373 1.497  33 24
   43    -- -- -- -- -- --  8 -- -- -- -- --   43          18  0.881  27.571    44  1.176 1.420  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --   39          17  0.901  28.389    45  1.240 1.441  39 22
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 35         16  0.924  28.985
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31         15  0.969  29.522
   27 -- --  8 -- 40 --  6 -- 40 --  8 -- -- 27            14  0.997  29.959
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23         13  1.087  30.156
   19 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 19         12  1.139  31.457
   15    -- -- -- -- -- -- -- -- -- -- -- --   15          11  1.178  32.460
   11    -- -- -- -- -- --  8 -- -- -- -- --   11          10  1.233  32.513
    7       -- -- -- -- -- -- -- -- -- --       7           9  1.276  33.439
    3             -- -- -- -- -- --             3           8  1.317  34.250
       2  6 10 14 18 22 26 30 34 38 42 46 50                7  1.364  35.091
                                                            6  1.416  36.228
                                                            5  1.446* 36.723*
                                                            4  1.427  36.038
Control Rod Density: %         6.11                         3  1.359  33.941
                                                            2  1.092  26.634
k-effective:                1.00025                 Bottom  1  0.309   7.777
Void Fraction:                0.499
Core Delta-P: psia           19.446             % AXIAL TILT -21.730 -14.724
Core Plate Delta-P: psia     14.899         AVG BOT 8ft/12ft  1.1208  1.0819
Coolant Temp: Deg-F           548.2
In Channel Flow: Mlb/hr       58.90   Active Channel Flow: Mlb/hr        56.74
Total Bypass Flow (%):         12.8   (of total core flow)
Total Water Rod Flow (%):       3.2   (of total core flow)
Source Convergence          0.00040
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.497	43	33	24	1.486	0.929	43	29	20	7.86	0.810	47.6	42	27	20	6	8.02	0.794	56.0	42	11	38	5
1.495	43	29	20	1.495	0.923	45	39	22	7.85	0.809	47.6	42	19	28	6	7.89	0.792	56.5	42	37	12	5
1.482	43	27	22	1.497	0.922	43	33	24	7.57	0.795	49.5	42	11	38	4	8.57	0.787	51.0	42	19	28	6
1.476	43	31	22	1.504	0.918	43	27	22	7.50	0.794	50.2	41	39	16	5	8.56	0.786	51.0	42	27	20	6
1.476	43	31	26	1.511	0.913	45	31	14	7.71	0.793	47.6	42	13	34	5	7.97	0.786	55.8	41	13	38	5
1.473	43	37	24	1.535	0.899	43	31	26	7.47	0.793	50.3	41	37	14	5	7.79	0.784	56.6	41	15	40	5
1.464	43	35	26	1.536	0.898	43	37	24	7.56	0.791	49.0	42	9	34	4	7.99	0.772	55.0	42	13	34	5
1.464	43	29	16	1.544	0.894	44	39	18	7.53	0.787	49.0	42	37	12	4	7.64	0.771	56.7	42	11	32	5
1.458	43	27	18	1.544	0.894	43	29	16	7.45	0.779	49.0	42	33	10	4	7.74	0.770	56.2	42	33	14	5
1.457	43	29	24	1.544	0.894	43	31	22	7.43	0.778	49.1	42	33	14	5	8.20	0.769	53.4	42	43	20	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.30 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 11,200.0 MWd/MTU

```
Cycle:                           23                   Core Average Exposure: MWd/MTU    28358.3
Exposure: MWd/MTU (GWd)     11700.0 (1188.07 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )          Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)      N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                Top 25  0.206   5.391    37  0.683 0.687   3 24
Inlet Subcooling: Btu/lbm    -24.63                    24  0.458  13.995    38  0.383 0.615  47 16
Flow: Mlb/hr                  67.76 ( 88.00 %)         23  0.728  19.221    39  0.411 0.757  17 48
                                                       22  0.841  22.646    40  0.468 0.895   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50           21  0.866  24.704    41  0.826 1.213  37 14
   51             -- -- -- -- --             51        20  0.883  26.191    42  1.127 1.301  35 24
   47       -- -- -- -- -- -- -- -- -- --       47     19  0.895  27.041    43  1.373 1.496  33 24
   43    -- -- -- -- -- --  8 -- -- -- -- --    43     18  0.916  28.060    44  1.179 1.422  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --    39     17  0.935  28.889    45  1.243 1.442  39 22
   35 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 35     16  0.957  29.492
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31     15  1.000  30.039
   27 -- --  8 -- 40 --  6 -- 40 --  8 -- -- 27        14  1.026  30.492
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23     13  1.114  30.687
   19 -- -- -- -- --  6 -- 40 --  6 -- -- -- -- 19     12  1.162  32.012
   15    -- -- -- -- -- -- -- -- -- -- -- --    15     11  1.195  33.033
   11    -- -- -- -- -- --  8 -- -- -- -- --    11     10  1.242  33.086
    7       -- -- -- -- -- -- -- -- -- --        7      9  1.276  34.027
    3             -- -- -- -- --                 3      8  1.304  34.854
       2  6 10 14 18 22 26 30 34 38 42 46 50            7  1.337  35.713
                                                        6  1.371  36.870
                                                        5  1.381* 37.375*
                                                        4  1.343  36.677
Control Rod Density: %         6.11                     3  1.264  34.545
                                                        2  1.013  27.119
k-effective:                1.00037             Bottom  1  0.286   7.924
Void Fraction:                0.491
Core Delta-P: psia           19.413              % AXIAL TILT -18.683 -14.697
Core Plate Delta-P: psia     14.866          AVG BOT 8ft/12ft  1.1054  1.0817
Coolant Temp: Deg-F           548.1
In Channel Flow: Mlb/hr       59.12  Active Channel Flow: Mlb/hr        56.98
Total Bypass Flow (%):         12.7  (of total core flow)
Total Water Rod Flow (%):       3.2  (of total core flow)
Source Convergence          0.00045
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.496	43	33	24	1.481	0.932	43	29	20	7.48	0.776	48.4	42	27	20	6	7.68	0.776	56.8	42	11	38	5
1.495	43	29	20	1.490	0.926	45	39	22	7.57	0.776	47.2	42	19	28	7	7.55	0.774	57.3	42	37	12	5
1.480	43	27	22	1.495	0.923	43	33	24	7.24	0.768	50.5	42	11	38	5	7.63	0.768	56.6	41	13	38	5
1.474	43	31	22	1.501	0.920	43	27	22	7.12	0.766	51.6	41	13	16	5	7.46	0.766	57.4	41	15	40	5
1.473	43	37	24	1.504	0.918	45	31	14	7.37	0.765	48.4	42	13	34	5	8.36	0.757	49.6	42	19	28	8
1.473	43	31	26	1.530	0.902	43	31	26	7.14	0.764	51.1	41	37	14	5	7.85	0.755	54.8	42	27	20	6
1.467	43	35	26	1.531	0.901	43	37	24	7.19	0.763	50.4	42	9	34	5	7.66	0.755	55.8	42	13	34	5
1.464	43	29	16	1.534	0.900	44	39	18	7.17	0.760	50.2	42	37	12	5	7.32	0.754	57.5	42	11	32	5
1.461	43	27	18	1.537	0.898	43	31	22	7.07	0.751	50.5	42	33	10	5	7.40	0.751	56.9	42	33	14	5
1.455	43	29	24	1.539	0.897	43	29	16	6.99	0.750	51.4	42	11	32	5	7.80	0.749	54.7	42	9	34	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.31 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 11,700.0 MWd/MTU

```
Cycle:                           23                 Core Average Exposure: MWd/MTU    28758.3
Exposure: MWd/MTU (GWd)     12100.0 (1228.69 )
Delta E: MWd/MTU, (GWd)       400.0 (  40.62 )         Axial Profile     Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)     N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7               Top 25  0.211   5.480    37  0.683 0.687   3 24
Inlet Subcooling: Btu/lbm    -24.47                   24  0.471  14.195    38  0.381 0.614  47 16
Flow: Mlb/hr                  68.14 ( 88.50 %)        23  0.751  19.542    39  0.410 0.755  17 48
                                                      22  0.867  23.017    40  0.467 0.894   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50            21  0.893  25.087    41  0.826 1.212  37 14
  51           -- -- -- -- -- --            51        20  0.912  26.582    42  1.126 1.297  35 24
  47       -- -- -- -- -- -- -- -- -- --        47    19  0.923  27.437    43  1.372 1.494  33 24
  43    -- -- -- -- -- --  8 -- -- -- -- --    43     18  0.945  28.465    44  1.182 1.424  39 18
  39    -- -- -- -- -- -- -- -- -- -- -- --    39     17  0.964  29.303    45  1.245 1.443  39 22
  35 -- -- -- --  6 -- 40 --  6 -- -- -- -- 35        16  0.984  29.911
  31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31        15  1.026  30.466
  27 -- --  8 -- 40 --  6 -- 40 --  8 -- -- 27        14  1.050  30.928
  23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23        13  1.136  31.121
  19 -- -- -- --  6 -- 40 --  6 -- -- -- -- 19        12  1.181  32.464
  15    -- -- -- -- -- -- -- -- -- -- -- --    15     11  1.209  33.496
  11    -- -- -- -- -- --  8 -- -- -- -- --    11     10  1.249  33.547
   7       -- -- -- -- -- -- -- -- -- --        7      9  1.275  34.497
   3           -- -- -- -- -- --            3          8  1.294  35.333
     2  6 10 14 18 22 26 30 34 38 42 46 50             7  1.314  36.202
                                                       6  1.335* 37.369
                                                       5  1.328  37.874*
                                                       4  1.275  37.159
Control Rod Density: %         6.11                    3  1.189  34.997
                                                       2  0.949  27.481
k-effective:                1.00048            Bottom  1  0.268   8.034
Void Fraction:                0.483
Core Delta-P: psia           19.478          % AXIAL TILT -16.221 -14.638
Core Plate Delta-P: psia     14.932       AVG BOT 8ft/12ft  1.0930  1.0813
Coolant Temp: Deg-F           548.1
In Channel Flow: Mlb/hr       59.51   Active Channel Flow: Mlb/hr       57.36
Total Bypass Flow (%):         12.7   (of total core flow)
Total Water Rod Flow (%):       3.1   (of total core flow)
Source Convergence          0.00032
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.494	43	33	24	1.482	0.931	43	29	20	7.48	0.764	46.9	42	19	28	8	7.40	0.761	57.4	42	11	38	5
1.493	43	29	20	1.488	0.927	45	39	22	7.46	0.763	47.0	42	27	20	8	7.27	0.758	58.0	42	37	12	5
1.477	43	27	22	1.495	0.923	43	33	24	6.99	0.747	51.1	42	11	38	5	7.35	0.753	57.3	41	13	38	5
1.473	43	37	24	1.501	0.919	45	31	14	6.86	0.742	52.2	41	13	16	5	7.18	0.750	58.0	41	15	40	5
1.472	43	31	22	1.503	0.918	43	27	22	6.95	0.742	51.0	42	9	34	5	8.17	0.744	50.3	42	19	28	8
1.470	43	31	26	1.529	0.903	43	37	24	7.09	0.741	49.0	42	13	34	5	8.13	0.742	50.4	42	27	20	8
1.468	43	35	26	1.529	0.902	44	39	18	6.87	0.740	51.7	41	37	14	5	7.38	0.739	56.4	42	13	34	5
1.464	43	29	16	1.531	0.902	43	31	26	6.92	0.738	50.8	42	37	12	5	7.06	0.738	58.1	42	11	32	5
1.462	43	27	18	1.535	0.899	43	31	22	7.31	0.732	45.0	42	17	30	8	7.53	0.735	55.4	42	9	34	5
1.451	43	29	24	1.535	0.899	43	35	26	7.21	0.729	46.0	42	29	18	8	7.11	0.733	57.5	42	33	14	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.32 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 12,100.0 MWd/MTU

```
Cycle:                           23                      Core Average Exposure: MWd/MTU    28759.3
Exposure: MWd/MTU (GWd)     12101.0 (1228.79 )
Delta E: MWd/MTU, (GWd)         1.0 (    0.10 )                 Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)            N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia          1044.7                      Top 25  0.176   5.481    37  0.704 0.718   3 24
Inlet Subcooling: Btu/lbm    -24.47                          24  0.392  14.195    38  0.395 0.622  47 16
Flow: Mlb/hr                  68.14 ( 88.50 %)               23  0.630  19.543    39  0.421 0.791  17 48
                                                             22  0.740  23.018    40  0.485 0.918   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50                 21  0.787  25.088    41  0.862 1.251  37 14
   51             -- -- -- -- --             51              20  0.830  26.583    42  1.084 1.277  35 20
   47       -- -- -- -- -- -- -- -- -- --       47           19  0.855  27.438    43  1.238 1.475  37 16
   43    -- -- -- -- -- -- -- -- -- -- -- --    43           18  0.889  28.466    44  1.254 1.478  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --    39           17  0.919  29.304    45  1.309 1.468  29 12
   35 -- -- -- -- --  6 --  0 -- -- -- -- -- 35              16  0.949  29.912
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31              15  1.000  30.467
   27 -- -- --  0 -- 10 -- 10 --  0 -- -- -- 27              14  1.032  30.930
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23              13  1.125  31.122
   19 -- -- -- -- --  0 --  0 -- -- -- -- -- 19              12  1.177  32.465
   15    -- -- -- -- -- -- -- -- -- -- -- --    15           11  1.211  33.498
   11    -- -- -- -- -- -- -- -- -- -- -- --    11           10  1.258  33.548
    7       -- -- -- -- -- -- -- -- -- --       7             9  1.291  34.498
    3             -- -- -- -- --             3                8  1.319  35.335
      2  6 10 14 18 22 26 30 34 38 42 46 50                   7  1.352  36.203
                                                              6  1.391  37.371
                                                              5  1.417  37.876*
                                                              4  1.419* 37.161
Control Rod Density: %         5.44                           3  1.377  34.998
                                                              2  1.137  27.482
k-effective:                1.00036                   Bottom  1  0.328   8.034
Void Fraction:                0.501
Core Delta-P: psia           19.707               % AXIAL TILT -22.950 -14.638
Core Plate Delta-P: psia     15.161           AVG BOT 8ft/12ft  1.1349  1.0813
Coolant Temp: Deg-F           548.3
In Channel Flow: Mlb/hr       59.40  Active Channel Flow: Mlb/hr        57.22
Total Bypass Flow (%):         12.8  (of total core flow)
Total Water Rod Flow (%):       3.2  (of total core flow)
Source Convergence          0.00035
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.478	44	39	18	1.463	0.943	45	27	10	7.85	0.820	49.0	42	25	42	4	7.76	0.809	58.0	42	37	12	5
1.475	43	37	16	1.483	0.930	44	39	18	8.31	0.819	43.6	42	29	10	4	7.87	0.809	57.4	42	11	38	5
1.474	43	37	20	1.497	0.922	44	35	14	7.47	0.801	51.4	42	31	12	5	7.90	0.805	57.1	42	21	12	5
1.473	43	35	18	1.517	0.909	45	29	12	7.45	0.801	51.5	41	39	16	5	7.82	0.800	57.3	41	13	38	5
1.469	44	35	14	1.532	0.901	45	39	22	7.43	0.800	51.7	41	37	14	5	7.85	0.800	57.1	41	37	14	5
1.468	45	29	12	1.536	0.898	43	35	18	7.64	0.799	49.0	42	13	34	5	7.77	0.797	57.3	42	19	44	5
1.465	45	27	10	1.539	0.897	45	31	14	7.45	0.797	51.1	42	33	10	5	7.90	0.797	56.7	42	25	12	5
1.452	45	33	12	1.543	0.895	43	37	20	7.51	0.794	50.1	41	43	24	4	7.70	0.794	57.5	42	33	14	5
1.444	45	31	14	1.550	0.890	45	33	12	7.41	0.791	51.0	42	9	34	5	8.97	0.794	47.0	42	29	10	4
1.441	45	41	20	1.550	0.890	45	35	12	7.40	0.791	51.1	42	11	38	5	10.31	0.792	26.5	45	27	10	4

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.33 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 12,101.0 MWd/MTU

```
Cycle:                           23                     Core Average Exposure: MWd/MTU    29258.3
Exposure: MWd/MTU (GWd)     12600.0 (1279.46 )
Delta E: MWd/MTU, (GWd)       499.0 (  50.67 )                Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)           N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                     Top 25  0.184   5.577    37  0.704 0.717   3 24
Inlet Subcooling: Btu/lbm    -24.17                         24  0.410  14.411    38  0.393 0.621  47 16
Flow: Mlb/hr                  68.92 ( 89.50 %)              23  0.660  19.892    39  0.420 0.789  17 48
                                                            22  0.777  23.429    40  0.483 0.916   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                 21  0.827  25.526    41  0.861 1.250  37 14
   51           -- -- -- -- -- --           51              20  0.872  27.045    42  1.084 1.274  35 20
   47        -- -- -- -- -- -- -- -- -- --        47        19  0.898  27.914    43  1.240 1.473  37 20
   43     -- -- -- -- -- -- -- -- -- -- -- --     43        18  0.933  28.961    44  1.256 1.478  39 18
   39     -- -- -- -- -- -- -- -- -- -- -- --     39        17  0.963  29.815    45  1.309 1.465  29 12
   35 -- -- -- -- -- --  6 --  0 -- -- -- -- -- 35          16  0.991  30.434
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31          15  1.041  31.002
   27 -- -- --  0 -- 10 -- 10 --  0 -- -- -- 27             14  1.070  31.481
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23          13  1.163  31.673
   19 -- -- -- -- -- --  0 --  0 -- -- -- -- -- 19          12  1.210  33.040
   15     -- -- -- -- -- -- -- -- -- -- -- --     15        11  1.237  34.087
   11     -- -- -- -- -- -- -- -- -- -- -- --     11        10  1.274  34.133
    7        -- -- -- -- -- -- -- -- -- --         7         9  1.295  35.093
    3           -- -- -- -- -- --                  3         8  1.307  35.939
      2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.322  36.819
                                                             6  1.338  37.998
                                                             5  1.339* 38.509*
                                                             4  1.314  37.789
Control Rod Density: %         5.44                          3  1.254  35.603
                                                             2  1.028  27.979
k-effective:                1.00048                Bottom  1  0.295   8.188
Void Fraction:                0.489
Core Delta-P: psia           19.879              % AXIAL TILT -19.240 -14.629
Core Plate Delta-P: psia     15.334          AVG BOT 8ft/12ft  1.1168  1.0813
Coolant Temp: Deg-F           548.2
In Channel Flow: Mlb/hr       60.15   Active Channel Flow: Mlb/hr        57.97
Total Bypass Flow (%):         12.7   (of total core flow)
Total Water Rod Flow (%):       3.2   (of total core flow)
Source Convergence           0.00030
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.478	44	39	18	1.469	0.940	45	27	10	7.30	0.778	50.8	42	25	12	5	7.45	0.783	58.2	42	11	38	5
1.473	43	37	20	1.485	0.929	44	39	18	7.71	0.767	44.4	42	29	10	4	7.34	0.782	58.8	42	37	12	5
1.473	43	37	16	1.497	0.922	44	35	14	7.16	0.766	51.1	41	39	16	6	7.46	0.777	57.9	42	21	12	5
1.470	43	35	18	1.516	0.910	45	29	12	7.12	0.765	51.5	41	37	14	6	7.40	0.774	58.1	41	13	38	5
1.468	44	35	14	1.528	0.903	45	39	22	7.05	0.763	52.2	42	31	12	5	7.25	0.773	58.8	41	15	40	5
1.465	45	29	12	1.537	0.898	43	35	18	7.23	0.762	49.8	42	13	34	5	7.38	0.773	58.1	42	19	44	5
1.463	45	27	10	1.539	0.897	45	31	14	7.06	0.762	51.8	42	33	10	5	7.46	0.768	57.5	42	25	12	5
1.451	45	33	12	1.542	0.895	43	37	20	7.05	0.759	51.7	42	9	34	5	7.28	0.767	58.3	42	33	14	5
1.443	45	31	14	1.546	0.893	45	35	12	7.02	0.759	52.1	41	43	24	5	7.16	0.764	58.8	42	11	32	5
1.441	45	41	20	1.547	0.892	45	33	12	7.02	0.757	51.8	42	11	38	5	7.38	0.763	57.7	42	43	20	5

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.34 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 12,600.0 MWd/MTU

```
Cycle:                          23                       Core Average Exposure: MWd/MTU    29758.2
Exposure: MWd/MTU (GWd)     13100.0 (1330.24 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )                Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                    Top 25  0.191   5.677    37  0.703 0.716   3 24
Inlet Subcooling: Btu/lbm    -23.96                        24  0.426  14.636    38  0.392 0.620  47 16
Flow: Mlb/hr                  69.45 ( 90.20 %)             23  0.690  20.258    39  0.419 0.788  17 48
                                                           22  0.813  23.861    40  0.481 0.914   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50                 21  0.865  25.987    41  0.861 1.249  37 14
  51             -- -- -- -- -- --            51           20  0.913  27.531    42  1.083 1.269  29 10
  47       -- -- -- -- -- -- -- -- -- --      47           19  0.940  28.415    43  1.240 1.471  37 20
  43    -- -- -- -- -- -- -- -- -- -- -- --   43           18  0.975  29.481    44  1.259 1.479  39 18
  39    -- -- -- -- -- -- -- -- -- -- -- --   39           17  1.005  30.351    45  1.311 1.464  29 12
  35 -- -- -- -- --  6 --  0 -- -- -- -- -- 35             16  1.032  30.980
  31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31             15  1.080  31.560
  27 -- -- --  0 -- 10 -- 10 --  0 -- -- -- 27             14  1.106  32.054
  23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23             13  1.196  32.242
  19 -- -- -- -- --  0 --  0 -- -- -- -- -- 19             12  1.239  33.631
  15    -- -- -- -- -- -- -- -- -- -- -- --   15           11  1.257  34.688
  11    -- -- -- -- -- -- -- -- -- -- -- --   11           10  1.285  34.725
   7       -- -- -- -- -- -- -- -- -- --       7            9  1.294* 35.690
   3             -- -- -- -- -- --             3            8  1.292  36.538
     2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.289  37.420
                                                            6  1.286  38.603
                                                            5  1.264  39.109*
                                                            4  1.218  38.373
Control Rod Density: %         5.44                         3  1.145  36.156
                                                            2  0.932  28.430
k-effective:                1.00059                 Bottom  1  0.267   8.328
Void Fraction:                0.478
Core Delta-P: psia           19.969               % AXIAL TILT -15.678 -14.559
Core Plate Delta-P: psia     15.424           AVG BOT 8ft/12ft  1.0993  1.0811
Coolant Temp: Deg-F           548.1
In Channel Flow: Mlb/hr       60.69  Active Channel Flow: Mlb/hr        58.51
Total Bypass Flow (%):         12.6  (of total core flow)
Total Water Rod Flow (%):       3.1  (of total core flow)
Source Convergence          0.00039
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.479	44	39	18	1.465	0.942	45	27	10	6.98	0.745	50.9	42	25	12	6	7.19	0.764	58.7	42	37	12	6
1.471	43	37	20	1.484	0.930	44	39	18	6.88	0.742	51.9	41	39	16	6	7.31	0.761	57.9	42	11	38	6
1.470	43	37	16	1.493	0.924	44	35	14	6.84	0.741	52.3	41	37	14	6	7.27	0.753	57.7	41	13	38	6
1.468	44	35	14	1.513	0.912	45	29	12	6.97	0.737	50.0	42	13	34	6	7.29	0.752	57.6	41	37	14	6
1.467	43	35	18	1.527	0.904	45	39	22	6.76	0.734	52.5	42	31	12	6	7.21	0.752	58.0	42	21	12	6
1.464	45	29	12	1.539	0.897	45	31	14	7.15	0.733	47.2	42	37	18	8	6.99	0.747	58.9	42	19	44	5
1.463	45	27	10	1.540	0.896	43	35	18	7.18	0.732	46.7	42	29	10	5	7.06	0.744	58.3	42	33	14	6
1.451	45	33	12	1.541	0.896	45	35	12	6.82	0.732	51.4	42	11	38	6	7.21	0.743	57.5	42	13	34	6
1.442	45	41	20	1.542	0.895	45	33	12	6.71	0.730	52.6	42	33	10	6	7.06	0.741	58.2	42	25	12	5
1.441	45	31	14	1.542	0.895	43	37	20	6.82	0.729	51.2	42	43	20	6	6.93	0.741	58.9	42	11	32	6

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.35 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 13,100.0 MWd/MTU

```
Cycle:                          23
Exposure: MWd/MTU (GWd)     13600.0 (1381.01 )
Delta E: MWd/MTU, (GWd)       500.0 (  50.77 )
Power: MWt                   2923.0 (100.00 %)
Core Pressure: psia          1044.7
Inlet Subcooling: Btu/lbm    -23.72
Flow: Mlb/hr                  70.07 ( 91.00 %)

       2  6 10 14 18 22 26 30 34 38 42 46 50
   51             -- -- -- -- -- --              51
   47       -- -- -- -- -- -- -- -- -- --        47
   43    -- -- -- -- -- -- -- -- -- -- -- --     43
   39    -- -- -- -- -- -- -- -- -- -- -- --     39
   35 -- -- -- -- --  6 --  0 -- -- -- -- -- 35
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31
   27 -- -- --  0 -- 10 -- 10 --  0 -- -- -- 27
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23
   19 -- -- -- -- --  0 --  0 -- -- -- -- -- 19
   15    -- -- -- -- -- -- -- -- -- -- -- --     15
   11    -- -- -- -- -- -- -- -- -- -- -- --     11
    7       -- -- -- -- -- -- -- -- -- --         7
    3             -- -- -- -- -- --               3
       2  6 10 14 18 22 26 30 34 38 42 46 50
```

Core Average Exposure: MWd/MTU 30258.2

	Axial Profile	
N(PRA)	Power	Exposure
Top 25	0.199	5.782
24	0.443	14.870
23	0.720	20.641
22	0.849	24.311
21	0.904	26.468
20	0.954	28.039
19	0.983	28.938
18	1.019	30.024
17	1.049	30.910
16	1.073	31.548
15	1.119	32.138
14	1.141	32.645
13	1.229	32.827
12	1.265	34.235
11	1.274	35.299
10	1.292*	35.322
9	1.290	36.286
8	1.274	37.129
7	1.254	38.007
6	1.233	39.184
5	1.190	39.675*
4	1.125	38.913
3	1.040	36.659
2	0.841	28.839
Bottom 1	0.240	8.453

Edit	Radial Power			
Zone	Avg.	Max.	IR	JR
37	0.703	0.715	3	24
38	0.391	0.619	47	16
39	0.419	0.788	17	48
40	0.480	0.914	5	34
41	0.861	1.247	37	14
42	1.081	1.269	29	10
43	1.238	1.468	37	16
44	1.262	1.479	39	18
45	1.314	1.464	27	10

```
Control Rod Density: %          5.44

k-effective:                 1.00069
Void Fraction:                 0.467
Core Delta-P: psia            20.089
Core Plate Delta-P: psia      15.545
Coolant Temp: Deg-F            547.9
In Channel Flow: Mlb/hr        61.29   Active Channel Flow: Mlb/hr        59.12
Total Bypass Flow (%):          12.5   (of total core flow)
Total Water Rod Flow (%):        3.1   (of total core flow)
Source Convergence           0.00034

% AXIAL TILT -12.055 -14.430
AVG BOT 8ft/12ft  1.0814  1.0805
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.479	44	39	18	1.463	0.943	45	27	10	7.45	0.733	43.2	42	37	18	14	6.90	0.748	59.4	42	37	12	6
1.468	43	37	16	1.482	0.931	44	39	18	7.02	0.731	48.7	41	37	14	9	7.02	0.746	58.7	42	11	38	6
1.467	43	37	20	1.492	0.925	44	35	14	7.06	0.730	48.0	41	39	16	9	7.56	0.739	55.4	41	37	14	10
1.467	44	35	14	1.511	0.913	45	29	12	7.11	0.725	46.8	42	39	20	9	7.00	0.738	58.4	41	13	38	6
1.464	45	27	10	1.527	0.904	45	39	22	6.96	0.724	48.5	42	33	14	9	6.91	0.735	58.7	42	21	12	6
1.464	45	29	12	1.537	0.898	45	35	12	7.04	0.724	47.4	42	25	12	9	6.82	0.733	59.1	42	19	44	6
1.462	43	35	18	1.538	0.897	45	33	12	6.88	0.723	49.6	42	31	12	9	6.93	0.729	58.3	42	13	34	6
1.452	45	33	12	1.541	0.896	45	31	14	7.49	0.722	41.3	42	35	16	14	6.77	0.727	59.0	42	33	14	6
1.443	45	41	20	1.543	0.895	45	41	20	6.57	0.711	52.1	42	11	38	6	8.20	0.727	47.1	42	37	18	14
1.440	45	31	14	1.545	0.893	43	35	18	6.57	0.708	51.9	42	43	20	6	6.67	0.727	59.6	42	11	32	6

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.36 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 13,600.0 MWd/MTU

```
Cycle:                          23                       Core Average Exposure: MWd/MTU    30658.2
Exposure: MWd/MTU (GWd)      14000.0 (1421.63 )
Delta E: MWd/MTU, (GWd)        400.0 (  40.62 )                 Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)            N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                      Top 25  0.205   5.868    37  0.703 0.715   3 24
Inlet Subcooling: Btu/lbm     -23.43                          24  0.456  15.063    38  0.390 0.618  47 16
Flow: Mlb/hr                   70.84 ( 92.00 %)               23  0.743  20.958    39  0.418 0.789  17 48
                                                              22  0.877  24.686    40  0.479 0.914   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                   21  0.935  26.869    41  0.861 1.246  37 14
   51             -- -- -- -- --             51               20  0.988  28.462    42  1.079 1.269  29 10
   47       -- -- -- -- -- -- -- -- --       47               19  1.017  29.374    43  1.236 1.465  37 16
   43    -- -- -- -- -- -- -- -- -- -- --    43               18  1.055  30.475    44  1.266 1.479  39 18
   39    -- -- -- -- -- -- -- -- -- -- --    39               17  1.084  31.375    45  1.316 1.466  27 10
   35 -- -- -- -- --  6 --  0 -- -- -- -- -- 35               16  1.106  32.018
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31               15  1.149  32.615
   27 -- -- --  0 -- 10 -- 10 --  0 -- -- -- 27               14  1.168  33.131
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23               13  1.252  33.306
   19 -- -- -- -- --  0 --  0 -- -- -- -- -- 19               12  1.283  34.727
   15    -- -- -- -- -- -- -- -- -- -- --    15               11  1.284  35.792
   11    -- -- -- -- -- -- -- -- -- -- --    11               10  1.295* 35.801
    7       -- -- -- -- -- -- -- -- --        7                9  1.284  36.760
    3             -- -- -- -- --              3                8  1.257  37.596
      2  6 10 14 18 22 26 30 34 38 42 46 50                    7  1.225  38.464
                                                               6  1.191  39.631
                                                               5  1.133  40.104*
                                                               4  1.055  39.315
Control Rod Density: %         5.44                            3  0.963  37.029
                                                               2  0.773  29.136
k-effective:                1.00080                     Bottom  1  0.221   8.545
Void Fraction:                0.458
Core Delta-P: psia           20.301                   % AXIAL TILT  -9.187 -14.287
Core Plate Delta-P: psia     15.757               AVG BOT 8ft/12ft  1.0671  1.0799
Coolant Temp: Deg-F           547.9
In Channel Flow: Mlb/hr       62.02   Active Channel Flow: Mlb/hr        59.85
Total Bypass Flow (%):         12.4   (of total core flow)
Total Water Rod Flow (%):       3.1   (of total core flow)
Source Convergence          0.00036
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.479	44	39	18	1.463	0.943	45	27	10	7.58	0.750	43.8	42	37	18	14	7.54	0.748	56.1	41	37	14	10
1.466	44	35	14	1.483	0.931	44	39	18	7.61	0.739	41.9	42	35	16	14	8.38	0.744	47.4	42	37	18	15
1.466	45	27	10	1.495	0.923	44	35	14	7.37	0.738	45.1	42	33	14	14	7.44	0.744	56.3	41	13	16	10
1.465	43	37	16	1.512	0.912	45	29	12	7.44	0.736	43.9	41	37	14	14	6.67	0.735	60.0	42	37	12	6
1.464	45	29	12	1.534	0.900	45	39	22	7.37	0.732	44.3	41	39	16	14	6.80	0.734	59.2	42	11	38	6
1.464	43	37	20	1.536	0.898	45	35	12	7.34	0.728	44.0	42	39	20	14	8.41	0.733	45.4	42	35	16	15
1.457	43	35	18	1.538	0.897	45	33	12	7.24	0.724	44.8	42	31	12	14	8.12	0.731	49.0	42	33	14	14
1.453	45	33	12	1.542	0.895	45	41	20	7.00	0.724	48.0	42	25	12	9	8.55	0.725	42.1	42	35	20	15
1.444	45	41	20	1.545	0.893	44	39	14	7.22	0.717	44.3	42	29	14	14	8.10	0.723	47.9	42	39	20	14
1.439	45	31	14	1.547	0.892	45	31	14	7.62	0.715	38.5	42	35	20	14	6.62	0.722	59.6	42	19	44	6

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.37 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 14,000.0 MWd/MTU

```
Cycle:                           23                     Core Average Exposure: MWd/MTU    31058.4
Exposure: MWd/MTU (GWd)     14400.0 (1462.25 )
Delta E: MWd/MTU, (GWd)       400.0 (  40.62 )                Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia          1044.7                    Top 25  0.210   5.957    37  0.703 0.716   3 24
Inlet Subcooling: Btu/lbm    -23.15                        24  0.469  15.263    38  0.390 0.618  47 16
Flow: Mlb/hr                  71.61 ( 93.00 %)             23  0.766  21.286    39  0.418 0.789  17 48
                                                           22  0.905  25.073    40  0.478 0.915   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50               21  0.966  27.283    41  0.861 1.244  37 14
   51             -- -- -- -- --             51            20  1.021  28.899    42  1.077 1.269  29 10
   47       -- -- -- -- -- -- -- -- -- --       47         19  1.052  29.824    43  1.233 1.461  37 16
   43    -- -- -- -- -- -- -- -- -- -- -- --    43         18  1.091  30.943    44  1.270 1.478  39 18
   39    -- -- -- -- -- -- -- -- -- -- -- --    39         17  1.119  31.854    45  1.319 1.468  27 10
   35 -- -- -- -- -- --  6 --  0 -- -- -- -- -- 35         16  1.139  32.502
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31         15  1.179  33.105
   27 -- -- --  0 -- 10 -- 10 --  0 -- -- -- 27         14  1.194  33.628
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23         13  1.275  33.794
   19 -- -- -- -- -- --  0 --  0 -- -- -- -- -- 19         12  1.299* 35.225
   15    -- -- -- -- -- -- -- -- -- -- -- --    15         11  1.292  36.289
   11    -- -- -- -- -- -- -- -- -- -- -- --    11         10  1.295  36.280
    7       -- -- -- -- -- -- -- -- -- --        7          9  1.276  37.232
    3             -- -- -- -- --                 3          8  1.237  38.056
      2  6 10 14 18 22 26 30 34 38 42 46 50                  7  1.195  38.910
                                                            6  1.147  40.062
                                                            5  1.077  40.511*
                                                            4  0.988  39.692
Control Rod Density: %         5.44                         3  0.892  37.371
                                                            2  0.712  29.410
k-effective:                1.00077                 Bottom  1  0.203   8.629
Void Fraction:                0.449
Core Delta-P: psia           20.516              % AXIAL TILT  -6.327 -14.110
Core Plate Delta-P: psia     15.972          AVG BOT 8ft/12ft  1.0528  1.0791
Coolant Temp: Deg-F           547.8
In Channel Flow: Mlb/hr       62.76   Active Channel Flow: Mlb/hr        60.57
Total Bypass Flow (%):         12.4   (of total core flow)
Total Water Rod Flow (%):       3.0   (of total core flow)
Source Convergence          0.00034
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.478	44	39	18	1.464	0.943	45	27	10	7.70	0.767	44.5	42	37	18	14	8.54	0.763	48.1	42	37	18	15
1.468	45	27	10	1.487	0.928	44	39	18	7.49	0.756	45.7	42	33	14	14	8.46	0.759	48.6	41	37	14	15
1.464	44	35	14	1.500	0.920	44	35	14	7.57	0.754	44.5	41	37	14	14	8.57	0.753	46.1	42	35	16	15
1.464	45	29	12	1.515	0.911	45	29	12	7.72	0.754	42.6	42	35	16	14	7.41	0.753	57.0	41	13	16	10
1.461	43	37	16	1.536	0.898	45	35	12	7.50	0.750	44.9	41	39	16	14	8.31	0.751	49.2	42	33	14	15
1.459	43	37	20	1.540	0.896	45	33	12	7.47	0.745	44.6	42	39	20	14	8.69	0.742	42.8	42	35	20	15
1.453	45	33	12	1.541	0.895	45	39	22	7.39	0.743	45.4	42	31	12	14	8.26	0.741	48.6	42	29	14	15
1.451	43	35	18	1.543	0.894	45	41	20	7.46	0.740	44.1	42	25	12	14	8.27	0.741	48.3	42	39	20	15
1.445	45	41	20	1.544	0.894	44	39	14	7.34	0.735	44.9	42	29	14	14	8.25	0.737	48.1	42	27	12	14
1.437	45	31	14	1.545	0.893	45	31	10	7.77	0.730	38.7	42	35	20	15	8.19	0.737	48.8	42	31	12	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.38 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 14,400.0 MWd/MTU

```
Cycle:                            23                 Core Average Exposure: MWd/MTU    31508.2
Exposure: MWd/MTU (GWd)      14850.0 (1507.94 )
Delta E: MWd/MTU, (GWd)        450.0 (  45.70 )          Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)      N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                Top 25  0.217   6.060    37  0.704 0.716   3 24
Inlet Subcooling: Btu/lbm     -22.74                    24  0.485  15.494    38  0.389 0.617  47 16
Flow: Mlb/hr                   72.76 ( 94.50 %)         23  0.794  21.667    39  0.418 0.791  17 48
                                                        22  0.940  25.524    40  0.478 0.916   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50            21  1.004  27.765    41  0.862 1.241  37 14
    51             -- -- -- -- --            51         20  1.062  29.409    42  1.074 1.269  29 10
    47       -- -- -- -- -- -- -- -- -- --       47     19  1.094  30.350    43  1.228 1.456  37 16
    43    -- -- -- -- -- -- -- -- -- -- -- --    43     18  1.133  31.487    44  1.275 1.476  39 18
    39    -- -- -- -- -- -- -- -- -- -- -- --    39     17  1.160  32.413    45  1.323 1.471  27 10
    35 -- -- -- -- --  6 --  0 -- -- -- -- -- 35        16  1.176  33.064
    31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31        15  1.213  33.671
    27 -- -- --  0 -- 10 -- 10 --  0 -- -- -- 27        14  1.222  34.199
    23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23        13  1.297  34.352
    19 -- -- -- -- --  0 --  0 -- -- -- -- -- 19        12  1.314* 35.793
    15    -- -- -- -- -- -- -- -- -- -- -- --    15     11  1.296  36.851
    11    -- -- -- -- -- -- -- -- -- -- -- --    11     10  1.292  36.819
     7       -- -- -- -- -- -- -- -- -- --        7      9  1.262  37.759
     3             -- -- -- -- --                3       8  1.213  38.564
       2  6 10 14 18 22 26 30 34 38 42 46 50             7  1.159  39.398
                                                         6  1.097  40.528
                                                         5  1.013  40.945*
                                                         4  0.914  40.086
Control Rod Density: %          5.44                     3  0.814  37.724
                                                         2  0.646  29.691
k-effective:                 1.00074             Bottom  1  0.185   8.715
Void Fraction:                 0.438
Core Delta-P: psia            20.874            % AXIAL TILT  -2.973 -13.871
Core Plate Delta-P: psia      16.330        AVG BOT 8ft/12ft  1.0357  1.0780
Coolant Temp: Deg-F            547.7
In Channel Flow: Mlb/hr        63.84   Active Channel Flow: Mlb/hr        61.65
Total Bypass Flow (%):          12.3   (of total core flow)
Total Water Rod Flow (%):        3.0   (of total core flow)
Source Convergence           0.00049
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.476	44	39	18	1.468	0.940	45	27	10	7.87	0.786	44.7	42	37	18	15	8.70	0.784	48.9	42	37	18	15
1.471	45	27	10	1.496	0.923	44	39	18	7.68	0.776	45.9	42	33	14	15	8.66	0.783	49.4	41	37	14	15
1.463	45	29	12	1.509	0.915	44	35	14	7.91	0.774	42.7	42	35	16	15	8.45	0.774	50.9	41	39	16	15
1.461	44	35	14	1.522	0.907	45	29	12	7.70	0.773	45.3	41	37	14	14	8.50	0.773	50.0	42	33	14	15
1.456	43	37	16	1.539	0.897	45	35	12	7.63	0.770	45.6	41	39	16	14	8.74	0.773	46.9	42	35	16	15
1.453	45	33	12	1.544	0.894	45	31	10	7.60	0.764	45.4	42	39	20	14	8.45	0.763	49.4	42	29	14	15
1.452	43	37	20	1.546	0.893	45	33	12	7.54	0.764	46.1	42	31	12	14	8.47	0.763	49.0	42	39	20	15
1.446	45	41	20	1.546	0.893	44	39	14	7.62	0.762	44.9	42	25	12	14	8.40	0.761	49.6	42	31	12	15
1.444	43	35	18	1.547	0.892	45	41	20	7.54	0.755	45.0	42	29	14	15	8.49	0.761	48.4	42	27	12	15
1.434	45	31	14	1.549	0.891	45	39	22	7.90	0.747	39.4	42	35	20	15	8.83	0.759	43.6	42	35	20	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.39 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 14,850.0 MWd/MTU

```
Cycle:                          23                       Core Average Exposure: MWd/MTU    31509.2
Exposure: MWd/MTU (GWd)    14851.0 (1508.04 )
Delta E: MWd/MTU, (GWd)        1.0 (    0.10 )                Axial Profile    Edit   Radial Power
Power: MWt                  2923.0 (100.00 %)            N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia         1044.7                      Top 25  0.225   6.060    37  0.685 0.700   3 24
Inlet Subcooling: Btu/lbm   -22.87                          24  0.501  15.494    38  0.376 0.601  47 16
Flow: Mlb/hr                 72.38 ( 94.00 %)               23  0.817  21.668    39  0.403 0.759  17 48
                                                            22  0.957  25.525    40  0.461 0.892   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                21  1.007  27.766    41  0.833 1.197  39 38
   51             -- -- -- -- -- --           51            20  1.060  29.411    42  1.108 1.295  27 26
   47       -- -- -- -- -- -- -- -- -- --     47            19  1.095  30.351    43  1.383 1.537  25 26
   43    -- -- -- -- -- -- -- -- -- -- -- --  43            18  1.135  31.489    44  1.223 1.408  39 18
   39    -- -- -- --  6 --  6 -- -- -- -- --  39            17  1.162  32.414    45  1.236 1.371  41 18
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35            16  1.177  33.066
   31 -- -- --  6 -- -- -- -- --  0 -- -- -- 31            15  1.211  33.672
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27            14  1.218  34.201
   23 -- -- --  0 -- -- -- -- --  6 -- -- -- 23            13  1.291  34.353
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19            12  1.305* 35.794
   15    -- -- -- --  6 --  0 -- -- -- --     15            11  1.286  36.852
   11    -- -- -- -- -- -- -- -- -- -- -- --  11            10  1.280  36.821
    7       -- -- -- -- -- -- -- -- -- --      7             9  1.250  37.760
    3             -- -- -- -- -- --            3             8  1.202  38.565
      2  6 10 14 18 22 26 30 34 38 42 46 50                 7  1.150  39.399
                                                             6  1.092  40.529
                                                             5  1.011  40.945*
                                                             4  0.916  40.087
Control Rod Density: %        5.38                           3  0.818  37.725
                                                             2  0.650  29.692
k-effective:               1.00043                  Bottom  1  0.186   8.716
Void Fraction:               0.437
Core Delta-P: psia          20.716                  % AXIAL TILT  -2.442 -13.871
Core Plate Delta-P: psia    16.174              AVG BOT 8ft/12ft  1.0318  1.0780
Coolant Temp: Deg-F          547.7
In Channel Flow: Mlb/hr      63.50   Active Channel Flow: Mlb/hr        61.32
Total Bypass Flow (%):        12.3   (of total core flow)
Total Water Rod Flow (%):      3.0   (of total core flow)
Source Convergence         0.00045
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.537	43	25	26	1.454	0.949	43	27	28	8.44	0.849	45.5	42	27	26	15	9.19	0.838	50.3	42	29	28	15
1.529	43	29	24	1.479	0.933	43	21	28	8.39	0.849	46.0	42	29	26	15	9.08	0.830	50.6	42	27	30	15
1.524	43	31	26	1.481	0.932	43	29	30	8.31	0.842	46.2	42	27	24	15	9.13	0.828	49.7	42	27	26	15
1.517	43	25	32	1.486	0.929	43	29	20	8.16	0.824	45.7	42	31	24	15	9.03	0.822	50.0	42	29	22	15
1.512	43	31	22	1.490	0.926	43	27	22	8.14	0.823	45.9	42	29	22	15	9.01	0.819	50.0	42	31	24	15
1.490	43	23	34	1.515	0.911	43	21	32	7.95	0.803	45.7	42	33	26	15	8.84	0.800	49.4	42	27	20	15
1.476	43	33	24	1.525	0.905	43	19	30	7.98	0.801	45.3	42	27	20	15	9.05	0.799	46.7	42	31	20	15
1.474	43	33	20	1.556	0.887	43	33	20	8.18	0.799	42.6	42	31	20	15	8.86	0.798	48.9	42	19	28	15
1.439	43	35	18	1.580	0.873	44	39	18	7.92	0.799	45.7	42	33	22	15	8.76	0.797	50.0	42	33	22	15
1.408	44	39	18	1.586	0.870	43	31	18	7.71	0.766	44.3	42	33	18	15	8.60	0.771	48.4	42	33	18	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.40 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 14,851.0 MWd/MTU

```
Cycle:                             23                Core Average Exposure: MWd/MTU    31858.3
Exposure: MWd/MTU (GWd)       15200.0 (1543.48 )
Delta E: MWd/MTU, (GWd)         349.0 (  35.44 )           Axial Profile    Edit   Radial Power
Power: MWt                     2923.0 (100.00 %)      N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia            1044.7                Top 25  0.231   6.146    37  0.687 0.702   3 24
Inlet Subcooling: Btu/lbm      -22.21                    24  0.516  15.685    38  0.377 0.602  47 16
Flow: Mlb/hr                    74.31 ( 96.50 %)         23  0.843  21.982    39  0.404 0.763  17 48
                                                         22  0.988  25.893    40  0.462 0.896   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50              21  1.039  28.155    41  0.836 1.200  39 38
   51             -- -- -- -- -- --           51         20  1.093  29.820    42  1.103 1.269  27 26
   47       -- -- -- -- -- -- -- -- -- --     47         19  1.129  30.774    43  1.371 1.509  27 28
   43    -- -- -- -- -- -- -- -- -- -- -- --  43         18  1.168  31.926    44  1.231 1.410  39 18
   39    -- -- -- --  6 --  6 -- -- -- -- --  39         17  1.192  32.861    45  1.243 1.376  41 18
   35 -- -- -- -- -- -- -- -- -- -- -- -- --  35         16  1.203  33.514
   31 -- -- --  6 -- -- -- -- --  0 -- -- --  31         15  1.234  34.121
   27 -- -- -- -- -- -- -- -- -- -- -- -- --  27         14  1.236  34.651
   23 -- -- --  0 -- -- -- -- --  6 -- -- --  23         13  1.304  34.790
   19 -- -- -- -- -- -- -- -- -- -- -- -- --  19         12  1.312* 36.235
   15    -- -- -- --  6 --  0 -- -- -- -- --  15         11  1.286  37.285
   11    -- -- -- -- -- -- -- -- -- -- -- --  11         10  1.274  37.233
    7       -- -- -- -- -- -- -- -- -- --      7          9  1.237  38.160
    3             -- -- -- -- -- --            3          8  1.183  38.949
      2  6 10 14 18 22 26 30 34 38 42 46 50               7  1.122  39.765
                                                          6  1.053  40.874
                                                          5  0.963  41.263*
                                                          4  0.860  40.373
Control Rod Density: %           5.38                     3  0.760  37.979
                                                          2  0.601  29.893
k-effective:                  1.00037             Bottom  1  0.172   8.778
Void Fraction:                  0.427
Core Delta-P: psia             21.415             % AXIAL TILT   0.208 -13.651
Core Plate Delta-P: psia       16.872          AVG BOT 8ft/12ft  1.0174  1.0770
Coolant Temp: Deg-F             547.6
In Channel Flow: Mlb/hr         65.26   Active Channel Flow: Mlb/hr        63.05
Total Bypass Flow (%):           12.2   (of total core flow)
Total Water Rod Flow (%):         3.0   (of total core flow)
Source Convergence            0.00020
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.509	43	27	28	1.504	0.918	43	27	28	8.31	0.846	46.6	42	29	26	15	9.10	0.836	51.1	42	29	28	15
1.503	43	23	30	1.522	0.907	43	29	30	8.35	0.846	46.1	42	27	26	15	9.01	0.828	51.2	42	27	30	15
1.498	43	21	28	1.525	0.905	43	21	28	8.22	0.839	46.8	42	27	24	15	9.03	0.824	50.4	42	27	26	15
1.494	43	25	32	1.527	0.903	43	29	20	8.11	0.823	46.3	42	31	24	15	8.97	0.821	50.7	42	29	22	15
1.491	43	21	32	1.534	0.900	43	27	22	8.09	0.823	46.4	42	29	22	15	8.96	0.818	50.4	42	21	30	15
1.474	43	23	34	1.556	0.887	43	21	32	7.92	0.804	46.3	42	33	26	15	9.04	0.803	47.4	42	31	20	15
1.461	43	33	20	1.557	0.886	43	19	30	7.92	0.804	46.3	42	33	22	15	8.81	0.801	50.0	42	27	20	15
1.456	43	33	24	1.590	0.868	44	13	36	7.95	0.804	45.9	42	27	20	15	8.84	0.801	49.6	42	19	28	15
1.433	43	35	18	1.591	0.867	43	19	20	8.17	0.803	43.2	42	31	20	15	8.75	0.801	50.7	42	33	22	15
1.410	44	39	18	1.602	0.861	44	35	14	7.75	0.775	44.8	42	33	18	15	8.65	0.779	49.0	42	33	18	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.41 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 15,200.0 MWd/MTU

```
Cycle:                             23
Exposure: MWd/MTU (GWd)       15600.0 (1584.10 )
Delta E: MWd/MTU, (GWd)         400.0 (  40.62 )
Power: MWt                     2923.0 (100.00 %)
Core Pressure: psia            1044.8
Inlet Subcooling: Btu/lbm      -21.33
Flow: Mlb/hr                    77.00 (100.00 %)

       2  6 10 14 18 22 26 30 34 38 42 46 50
   51             -- -- -- -- -- --             51
   47       -- -- -- -- -- -- -- -- -- --       47
   43    -- -- -- -- -- -- -- -- -- -- -- --    43
   39    -- -- -- --  6 --  6 -- -- -- -- --    39
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35
   31 -- -- --  6 -- -- -- -- --  0 -- -- -- 31
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27
   23 -- -- --  0 -- -- -- -- --  6 -- -- -- 23
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19
   15    -- -- -- --  6 --  0 -- -- -- -- --    15
   11    -- -- -- -- -- -- -- -- -- -- -- --    11
    7       -- -- -- -- -- -- -- -- -- --        7
    3             -- -- -- -- -- --              3
       2  6 10 14 18 22 26 30 34 38 42 46 50

Control Rod Density: %           5.38

k-effective:                  1.00048
Void Fraction:                  0.415
Core Delta-P: psia             22.439
Core Plate Delta-P: psia       17.893
Coolant Temp: Deg-F             547.6
In Channel Flow: Mlb/hr         67.72   Active Channel Flow: Mlb/hr        65.46
Total Bypass Flow (%):           12.0   (of total core flow)
Total Water Rod Flow (%):         2.9   (of total core flow)
Source Convergence            0.00050
```

Core Average Exposure: MWd/MTU 32258.3

Axial Profile

N(PRA)	Power	Exposure
Top 25	0.238	6.246
24	0.532	15.911
23	0.872	22.354
22	1.022	26.330
21	1.076	28.616
20	1.132	30.304
19	1.167	31.274
18	1.205	32.443
17	1.227	33.388
16	1.233	34.039
15	1.259	34.646
14	1.255	35.175
13	1.318	35.297
12	1.320*	36.743
11	1.286	37.781
10	1.268	37.704
9	1.224	38.614
8	1.161	39.381
7	1.089	40.172
6	1.009	41.254
5	0.908	41.608*
4	0.798	40.679
3	0.696	38.247
2	0.548	30.104
Bottom 1	0.157	8.843
% AXIAL TILT	3.178	-13.370
AVG BOT 8ft/12ft	1.0013	1.0756

Edit Zone	Radial Power Avg.	Max.	IR	JR
37	0.690	0.705	3	24
38	0.377	0.602	47	16
39	0.405	0.766	17	48
40	0.463	0.901	5	34
41	0.839	1.202	39	38
42	1.099	1.246	21	30
43	1.359	1.482	27	28
44	1.239	1.410	39	18
45	1.250	1.382	41	18

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.482	43	27	28	1.560	0.885	43	27	28	8.25	0.845	47.1	42	23	28	15	9.03	0.835	51.8	42	29	28	15
1.478	43	23	30	1.566	0.881	43	29	30	8.27	0.844	46.8	42	27	26	15	8.95	0.829	52.0	42	27	30	15
1.474	43	21	28	1.575	0.876	43	21	28	8.16	0.839	47.5	42	27	24	15	8.95	0.822	51.1	42	27	26	15
1.472	43	21	32	1.577	0.875	43	29	20	7.98	0.826	48.0	42	21	24	15	8.92	0.822	51.4	42	29	22	15
1.472	43	25	32	1.583	0.872	43	27	22	7.96	0.824	48.1	42	23	22	15	8.94	0.822	51.2	42	21	30	15
1.457	43	23	34	1.595	0.865	43	19	30	7.91	0.809	46.9	42	33	22	15	9.02	0.807	48.1	42	31	20	15
1.446	43	33	20	1.597	0.864	43	21	32	7.97	0.808	46.2	42	19	26	15	8.84	0.806	50.3	42	19	28	15
1.436	43	33	24	1.601	0.862	44	13	36	8.16	0.808	43.8	42	31	20	15	8.74	0.805	51.4	42	33	22	15
1.425	43	35	18	1.622	0.851	44	35	14	7.93	0.807	46.6	42	27	20	15	8.78	0.804	50.8	42	27	20	15
1.410	44	39	18	1.625	0.849	43	19	20	7.80	0.785	45.5	42	33	18	15	8.69	0.788	49.7	42	33	18	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.42 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 15,600.0 MWd/MTU

```
Cycle:                          23
Exposure: MWd/MTU (GWd)    16000.0 (1624.72 )
Delta E: MWd/MTU, (GWd)      400.0 (  40.62 )
Power: MWt                  2923.0 (100.00 %)
Core Pressure: psia         1044.8
Inlet Subcooling: Btu/lbm   -20.29
Flow: Mlb/hr                 80.46 (104.50 %)

       2  6 10 14 18 22 26 30 34 38 42 46 50
   51             -- -- -- -- --             51
   47       -- -- -- -- -- -- -- -- --       47
   43    -- -- -- -- -- -- -- -- -- -- --    43
   39    -- -- -- --  6 --  6 -- -- -- --    39
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35
   31 -- -- --  6 -- -- -- -- --  0 -- -- -- 31
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27
   23 -- -- --  0 -- -- -- -- --  6 -- -- -- 23
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19
   15    -- -- -- --  6 --  0 -- -- -- --    15
   11    -- -- -- -- -- -- -- -- -- -- --    11
    7       -- -- -- -- -- -- -- -- --        7
    3             -- -- -- -- --              3
       2  6 10 14 18 22 26 30 34 38 42 46 50


Control Rod Density: %          5.38

k-effective:                 1.00060
Void Fraction:                 0.401
Core Delta-P: psia            23.814
Core Plate Delta-P: psia      19.267
Coolant Temp: Deg-F            547.6
In Channel Flow: Mlb/hr        70.88   Active Channel Flow: Mlb/hr      68.56
Total Bypass Flow (%):          11.9   (of total core flow)
Total Water Rod Flow (%):        2.9   (of total core flow)
Source Convergence           0.00046
```

Core Average Exposure: MWd/MTU 32658.3

N(PRA)	Axial Profile Power	Axial Profile Exposure
Top 25	0.245	6.350
24	0.549	16.144
23	0.904	22.740
22	1.059	26.782
21	1.116	29.093
20	1.174	30.806
19	1.208	31.791
18	1.244	32.977
17	1.261	33.930
16	1.261	34.577
15	1.283	35.181
14	1.272	35.707
13	1.330*	35.808
12	1.324	37.253
11	1.281	38.276
10	1.257	38.171
9	1.208	39.063
8	1.137	39.805
7	1.054	40.568
6	0.963	41.618
5	0.854	41.933*
4	0.739	40.962
3	0.637	38.493
2	0.500	30.297
Bottom 1	0.143	8.902
% AXIAL TILT	6.256	-13.058
AVG BOT 8ft/12ft	0.9841	1.0741

Edit Zone	Radial Power Avg.	Radial Power Max.	IR	JR
37	0.692	0.708	3	24
38	0.377	0.602	47	16
39	0.405	0.770	17	48
40	0.463	0.906	5	34
41	0.842	1.204	39	38
42	1.094	1.229	31	20
43	1.346	1.456	27	28
44	1.248	1.410	39	18
45	1.258	1.386	41	18

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	Power FT	Power IR	Power JR	MCPR Value	MCPR Margin	MCPR FT	MCPR IR	MCPR JR	APLHGR Value	APLHGR Margin	APLHGR Exp.	APLHGR FT	APLHGR IR	APLHGR JR	APLHGR K	LHGR Value	LHGR Margin	LHGR Exp.	LHGR FT	LHGR IR	LHGR JR	LHGR K
1.456	43	27	28	1.609	0.858	43	27	28	8.38	0.844	45.5	42	27	26	17	9.15	0.834	50.3	42	29	28	17
1.455	43	21	32	1.613	0.856	43	29	30	8.34	0.844	45.9	42	23	26	17	9.08	0.830	50.6	42	27	30	17
1.455	43	23	30	1.616	0.854	44	13	36	8.27	0.839	46.2	42	25	24	17	8.90	0.823	51.9	42	21	30	15
1.451	43	21	28	1.621	0.851	43	21	28	8.11	0.829	46.9	42	31	30	17	9.06	0.821	49.7	42	27	26	17
1.450	43	25	32	1.625	0.849	43	29	20	8.13	0.828	46.6	42	23	22	17	8.85	0.821	52.2	42	29	22	15
1.441	43	23	34	1.632	0.846	43	27	22	7.89	0.812	47.6	42	33	22	15	8.89	0.811	50.4	42	21	20	15
1.437	43	19	34	1.634	0.844	43	19	30	7.94	0.811	46.9	42	19	26	15	8.86	0.809	50.4	42	19	22	15
1.422	43	17	36	1.642	0.840	43	21	32	8.13	0.811	44.5	42	31	20	15	8.81	0.808	51.0	42	19	28	15
1.420	43	19	30	1.648	0.838	44	35	14	8.09	0.810	45.0	42	25	20	17	8.76	0.808	51.5	41	37	14	15
1.410	44	39	18	1.654	0.834	44	39	40	7.83	0.798	46.6	42	37	18	15	8.73	0.805	51.5	42	27	20	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.43 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 16,000.0 MWd/MTU

```
Cycle:                          23                    Core Average Exposure: MWd/MTU    32659.2
Exposure: MWd/MTU (GWd)     16001.0 (1624.82 )
Delta E: MWd/MTU, (GWd)         1.0 (   0.10 )              Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)         N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                    Top 25  0.274   6.350    37  0.690 0.709   3 24
Inlet Subcooling: Btu/lbm    -24.15                        24  0.608  16.144    38  0.377 0.603  47 16
Flow: Mlb/hr                  68.92 ( 89.50 %)             23  0.997  22.741    39  0.403 0.755  17 48
                                                           22  1.168  26.783    40  0.461 0.897   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50               21  1.231  29.094    41  0.835 1.192  37 14
   51             -- -- -- -- --             51            20  1.257  30.808    42  1.105 1.248  35 20
   47       -- -- -- -- -- -- -- -- --       47            19  1.257  31.793    43  1.357 1.451  31 22
   43    -- -- -- -- -- -- -- -- -- -- --    43            18  1.266  32.978    44  1.229 1.408  39 18
   39    -- -- -- --  8 --  8 -- -- -- --    39            17  1.261  33.931    45  1.253 1.381  43 26
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35            16  1.244  34.579
   31 -- -- -- 10 -- -- -- -- --  8 -- -- -- 31            15  1.250  35.182
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27            14  1.227  35.708
   23 -- -- --  8 -- -- -- -- -- 10 -- -- -- 23            13  1.273* 35.809
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19            12  1.260  37.254
   15    -- -- -- --  8 --  8 -- -- -- --    15            11  1.217  38.277
   11    -- -- -- -- -- -- -- -- -- -- --    11            10  1.193  38.172
    7       -- -- -- -- -- -- -- -- --        7             9  1.147  39.064
    3             -- -- -- -- --              3             8  1.084  39.806
       2  6 10 14 18 22 26 30 34 38 42 46 50                7  1.012  40.569
                                                            6  0.932  41.619
                                                            5  0.835  41.934*
                                                            4  0.730  40.963
Control Rod Density: %         4.81                         3  0.634  38.493
                                                            2  0.499  30.298
k-effective:                1.00024                 Bottom  1  0.143   8.902
Void Fraction:                0.415
Core Delta-P: psia           18.964               % AXIAL TILT   9.925 -13.057
Core Plate Delta-P: psia     14.429           AVG BOT 8ft/12ft  0.9512  1.0741
Coolant Temp: Deg-F           547.1
In Channel Flow: Mlb/hr       60.56   Active Channel Flow: Mlb/hr        58.52
Total Bypass Flow (%):         12.1   (of total core flow)
Total Water Rod Flow (%):       3.0   (of total core flow)
Source Convergence          0.00022
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.451	43	31	22	1.477	0.935	43	29	20	8.48	0.851	45.1	42	29	26	18	9.28	0.840	49.5	42	29	28	18
1.446	43	33	20	1.478	0.934	43	21	28	8.47	0.847	44.9	42	27	26	18	9.85	0.833	41.7	42	37	22	21
1.445	43	31	26	1.481	0.932	43	27	22	8.42	0.846	45.3	42	27	24	18	9.19	0.832	49.5	42	25	24	18
1.444	43	25	26	1.482	0.931	44	39	18	8.41	0.841	44.9	42	31	24	18	9.23	0.832	49.1	42	29	22	18
1.444	43	29	24	1.488	0.927	43	27	28	8.37	0.838	45.0	42	29	22	18	9.21	0.830	49.1	42	31	24	18
1.441	43	27	22	1.491	0.925	43	29	30	8.40	0.834	44.1	42	33	22	18	9.24	0.827	48.2	42	33	22	18
1.440	43	29	20	1.496	0.922	43	33	20	8.34	0.831	44.5	42	33	26	18	9.15	0.825	49.1	42	27	26	18
1.427	43	33	24	1.496	0.922	43	21	22	8.55	0.826	41.5	42	31	20	18	9.41	0.821	45.5	42	31	20	18
1.427	43	35	18	1.502	0.919	43	19	30	8.68	0.825	39.9	42	37	22	20	9.14	0.820	48.6	42	33	26	18
1.408	44	39	18	1.506	0.916	44	35	14	8.30	0.823	44.0	42	27	20	18	9.17	0.818	48.0	42	27	20	18

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.44 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 16,001.0 MWd/MTU

```
Cycle:                            23                   Core Average Exposure: MWd/MTU    33158.2
Exposure: MWd/MTU (GWd)      16500.0 (1675.49 )
Delta E: MWd/MTU, (GWd)        499.0 (  50.67 )              Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                    Top 25  0.282   6.499    37  0.693 0.713   3 24
Inlet Subcooling: Btu/lbm     -22.34                        24  0.627  16.476    38  0.377 0.602  47 16
Flow: Mlb/hr                   73.92 ( 96.00 %)             23  1.033  23.291    39  0.404 0.760  17 48
                                                            22  1.211  27.427    40  0.461 0.904   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50                21  1.279  29.776    41  0.838 1.194  39 38
   51              -- -- -- -- -- --          51            20  1.305  31.504    42  1.099 1.233  35 20
   47        -- -- -- -- -- -- -- -- -- --    47            19  1.302  32.488    43  1.341 1.425  33 20
   43     -- -- -- -- -- -- -- -- -- -- -- -- 43            18  1.308* 33.677    44  1.240 1.406  39 18
   39     -- -- -- -- --  8 --  8 -- -- -- -- 39            17  1.298  34.626    45  1.263 1.390  43 26
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35             16  1.274  35.256
   31 -- -- -- 10 -- -- -- -- -- --  8 -- -- -- 31          15  1.275  35.845
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27             14  1.245  36.357
   23 -- -- --  8 -- -- -- -- -- 10 -- -- -- 23             13  1.286  36.425
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19             12  1.266  37.863
   15     -- -- -- -- --  8 --  8 -- -- -- -- 15            11  1.214  38.862
   11     -- -- -- -- -- -- -- -- -- -- -- -- 11            10  1.183  38.721
    7        -- -- -- -- -- -- -- -- -- --     7             9  1.131  39.588
    3              -- -- -- -- -- --           3             8  1.057  40.299
       2  6 10 14 18 22 26 30 34 38 42 46 50                 7  0.973  41.025
                                                             6  0.881  42.036
                                                             5  0.772  42.303*
                                                             4  0.661  41.283
Control Rod Density: %          4.81                         3  0.566  38.769
                                                             2  0.444  30.515
k-effective:                 1.00035                 Bottom  1  0.127   8.969
Void Fraction:                 0.397
Core Delta-P: psia            20.834              % AXIAL TILT  13.340 -12.572
Core Plate Delta-P: psia      16.296          AVG BOT 8ft/12ft  0.9318  1.0716
Coolant Temp: Deg-F            547.2
In Channel Flow: Mlb/hr        65.10   Active Channel Flow: Mlb/hr       62.95
Total Bypass Flow (%):          11.9   (of total core flow)
Total Water Rod Flow (%):        2.9   (of total core flow)
Source Convergence           0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.425	43	33	20	1.533	0.900	44	39	18	8.42	0.852	46.0	42	29	26	18	10.03	0.856	42.7	42	37	22	21
1.422	43	31	22	1.545	0.893	45	43	26	8.41	0.849	45.8	42	27	26	18	9.23	0.842	50.4	42	29	28	18
1.416	43	21	28	1.548	0.892	43	21	28	8.84	0.848	40.8	42	37	22	20	9.91	0.842	42.2	42	39	24	21
1.414	43	35	18	1.549	0.891	43	29	20	8.36	0.848	46.2	42	27	24	18	9.20	0.836	49.9	42	29	22	18
1.414	43	29	20	1.551	0.890	44	35	14	8.37	0.845	45.8	42	31	24	18	9.15	0.836	50.5	42	25	24	18
1.410	43	23	30	1.554	0.888	43	27	22	8.30	0.844	46.5	42	23	22	18	9.12	0.835	50.7	42	21	24	18
1.410	43	25	26	1.560	0.885	43	19	20	8.42	0.843	45.0	42	33	22	18	9.24	0.834	49.2	42	33	22	18
1.409	43	27	22	1.561	0.884	43	21	22	8.33	0.837	45.4	42	33	26	18	9.61	0.832	44.4	42	35	24	20
1.406	44	39	18	1.563	0.883	43	19	30	8.75	0.836	40.4	42	35	24	20	9.42	0.830	46.4	42	31	20	18
1.401	43	19	30	1.567	0.881	44	39	14	8.57	0.835	42.4	42	31	20	18	9.23	0.829	48.6	42	19	28	18

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.45 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 16,500.0 MWd/MTU

```
Cycle:                            23                   Core Average Exposure: MWd/MTU    33658.3
Exposure: MWd/MTU (GWd)      17000.0 (1726.26 )
Delta E: MWd/MTU, (GWd)        500.0 (  50.77 )              Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)         N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.8                   Top 25  0.290   6.652    37  0.695 0.717   3 24
Inlet Subcooling: Btu/lbm     -20.29                       24  0.648  16.819    38  0.376 0.600  47 16
Flow: Mlb/hr                   80.46 (104.50 %)            23  1.072  23.862    39  0.404 0.764  17 48
                                                           22  1.257  28.097    40  0.461 0.912   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50                 21  1.330  30.486    41  0.842 1.198  13 38
  51             -- -- -- -- --             51             20  1.357* 32.228    42  1.092 1.218  35 20
  47       -- -- -- -- -- -- -- -- -- --       47          19  1.350  33.210    43  1.324 1.404  19 34
  43    -- -- -- -- -- -- -- -- -- -- -- --    43          18  1.350  34.401    44  1.253 1.405  13 36
  39    -- -- -- --  8 --  8 -- -- -- -- --    39          17  1.333  35.343    45  1.274 1.400  43 26
  35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35             16  1.302  35.951
  31 -- -- -- 10 -- -- -- -- --  8 -- -- -- 31             15  1.297  36.521
  27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27             14  1.260  37.016
  23 -- -- --  8 -- -- -- -- -- 10 -- -- -- 23             13  1.295  37.047
  19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19             12  1.268  38.474
  15    -- -- -- --  8 --  8 -- -- -- -- --    15          11  1.208  39.446
  11    -- -- -- -- -- -- -- -- -- -- -- --    11          10  1.171  39.266
   7       -- -- -- -- -- -- -- -- -- --        7           9  1.112  40.105
   3             -- -- -- -- --              3              8  1.027  40.779
     2  6 10 14 18 22 26 30 34 38 42 46 50                  7  0.930  41.464
                                                            6  0.826  42.430
                                                            5  0.709  42.645*
                                                            4  0.596  41.572
Control Rod Density: %          4.81                        3  0.505  39.016
                                                            2  0.394  30.707
k-effective:                 1.00059               Bottom  1  0.113   9.029
Void Fraction:                 0.377
Core Delta-P: psia            23.443            % AXIAL TILT  16.831 -12.049
Core Plate Delta-P: psia      18.901        AVG BOT 8ft/12ft  0.9113  1.0688
Coolant Temp: Deg-F            547.3
In Channel Flow: Mlb/hr        71.03   Active Channel Flow: Mlb/hr        68.76
Total Bypass Flow (%):          11.7   (of total core flow)
Total Water Rod Flow (%):        2.8   (of total core flow)
Source Convergence           0.00034
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.405	44	13	36	1.574	0.889	44	13	36	9.00	0.872	41.8	42	37	22	20	10.21	0.879	43.7	42	37	22	21
1.404	43	19	34	1.582	0.885	45	43	28	9.12	0.858	38.9	42	39	24	21	10.13	0.867	43.2	42	39	24	21
1.404	43	17	36	1.600	0.875	44	35	14	8.58	0.855	44.5	42	33	22	19	9.72	0.848	45.4	42	35	24	20
1.400	45	43	26	1.601	0.875	45	11	36	8.37	0.855	46.9	42	23	26	18	9.52	0.846	47.5	42	33	22	20
1.398	43	21	32	1.609	0.870	45	43	22	8.86	0.854	41.3	42	35	24	20	10.10	0.846	40.5	42	35	20	20
1.390	43	15	38	1.613	0.868	44	39	14	8.31	0.853	47.4	42	21	24	18	9.17	0.844	51.4	42	29	28	18
1.387	45	41	18	1.619	0.865	45	27	10	8.29	0.851	47.4	42	23	22	18	9.11	0.841	51.7	42	21	24	18
1.387	43	21	28	1.621	0.864	43	19	20	8.30	0.850	47.1	42	25	24	18	9.36	0.840	48.6	42	21	20	18
1.387	43	29	20	1.622	0.863	45	41	20	8.33	0.849	46.6	42	27	26	18	9.17	0.840	50.8	42	29	22	18
1.380	43	19	30	1.622	0.863	43	21	28	8.40	0.845	45.4	42	19	28	18	9.26	0.839	49.6	42	19	28	18

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.46 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 17,000.0 MWd/MTU

```
Cycle:                           23                Core Average Exposure: MWd/MTU    33659.3
Exposure: MWd/MTU (GWd)     17001.0 (1726.36 )
Delta E: MWd/MTU, (GWd)         1.0 (    0.10 )           Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)      N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                Top 25  0.270   6.652    37  0.698 0.724   3 24
Inlet Subcooling: Btu/lbm    -22.73                    24  0.601  16.820    38  0.378 0.600  47 16
Flow: Mlb/hr                  72.76 ( 94.50 %)         23  0.991  23.863    39  0.406 0.769  17 48
                                                       22  1.164  28.099    40  0.464 0.916   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50           21  1.239  30.487    41  0.845 1.216   9 30
   51             -- -- -- -- -- --          51        20  1.290  32.230    42  1.085 1.234  41 22
   47       -- -- -- -- -- -- -- -- -- --    47        19  1.304  33.211    43  1.261 1.397  33 16
   43    -- -- -- -- -- -- -- -- -- -- -- -- 43        18  1.321* 34.402    44  1.263 1.424  13 36
   39    -- -- -- -- -- 10 -- -- -- -- -- -- 39        17  1.319  35.344    45  1.320 1.442  43 26
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35        16  1.301  35.953
   31 -- -- -- --  8 -- -- --  6 -- -- -- -- 31        15  1.304  36.523
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27        14  1.272  37.017
   23 -- -- -- --  6 -- -- --  8 -- -- -- -- 23        13  1.309  37.049
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19        12  1.283  38.475
   15    -- -- -- -- -- 10 -- -- -- -- -- -- 15        11  1.225  39.448
   11    -- -- -- -- -- -- -- -- -- -- -- -- 11        10  1.192  39.267
    7       -- -- -- -- -- -- -- -- -- --     7         9  1.135  40.106
    3             -- -- -- -- -- --           3         8  1.057  40.780
       2  6 10 14 18 22 26 30 34 38 42 46 50            7  0.970  41.464
                                                        6  0.877  42.430
                                                        5  0.770  42.646*
                                                        4  0.661  41.573
Control Rod Density: %         3.65                     3  0.568  39.017
                                                        2  0.447  30.708
k-effective:                1.00030             Bottom  1  0.129   9.029
Void Fraction:                0.400
Core Delta-P: psia           20.391            % AXIAL TILT  12.932 -12.048
Core Plate Delta-P: psia     15.858        AVG BOT 8ft/12ft  0.9402  1.0688
Coolant Temp: Deg-F           547.1
In Channel Flow: Mlb/hr       64.05  Active Channel Flow: Mlb/hr        61.93
Total Bypass Flow (%):         12.0  (of total core flow)
Total Water Rod Flow (%):       2.9  (of total core flow)
Source Convergence          0.00033
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.442	45	43	26	1.494	0.937	45	43	28	8.82	0.841	40.2	42	27	16	21	9.78	0.843	44.0	42	27	16	21
1.434	45	41	24	1.515	0.924	45	31	14	8.20	0.835	46.6	42	33	14	17	9.19	0.832	49.5	41	37	14	17
1.424	44	13	36	1.521	0.921	44	13	36	8.36	0.823	43.4	42	35	16	17	8.64	0.828	54.6	41	39	16	15
1.423	45	41	20	1.521	0.920	45	11	30	8.13	0.822	46.0	42	37	18	17	9.00	0.825	50.9	42	33	14	17
1.418	45	39	22	1.526	0.917	45	13	28	8.23	0.820	44.6	41	37	14	17	8.83	0.817	52.0	41	43	24	15
1.416	45	13	28	1.533	0.913	44	35	14	8.21	0.818	44.5	42	33	18	18	9.16	0.816	47.6	42	35	16	17
1.413	45	31	14	1.538	0.910	45	13	32	8.22	0.816	44.1	42	21	16	18	9.46	0.816	44.0	42	29	14	20
1.413	44	35	14	1.541	0.908	45	35	12	7.83	0.816	48.8	41	13	16	15	8.95	0.815	50.2	42	37	18	17
1.407	45	33	12	1.544	0.907	45	43	22	7.89	0.812	47.6	42	13	34	15	9.05	0.813	48.7	42	33	18	18
1.401	45	41	18	1.545	0.906	45	27	10	7.92	0.811	47.2	42	41	26	15	8.76	0.812	52.2	42	13	20	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.47 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 17,001.0 MWd/MTU

```
Cycle:                          23                    Core Average Exposure: MWd/MTU    34158.3
Exposure: MWd/MTU (GWd)    17500.0 (1777.03 )
Delta E: MWd/MTU, (GWd)      499.0 (  50.67 )                Axial Profile    Edit   Radial Power
Power: MWt                  2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia         1044.8                    Top 25  0.279   6.799    37  0.699 0.727   3 24
Inlet Subcooling: Btu/lbm   -20.29                        24  0.624  17.149    38  0.376 0.596  47 16
Flow: Mlb/hr                 80.46 (104.50 %)             23  1.034  24.412    39  0.405 0.773  17 48
                                                          22  1.214  28.743    40  0.463 0.922   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50              21  1.293  31.175    41  0.848 1.227   9 30
   51             -- -- -- -- -- --           51          20  1.344  32.945    42  1.080 1.232  41 22
   47       -- -- -- -- -- -- -- -- -- --     47          19  1.353  33.933    43  1.249 1.400  15 38
   43    -- -- -- -- -- -- -- -- -- -- -- --  43          18  1.365* 35.132    44  1.272 1.431  13 36
   39    -- -- -- -- -- 10 -- -- -- -- -- --  39          17  1.355  36.070    45  1.329 1.452   9 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35          16  1.328  36.660
   31 -- -- -- -- --  8 -- -- --  6 -- -- -- -- 31       15  1.325  37.213
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27          14  1.286  37.689
   23 -- -- -- --  6 -- -- --  8 -- -- -- -- 23          13  1.316  37.681
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19          12  1.283  39.093
   15    -- -- -- -- -- 10 -- -- -- -- -- --  15          11  1.218  40.036
   11    -- -- -- -- -- -- -- -- -- -- -- --  11          10  1.178  39.814
    7       -- -- -- -- -- -- -- -- -- --      7           9  1.114  40.624
    3             -- -- -- -- -- --            3           8  1.025  41.259
       2  6 10 14 18 22 26 30 34 38 42 46 50               7  0.926  41.901
                                                           6  0.822  42.821
                                                           5  0.706  42.985*
                                                           4  0.595  41.862
Control Rod Density: %        3.65                         3  0.506  39.264
                                                           2  0.396  30.902
k-effective:               1.00034                 Bottom  1  0.114   9.089
Void Fraction:               0.377
Core Delta-P: psia          23.461              % AXIAL TILT  16.535 -11.548
Core Plate Delta-P: psia    18.923          AVG BOT 8ft/12ft  0.9186  1.0663
Coolant Temp: Deg-F          547.3
In Channel Flow: Mlb/hr      71.03   Active Channel Flow: Mlb/hr        68.75
Total Bypass Flow (%):        11.7   (of total core flow)
Total Water Rod Flow (%):      2.8   (of total core flow)
Source Convergence         0.00048
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.452	45	9	28	1.539	0.910	45	9	26	9.02	0.868	41.1	42	27	16	21	10.00	0.871	45.0	42	27	16	21
1.440	45	11	30	1.570	0.892	44	13	36	8.38	0.856	46.8	42	33	14	18	8.94	0.865	55.1	41	13	16	15
1.431	44	13	36	1.571	0.891	45	11	30	8.40	0.845	45.4	41	37	14	17	8.87	0.861	55.2	41	37	40	15
1.430	45	11	34	1.578	0.887	45	13	28	8.60	0.844	43.0	42	35	16	18	9.22	0.849	51.3	42	19	14	17
1.422	45	13	32	1.582	0.885	45	21	14	8.28	0.843	46.5	41	13	16	17	9.74	0.847	45.0	42	29	14	20
1.422	45	13	28	1.590	0.880	45	27	44	8.24	0.841	46.8	42	37	18	17	9.05	0.845	52.9	41	43	24	15
1.413	44	17	40	1.592	0.879	45	11	36	8.75	0.841	40.9	42	29	14	20	9.05	0.838	52.0	42	11	28	15
1.412	45	11	36	1.592	0.879	44	17	40	8.31	0.840	45.9	42	13	34	17	9.44	0.837	47.2	42	35	16	18
1.408	45	9	32	1.593	0.879	45	13	32	8.37	0.838	45.0	42	21	16	18	9.17	0.836	50.2	42	13	20	17
1.407	45	31	14	1.597	0.877	45	9	32	8.32	0.838	45.5	42	41	26	17	9.08	0.834	51.1	42	37	18	17

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.48 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 17,500.0 MWd/MTU

```
Cycle:                          23                        Core Average Exposure: MWd/MTU    34159.3
Exposure: MWd/MTU (GWd)     17501.0 (1777.14 )
Delta E: MWd/MTU, (GWd)         1.0 (   0.10 )                Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                    Top 25  0.260   6.799    37  0.684 0.707   3 24
Inlet Subcooling: Btu/lbm    -22.20                        24  0.579  17.150    38  0.371 0.584  37 48
Flow: Mlb/hr                  74.31 ( 96.50 %)             23  0.956  24.413    39  0.400 0.770  17 48
                                                           22  1.123  28.744    40  0.456 0.896   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                21  1.202  31.177    41  0.835 1.189   9 24
   51             -- -- -- -- -- --            51          20  1.270  32.947    42  1.089 1.254  31 16
   47       -- -- -- -- -- -- -- -- -- --       47          19  1.305  33.935    43  1.256 1.450  29 16
   43    -- -- -- -- -- -- -- -- -- -- -- --    43          18  1.335  35.133    44  1.257 1.406  17 40
   39    -- -- -- -- -- -- -- -- -- -- -- --    39          17  1.341* 36.072    45  1.337 1.476  27 14
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 35          16  1.328  36.662
   31 -- -- -- --  6 -- -- --  6 -- -- -- -- 31          15  1.333  37.214
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 27          14  1.299  37.690
   23 -- -- -- --  6 -- -- --  6 -- -- -- -- 23          13  1.333  37.682
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 19          12  1.301  39.094
   15    -- -- -- -- -- -- -- -- -- -- -- --    15          11  1.237  40.037
   11    -- -- -- -- -- -- -- -- -- -- -- --    11          10  1.199  39.815
    7       -- -- -- -- -- -- -- -- -- --        7           9  1.138  40.625
    3             -- -- -- -- -- --              3           8  1.055  41.260
      2  6 10 14 18 22 26 30 34 38 42 46 50                 7  0.965  41.901
                                                            6  0.871  42.822
                                                            5  0.764  42.986*
                                                            4  0.658  41.863
Control Rod Density: %         2.55                         3  0.568  39.264
                                                            2  0.449  30.902
k-effective:                1.00017                 Bottom  1  0.130   9.089
Void Fraction:                0.397
Core Delta-P: psia           21.034                % AXIAL TILT  12.654 -11.547
Core Plate Delta-P: psia     16.504            AVG BOT 8ft/12ft  0.9475  1.0663
Coolant Temp: Deg-F           547.2
In Channel Flow: Mlb/hr       65.42   Active Channel Flow: Mlb/hr        63.26
Total Bypass Flow (%):         12.0   (of total core flow)
Total Water Rod Flow (%):       2.9   (of total core flow)
Source Convergence          0.00032
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.476	45	27	14	1.473	0.950	45	27	44	8.69	0.874	45.4	42	29	14	17	9.59	0.875	50.4	42	29	14	17
1.465	45	31	14	1.493	0.938	45	31	40	8.34	0.865	48.3	42	25	12	15	8.96	0.862	54.8	42	21	12	15
1.462	45	27	10	1.496	0.936	45	27	14	8.45	0.861	46.6	42	27	16	17	8.78	0.860	55.5	42	19	40	15
1.460	45	29	12	1.513	0.925	45	29	12	8.53	0.858	45.4	42	21	16	17	9.19	0.859	53.0	42	27	12	15
1.450	43	29	16	1.553	0.901	45	9	26	8.29	0.852	47.4	42	33	14	17	9.28	0.851	51.0	42	27	16	17
1.420	45	33	42	1.555	0.901	43	29	38	8.03	0.848	49.9	42	21	12	15	9.37	0.850	49.8	42	21	16	17
1.409	45	9	28	1.560	0.897	45	19	12	8.27	0.836	45.9	42	23	18	17	8.75	0.850	55.2	41	37	40	15
1.406	44	17	40	1.564	0.895	45	31	44	8.32	0.829	44.5	42	17	16	17	8.69	0.842	55.1	41	13	16	15
1.402	43	19	38	1.572	0.890	44	17	14	7.95	0.825	48.3	41	15	40	15	8.40	0.834	56.1	42	33	10	15
1.400	45	31	44	1.582	0.885	44	13	36	7.80	0.820	49.6	41	13	16	15	9.10	0.828	50.2	42	23	18	17

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.49 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 17,501.0 MWd/MTU

Cycle:	23
Exposure: MWd/MTU (GWd)	17800.0 (1807.50)
Delta E: MWd/MTU, (GWd)	299.0 (30.36)
Power: MWt	2923.0 (100.00 %)
Core Pressure: psia	1044.8
Inlet Subcooling: Btu/lbm	-20.29
Flow: Mlb/hr	80.46 (104.50 %)

Core Average Exposure: MWd/MTU 34458.3

	2	6	10	14	18	22	26	30	34	38	42	46	50	
51					--	--	--	--	--	--				51
47			--	--	--	--	--	--	--	--	--			47
43		--	--	--	--	--	--	--	--	--	--	--		43
39		--	--	--	--	--	--	--	--	--	--	--		39
35	--	--	--	--	--	--	--	--	--	--	--	--	--	35
31	--	--	--	--	6	--	--	--	6	--	--	--	--	31
27	--	--	--	--	--	--	--	--	--	--	--	--	--	27
23	--	--	--	--	6	--	--	--	6	--	--	--	--	23
19	--	--	--	--	--	--	--	--	--	--	--	--	--	19
15		--	--	--	--	--	--	--	--	--	--	--		15
11		--	--	--	--	--	--	--	--	--	--	--		11
7			--	--	--	--	--	--	--	--	--			7
3					--	--	--	--	--	--				3
	2	6	10	14	18	22	26	30	34	38	42	46	50	

	Axial Profile		Edit	Radial Power			
N(PRA)	Power	Exposure	Zone	Avg.	Max.	IR	JR
Top 25	0.266	6.884	37	0.685	0.710	3	24
24	0.595	17.339	38	0.370	0.583	37	48
23	0.985	24.728	39	0.399	0.771	17	48
22	1.157	29.114	40	0.455	0.901	5	34
21	1.238	31.574	41	0.837	1.198	9	30
20	1.305	33.366	42	1.087	1.246	31	16
19	1.337	34.365	43	1.248	1.440	29	38
18	1.362*	35.572	44	1.263	1.409	17	40
17	1.362	36.512	45	1.343	1.471	27	40
16	1.343	37.093					
15	1.345	37.635					
14	1.306	38.100					
13	1.337	38.067					
12	1.301	39.470					
11	1.233	40.393					
10	1.191	40.146					
9	1.126	40.937					
8	1.036	41.548					
7	0.938	42.164					
6	0.836	43.057					
5	0.723	43.191*					
4	0.615	42.038					
3	0.527	39.415					
2	0.415	31.021					
Bottom 1	0.120	9.126					
% AXIAL TILT	14.959	-11.262					
AVG BOT 8ft/12ft	0.9335	1.0649					

Control Rod Density: %	2.55	
k-effective:	1.00038	
Void Fraction:	0.381	
Core Delta-P: psia	23.532	
Core Plate Delta-P: psia	18.999	
Coolant Temp: Deg-F	547.3	
In Channel Flow: Mlb/hr	71.00	Active Channel Flow: Mlb/hr 68.71
Total Bypass Flow (%):	11.8	(of total core flow)
Total Water Rod Flow (%):	2.8	(of total core flow)
Source Convergence	0.00037	

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.471	45	27	40	1.513	0.925	45	27	44	8.76	0.887	46.0	42	29	14	17	9.66	0.886	51.0	42	29	14	17
1.463	45	27	44	1.544	0.907	45	31	40	8.69	0.880	46.1	42	25	12	17	9.02	0.880	55.4	42	21	12	15
1.459	45	31	40	1.551	0.902	45	25	40	8.49	0.870	47.1	42	27	16	17	8.85	0.879	56.1	42	19	40	15
1.458	45	29	42	1.566	0.894	45	29	12	8.59	0.869	46.0	42	21	16	17	8.86	0.872	55.7	41	37	40	15
1.440	43	29	38	1.584	0.884	45	9	26	8.42	0.866	47.5	42	19	14	17	9.56	0.872	50.4	42	27	12	17
1.422	45	33	42	1.605	0.872	45	19	12	8.41	0.864	47.4	42	21	12	17	8.83	0.867	55.6	41	13	16	15
1.422	45	9	28	1.607	0.871	45	21	44	8.30	0.843	46.4	42	23	18	17	9.37	0.862	51.4	42	27	38	17
1.409	44	17	40	1.610	0.870	43	29	38	8.42	0.843	45.0	42	17	16	17	9.44	0.862	50.4	42	21	16	17
1.405	45	31	44	1.620	0.864	44	17	40	8.24	0.841	46.8	41	37	40	17	8.48	0.853	56.6	42	33	10	15
1.404	45	11	30	1.621	0.864	44	13	36	8.18	0.837	47.0	41	13	16	17	9.26	0.837	49.3	42	29	44	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.50 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 17,800.0 MWd/MTU

```
Cycle:                            23                   Core Average Exposure: MWd/MTU    34459.2
Exposure: MWd/MTU (GWd)      17801.0 (1807.60 )
Delta E: MWd/MTU, (GWd)          1.0 (   0.10 )              Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                    Top 25  0.247   6.884    37  0.671 0.702   3 24
Inlet Subcooling: Btu/lbm     -22.59                        24  0.550  17.339    38  0.363 0.577   5 16
Flow: Mlb/hr                   73.15 ( 95.00 %)             23  0.912  24.729    39  0.389 0.749  17 48
                                                            22  1.084  29.115    40  0.446 0.877   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50                21  1.185  31.575    41  0.821 1.197   9 24
   51             -- -- -- -- -- --             51          20  1.268  33.367    42  1.101 1.235  15 18
   47       -- -- -- -- -- -- -- -- -- --       47          19  1.313  34.366    43  1.301 1.443  29 38
   43    -- -- -- -- -- -- -- -- -- -- -- --    43          18  1.348  35.574    44  1.238 1.424  13 18
   39    -- -- -- -- -- -- -- -- -- -- -- --    39          17  1.357* 36.513    45  1.323 1.454  31 40
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35             16  1.345  37.094
   31 -- -- -- -- --  0 -- -- -- -- -- -- -- 31             15  1.350  37.637
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27             14  1.314  38.101
   23 -- -- -- -- -- -- -- --  0 -- -- -- -- 23             13  1.345  38.069
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19             12  1.309  39.471
   15    -- -- -- -- -- -- -- -- -- -- -- --    15          11  1.242  40.394
   11    -- -- -- -- -- -- -- -- -- -- -- --    11          10  1.202  40.147
    7       -- -- -- -- -- -- -- -- -- --        7           9  1.138  40.938
    3             -- -- -- -- -- --              3           8  1.055  41.549
       2  6 10 14 18 22 26 30 34 38 42 46 50                 7  0.965  42.165
                                                             6  0.872  43.058
                                                             5  0.768  43.192*
                                                             4  0.664  42.039
Control Rod Density: %          1.46                         3  0.576  39.416
                                                             2  0.458  31.021
k-effective:                 1.00038               Bottom  1  0.133   9.126
Void Fraction:                 0.400
Core Delta-P: psia            20.602              % AXIAL TILT  12.221 -11.261
Core Plate Delta-P: psia      16.076          AVG BOT 8ft/12ft  0.9536  1.0649
Coolant Temp: Deg-F            547.1
In Channel Flow: Mlb/hr        64.37   Active Channel Flow: Mlb/hr        62.23
Total Bypass Flow (%):          12.0   (of total core flow)
Total Water Rod Flow (%):        2.9   (of total core flow)
Source Convergence           0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.454	45	31	40	1.495	0.936	45	13	22	8.63	0.873	46.0	42	21	16	17	8.84	0.868	55.6	41	13	16	15
1.451	45	13	22	1.496	0.936	45	31	40	8.59	0.871	46.2	42	19	18	17	9.04	0.868	54.7	42	19	14	15
1.450	45	27	40	1.501	0.932	45	27	44	8.57	0.868	46.1	42	17	20	17	8.81	0.867	55.8	41	37	40	15
1.443	43	29	38	1.524	0.918	45	27	40	8.52	0.867	46.6	42	23	14	17	8.87	0.865	55.4	42	21	12	15
1.438	43	21	18	1.534	0.913	45	9	26	8.56	0.862	45.5	42	15	22	17	9.47	0.864	50.4	42	21	16	17
1.437	43	17	18	1.542	0.908	45	13	26	8.37	0.861	47.5	42	19	14	17	9.42	0.861	50.6	42	19	18	17
1.434	45	29	42	1.548	0.904	44	13	18	8.20	0.857	49.0	42	13	20	15	9.15	0.860	53.6	42	13	20	15
1.431	43	15	20	1.556	0.900	45	29	42	8.37	0.856	47.1	42	25	16	17	9.36	0.860	51.1	42	23	14	17
1.428	45	27	44	1.559	0.898	45	11	20	8.23	0.855	48.5	42	27	42	15	9.40	0.859	50.5	42	17	20	17
1.428	45	13	26	1.560	0.898	43	29	38	8.54	0.855	45.0	42	17	16	17	9.17	0.854	52.6	42	15	22	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.51 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 17,801.0 MWd/MTU

```
Cycle:                            23                   Core Average Exposure: MWd/MTU    34808.2
Exposure: MWd/MTU (GWd)      18150.0 (1843.04 )
Delta E: MWd/MTU, (GWd)        349.0 (  35.44 )             Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)        N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.8                  Top 25  0.254   6.978    37  0.673 0.704   3 24
Inlet Subcooling: Btu/lbm     -20.29                      24  0.569  17.549    38  0.361 0.577   5 16
Flow: Mlb/hr                   80.46 (104.50 %)           23  0.946  25.081    39  0.389 0.751  17 48
                                                          22  1.123  29.533    40  0.445 0.883   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50              21  1.227  32.033    41  0.823 1.206   9 24
   51             -- -- -- -- --              51          20  1.309  33.857    42  1.097 1.233  15 18
   47       -- -- -- -- -- -- -- -- -- --     47          19  1.348  34.872    43  1.291 1.434  29 38
   43    -- -- -- -- -- -- -- -- -- -- -- --  43          18  1.378  36.092    44  1.246 1.425  13 18
   39    -- -- -- -- -- -- -- -- -- -- -- --  39          17  1.379* 37.033    45  1.329 1.451  13 22
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35          16  1.361  37.603
   31 -- -- -- -- 0 -- -- -- -- -- -- -- -- 31          15  1.362  38.134
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27          14  1.320  38.585
   23 -- -- -- -- -- -- -- -- 0 -- -- -- -- 23          13  1.348  38.522
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19          12  1.308  39.912
   15    -- -- -- -- -- -- -- -- -- -- -- --  15          11  1.236  40.811
   11    -- -- -- -- -- -- -- -- -- -- -- --  11          10  1.193  40.534
    7       -- -- -- -- -- -- -- -- -- --      7           9  1.125  41.302
    3             -- -- -- -- --               3           8  1.034  41.885
       2  6 10 14 18 22 26 30 34 38 42 46 50               7  0.936  42.470
                                                           6  0.834  43.333
                                                           5  0.723  43.431*
                                                           4  0.616  42.244
Control Rod Density: %          1.46                       3  0.530  39.594
                                                           2  0.420  31.162
k-effective:                 1.00036               Bottom  1  0.122   9.170
Void Fraction:                 0.381
Core Delta-P: psia            23.560              % AXIAL TILT  14.802 -10.938
Core Plate Delta-P: psia      19.030          AVG BOT 8ft/12ft  0.9375  1.0633
Coolant Temp: Deg-F            547.3
In Channel Flow: Mlb/hr        70.98   Active Channel Flow: Mlb/hr        68.70
Total Bypass Flow (%):          11.8   (of total core flow)
Total Water Rod Flow (%):        2.8   (of total core flow)
Source Convergence           0.00029
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.451	45	13	22	1.548	0.904	45	27	44	8.69	0.885	46.6	42	21	16	17	8.97	0.896	56.3	41	13	16	15
1.451	45	31	40	1.553	0.901	45	13	22	8.60	0.882	47.2	42	23	14	17	8.91	0.892	56.4	41	37	40	15
1.447	45	27	40	1.558	0.899	45	31	40	8.64	0.882	46.8	42	19	18	17	8.93	0.886	56.0	42	21	12	15
1.437	45	27	44	1.576	0.888	45	9	26	8.63	0.879	46.7	42	17	20	17	9.07	0.886	55.4	42	19	14	15
1.436	45	29	42	1.589	0.881	45	27	40	8.46	0.878	48.4	42	33	40	17	9.54	0.875	51.0	42	21	16	17
1.434	43	29	38	1.596	0.877	45	13	28	8.64	0.876	46.1	42	15	22	17	9.22	0.875	54.2	42	13	20	15
1.431	45	11	24	1.608	0.871	44	13	18	8.54	0.874	47.0	42	13	20	17	8.93	0.874	55.5	42	11	22	15
1.430	45	13	26	1.610	0.870	45	11	20	8.56	0.873	46.7	42	25	12	17	9.45	0.874	51.8	42	23	14	17
1.430	43	17	18	1.615	0.867	45	29	42	8.63	0.870	45.6	42	17	16	17	9.48	0.872	51.3	42	19	18	17
1.427	45	9	26	1.619	0.865	45	11	24	8.43	0.869	47.7	42	27	38	17	9.47	0.870	51.2	42	17	20	17

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.52 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 18,150.0 MWd/MTU

```
Cycle:                            23                Core Average Exposure: MWd/MTU    34809.2
Exposure: MWd/MTU (GWd)      18151.0 (1843.14 )
Delta E: MWd/MTU, (GWd)          1.0 (    0.10 )           Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)       N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                 Top 25  0.259   6.978    37  0.664 0.688   3 24
Inlet Subcooling: Btu/lbm     -22.33                     24  0.576  17.550    38  0.356 0.568  47 16
Flow: Mlb/hr                   73.92 ( 96.00 %)          23  0.954  25.082    39  0.383 0.734  17 48
                                                         22  1.129  29.535    40  0.438 0.863   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50              21  1.228  32.035    41  0.810 1.188  43 30
   51             -- -- -- -- --             51          20  1.306  33.858    42  1.111 1.239  31 16
   47       -- -- -- -- -- -- -- -- --       47          19  1.343  34.873    43  1.332 1.433  37 24
   43    -- -- -- -- -- -- -- -- -- -- --    43          18  1.371  36.093    44  1.225 1.396  39 36
   39    -- -- -- -- -- -- -- -- -- -- --    39          17  1.371* 37.035    45  1.312 1.462  39 26
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35          16  1.352  37.605
   31 -- -- -- --  6 -- -- -- -- -- -- -- -- 31          15  1.352  38.136
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27          14  1.310  38.586
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23          13  1.335  38.523
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19          12  1.294  39.913
   15    -- -- -- -- -- -- -- -- -- -- --    15          11  1.223  40.812
   11    -- -- -- -- -- -- -- -- -- -- --    11          10  1.181  40.535
    7       -- -- -- -- -- -- -- -- --        7           9  1.116  41.303
    3             -- -- -- -- --              3           8  1.031  41.886
      2  6 10 14 18 22 26 30 34 38 42 46 50               7  0.938  42.471
                                                          6  0.843  43.333
                                                          5  0.738  43.432*
                                                          4  0.635  42.245
Control Rod Density: %          0.64                      3  0.550  39.594
                                                          2  0.438  31.163
k-effective:                 1.00057              Bottom  1  0.128   9.171
Void Fraction:                 0.393
Core Delta-P: psia            20.848           % AXIAL TILT  14.511 -10.937
Core Plate Delta-P: psia      16.325       AVG BOT 8ft/12ft  0.9376  1.0633
Coolant Temp: Deg-F            547.1
In Channel Flow: Mlb/hr        65.09   Active Channel Flow: Mlb/hr        62.95
Total Bypass Flow (%):          11.9   (of total core flow)
Total Water Rod Flow (%):        2.9   (of total core flow)
Source Convergence           0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.462	45	39	26	1.502	0.932	45	39	28	8.55	0.871	46.6	42	29	14	17	9.44	0.871	51.6	42	29	14	17
1.444	45	39	22	1.527	0.917	45	39	32	8.55	0.870	46.5	42	39	24	17	8.66	0.867	56.4	41	37	40	15
1.433	43	37	24	1.534	0.913	45	43	28	8.55	0.868	46.4	42	37	32	17	8.67	0.866	56.3	41	13	16	15
1.428	45	27	14	1.543	0.907	45	31	14	8.52	0.867	46.6	42	21	16	17	9.09	0.865	54.3	42	39	24	15
1.427	45	31	14	1.546	0.905	45	27	14	8.47	0.865	46.9	42	35	34	17	8.70	0.863	56.0	42	21	12	15
1.425	45	41	24	1.548	0.904	45	27	44	8.41	0.865	47.4	42	33	18	17	9.43	0.862	50.5	42	37	22	17
1.421	43	29	16	1.570	0.892	45	29	12	8.52	0.863	46.0	42	37	28	17	8.83	0.862	55.4	42	19	14	15
1.421	43	31	18	1.573	0.890	43	37	30	8.35	0.862	47.8	42	27	16	17	9.35	0.858	51.1	42	21	16	17
1.418	45	43	26	1.578	0.887	45	41	24	8.38	0.857	47.0	42	39	34	17	9.38	0.855	50.3	42	37	28	17
1.416	43	35	22	1.588	0.882	43	35	22	8.24	0.857	48.6	42	33	14	17	9.28	0.854	51.3	42	35	34	17

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.53 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 18,151.0 MWd/MTU

```
Cycle:                          23                    Core Average Exposure: MWd/MTU    35158.3
Exposure: MWd/MTU (GWd)     18500.0 (1878.58 )
Delta E: MWd/MTU, (GWd)       349.0 (  35.44 )              Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)         N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.8                    Top 25  0.266   7.076   37  0.666 0.691   3 24
Inlet Subcooling: Btu/lbm    -20.29                        24  0.594  17.770   38  0.356 0.565  47 16
Flow: Mlb/hr                  80.46 (104.50 %)             23  0.986  25.449   39  0.383 0.737  17 48
                                                           22  1.165  29.969   40  0.438 0.870   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                21  1.266  32.509   41  0.812 1.191  43 30
   51             -- -- -- -- --             51            20  1.342  34.361   42  1.107 1.230  31 16
   47       -- -- -- -- -- -- -- -- -- --       47         19  1.373  35.389   43  1.321 1.421  37 24
   43    -- -- -- -- -- -- -- -- -- -- -- --    43         18  1.395* 36.619   44  1.232 1.395  39 36
   39    -- -- -- -- -- -- -- -- -- -- -- --    39         17  1.389  37.559   45  1.318 1.456  39 26
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35            16  1.363  38.116
   31 -- -- -- -- --  6 -- -- -- -- -- -- -- 31            15  1.359  38.633
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27            14  1.312  39.067
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23            13  1.335  38.973
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19            12  1.291  40.348
   15    -- -- -- -- -- -- -- -- -- -- -- --    15         11  1.217  41.223
   11    -- -- -- -- -- -- -- -- -- -- -- --    11         10  1.173  40.915
    7       -- -- -- -- -- -- -- -- -- --        7          9  1.105  41.660
    3             -- -- -- -- --              3             8  1.012  42.215
      2  6 10 14 18 22 26 30 34 38 42 46 50                 7  0.912  42.769
                                                            6  0.810  43.600
                                                            5  0.700  43.664*
                                                            4  0.596  42.443
Control Rod Density: %          0.64                        3  0.513  39.765
                                                            2  0.407  31.299
k-effective:                 1.00012               Bottom  1  0.119   9.213
Void Fraction:                 0.376
Core Delta-P: psia            23.497           % AXIAL TILT  16.719 -10.600
Core Plate Delta-P: psia      18.972       AVG BOT 8ft/12ft  0.9232  1.0616
Coolant Temp: Deg-F            547.2
In Channel Flow: Mlb/hr        71.01   Active Channel Flow: Mlb/hr        68.73
Total Bypass Flow (%):          11.7   (of total core flow)
Total Water Rod Flow (%):        2.8   (of total core flow)
Source Convergence           0.00043
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.456	45	39	26	1.564	0.895	45	39	28	8.60	0.882	47.2	42	29	14	17	8.78	0.891	56.9	41	13	16	15
1.437	45	39	22	1.583	0.884	45	43	28	8.60	0.881	47.1	42	39	24	17	8.74	0.889	57.0	41	37	40	15
1.422	45	27	14	1.586	0.882	45	39	32	8.56	0.877	47.2	42	21	16	17	9.05	0.882	55.4	42	29	14	15
1.422	45	41	24	1.588	0.882	45	27	44	8.58	0.877	47.0	42	37	32	17	8.74	0.881	56.7	42	21	12	15
1.421	45	31	14	1.597	0.877	45	21	14	8.49	0.873	47.5	42	35	34	17	8.85	0.878	56.0	42	19	14	15
1.421	43	37	24	1.607	0.871	45	27	14	8.48	0.873	47.6	42	33	36	17	9.07	0.877	55.0	42	39	24	15
1.421	45	43	28	1.625	0.862	45	29	12	8.49	0.871	47.4	42	25	12	17	8.73	0.869	56.2	42	11	22	15
1.411	43	29	16	1.636	0.856	45	41	30	8.46	0.871	47.6	42	39	34	17	9.44	0.868	51.2	42	37	22	17
1.409	45	27	10	1.636	0.856	43	37	30	8.33	0.870	49.0	42	33	40	17	9.39	0.867	51.7	42	21	16	17
1.407	43	31	18	1.640	0.854	45	11	20	8.49	0.870	47.2	42	41	26	17	8.99	0.867	54.9	42	13	20	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.54 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 18,500.0 MWd/MTU

```
Cycle:                            23                      Core Average Exposure: MWd/MTU    35159.3
Exposure: MWd/MTU (GWd)      18501.0 (1878.68 )
Delta E: MWd/MTU, (GWd)          1.0 (    0.10 )                Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)             N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.8                       Top 25  0.261   7.077    37  0.659 0.689   3 24
Inlet Subcooling: Btu/lbm     -21.56                           24  0.580  17.770    38  0.351 0.559   5 16
Flow: Mlb/hr                   76.23 ( 99.00 %)                23  0.963  25.450    39  0.380 0.734  17 48
                                                               22  1.141  29.970    40  0.434 0.877   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50                   21  1.247  32.510    41  0.802 1.190   9 30
   51              -- -- -- -- --              51              20  1.327  34.363    42  1.116 1.219  15 28
   47        -- -- -- -- -- -- -- -- --        47              19  1.362  35.391    43  1.352 1.435  15 30
   43     -- -- -- -- -- -- -- -- -- -- -- --  43              18  1.387* 36.621    44  1.217 1.397  13 36
   39     -- -- -- -- -- -- -- -- -- -- -- --  39              17  1.383  37.561    45  1.306 1.460  13 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35                16  1.361  38.118
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31                15  1.357  38.635
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27                14  1.312  39.069
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23                13  1.334  38.974
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19                12  1.290  40.350
   15     -- -- -- -- -- -- -- -- -- -- -- --  15              11  1.217  41.224
   11     -- -- -- -- -- -- -- -- -- -- -- --  11              10  1.174  40.916
    7        -- -- -- -- -- -- -- -- --         7               9  1.107  41.661
    3              -- -- -- -- --               3               8  1.019  42.216
       2  6 10 14 18 22 26 30 34 38 42 46 50                    7  0.924  42.770
                                                                6  0.827  43.600
                                                                5  0.721  43.664*
                                                                4  0.619  42.444
Control Rod Density: %          0.00                            3  0.536  39.766
                                                                2  0.427  31.299
k-effective:                 1.00029                    Bottom  1  0.125   9.213
Void Fraction:                 0.386
Core Delta-P: psia            21.764                  % AXIAL TILT  15.622 -10.599
Core Plate Delta-P: psia      17.242              AVG BOT 8ft/12ft  0.9306  1.0616
Coolant Temp: Deg-F            547.1
In Channel Flow: Mlb/hr        67.18   Active Channel Flow: Mlb/hr        64.99
Total Bypass Flow (%):          11.9   (of total core flow)
Total Water Rod Flow (%):        2.9   (of total core flow)
Source Convergence           0.00034
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.460	45	13	28	1.516	0.924	45	13	28	8.64	0.881	46.8	42	15	32	17	8.62	0.884	57.3	42	19	40	15
1.444	45	13	32	1.537	0.911	45	13	32	8.59	0.879	47.0	42	13	30	17	9.52	0.878	51.6	42	13	30	17
1.435	43	15	30	1.549	0.904	45	9	26	8.67	0.875	45.8	42	15	28	17	8.64	0.877	56.9	41	13	16	15
1.424	45	11	30	1.567	0.893	45	11	30	8.51	0.873	47.3	42	17	34	17	8.69	0.877	56.7	41	15	40	15
1.418	45	9	28	1.583	0.885	45	27	44	8.46	0.870	47.6	42	13	34	17	9.49	0.872	51.1	42	15	32	17
1.415	43	17	32	1.583	0.884	45	21	40	8.44	0.868	47.5	42	19	36	17	8.75	0.871	56.2	42	11	22	15
1.409	43	15	34	1.599	0.876	44	13	36	8.43	0.867	47.5	42	21	38	17	9.11	0.869	54.5	42	11	28	15
1.408	45	25	40	1.601	0.875	43	15	30	8.51	0.867	46.6	42	17	30	17	9.03	0.866	54.7	42	13	34	15
1.406	45	21	40	1.606	0.872	45	25	40	8.51	0.867	46.6	42	11	28	17	9.50	0.866	50.2	42	15	28	17
1.406	43	19	34	1.620	0.864	45	11	34	8.36	0.863	47.8	42	23	40	17	8.57	0.864	56.7	42	21	42	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.55 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 18,501.0 MWd/MTU

```
Cycle:                           23                  Core Average Exposure: MWd/MTU    35397.5
Exposure: MWd/MTU (GWd)     18739.2 (1902.87 )
Delta E: MWd/MTU, (GWd)       238.2 (  24.19 )             Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)        N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.8                  Top 25  0.265   7.144    37  0.660 0.691   3 24
Inlet Subcooling: Btu/lbm    -20.29                      24  0.593  17.921    38  0.351 0.560   5 16
Flow: Mlb/hr                  80.46 (104.50 %)           23  0.984  25.702    39  0.380 0.735  17 48
                                                         22  1.165  30.269    40  0.434 0.879   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50              21  1.272  32.837    41  0.804 1.194   9 30
   51             -- -- -- -- -- --          51          20  1.350  34.710    42  1.114 1.215  15 28
   47       -- -- -- -- -- -- -- -- -- --    47          19  1.381  35.746    43  1.345 1.430  15 30
   43    -- -- -- -- -- -- -- -- -- -- -- -- 43          18  1.401* 36.982    44  1.221 1.398  13 36
   39    -- -- -- -- -- -- -- -- -- -- -- -- 39          17  1.393  37.921    45  1.310 1.460  13 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35          16  1.367  38.468
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31          15  1.361  38.975
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27          14  1.312  39.398
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23          13  1.333  39.281
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19          12  1.287  40.646
   15    -- -- -- -- -- -- -- -- -- -- -- -- 15          11  1.212  41.503
   11    -- -- -- -- -- -- -- -- -- -- -- -- 11          10  1.167  41.174
    7       -- -- -- -- -- -- -- -- -- --     7           9  1.099  41.903
    3             -- -- -- -- -- --           3           8  1.007  42.438
      2  6 10 14 18 22 26 30 34 38 42 46 50               7  0.907  42.971
                                                          6  0.807  43.780
                                                          5  0.698  43.820*
                                                          4  0.596  42.577
Control Rod Density: %         0.00                       3  0.514  39.881
                                                          2  0.409  31.391
k-effective:                0.99974               Bottom  1  0.120   9.242
Void Fraction:                0.375
Core Delta-P: psia           23.498              % AXIAL TILT  16.988 -10.368
Core Plate Delta-P: psia     18.975          AVG BOT 8ft/12ft  0.9215  1.0604
Coolant Temp: Deg-F           547.2
In Channel Flow: Mlb/hr       71.01   Active Channel Flow: Mlb/hr        68.73
Total Bypass Flow (%):         11.8   (of total core flow)
Total Water Rod Flow (%):       2.8   (of total core flow)
Source Convergence          0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.460	45	13	28	1.550	0.910	45	13	28	8.64	0.888	47.4	42	13	30	17	8.63	0.896	57.8	42	19	40	15
1.444	45	13	32	1.571	0.897	45	13	32	8.66	0.888	47.2	42	15	32	17	8.70	0.893	57.4	41	13	16	15
1.430	43	15	30	1.575	0.895	45	9	26	8.69	0.882	46.2	42	15	28	17	8.74	0.892	57.1	41	15	40	15
1.427	45	11	30	1.597	0.883	45	11	30	8.52	0.881	48.0	42	13	34	17	9.57	0.886	52.0	42	13	30	17
1.424	45	9	28	1.609	0.876	45	27	44	8.59	0.879	47.0	42	11	28	17	8.79	0.885	56.6	42	11	22	15
1.409	43	17	32	1.618	0.871	45	21	40	8.52	0.879	47.7	42	17	34	17	9.15	0.882	54.9	42	11	28	15
1.407	45	25	40	1.628	0.866	44	13	36	8.45	0.874	48.0	42	19	36	17	9.52	0.878	51.6	42	15	32	17
1.406	45	21	40	1.637	0.861	43	15	30	8.45	0.873	48.0	42	21	38	17	8.60	0.877	57.1	42	21	42	15
1.406	43	15	34	1.643	0.858	45	25	40	8.41	0.872	48.2	42	23	40	17	9.04	0.877	55.1	42	13	34	15
1.401	43	17	36	1.647	0.856	45	11	34	8.51	0.870	47.0	42	17	30	17	9.54	0.872	50.7	42	15	28	17

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.56 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 18,739.2 MWd/MTU

```
Cycle:                            23                      Core Average Exposure: MWd/MTU    35398.5
Exposure: MWd/MTU (GWd)      18740.2 (1902.97 )
Delta E: MWd/MTU, (GWd)          1.0 (    0.10 )              Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)           N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                     Top 25  0.262   7.144    37  0.665 0.696   3 24
Inlet Subcooling: Btu/lbm     -25.15                         24  0.586  17.921    38  0.352 0.564   5 16
Flow: Mlb/hr                   76.23 ( 99.00 %)              23  0.970  25.703    39  0.381 0.740  17 48
                                                             22  1.144  30.270    40  0.436 0.883   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                  21  1.246  32.838    41  0.808 1.193   9 30
   51              -- -- -- -- --               51           20  1.321  34.711    42  1.113 1.213  15 28
   47        -- -- -- -- -- -- -- -- -- --      47           19  1.352  35.748    43  1.342 1.428  15 30
   43     -- -- -- -- -- -- -- -- -- -- -- --   43           18  1.373* 36.984    44  1.222 1.396  13 36
   39     -- -- -- -- -- -- -- -- -- -- -- --   39           17  1.366  37.922    45  1.308 1.458  13 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 35           16  1.343  38.470
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31           15  1.341  38.977
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 27           14  1.297  39.399
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23           13  1.325  39.282
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 19           12  1.286  40.647
   15     -- -- -- -- -- -- -- -- -- -- -- --   15           11  1.218  41.505
   11     -- -- -- -- -- -- -- -- -- -- -- --   11           10  1.183  41.175
    7        -- -- -- -- -- -- -- -- -- --       7            9  1.123  41.904
    3              -- -- -- -- --                3            8  1.037  42.439
      2  6 10 14 18 22 26 30 34 38 42 46 50                   7  0.942  42.972
                                                              6  0.842  43.780
                                                              5  0.730  43.821*
                                                              4  0.622  42.578
Control Rod Density: %          0.00                          3  0.538  39.881
                                                              2  0.428  31.391
k-effective:                 0.99995                  Bottom  1  0.125   9.242
Void Fraction:                 0.372
Core Delta-P: psia            21.497               % AXIAL TILT  14.897 -10.367
Core Plate Delta-P: psia      16.953           AVG BOT 8ft/12ft  0.9326  1.0604
Coolant Temp: Deg-F            546.3
In Channel Flow: Mlb/hr        67.28   Active Channel Flow: Mlb/hr        65.11
Total Bypass Flow (%):          11.7   (of total core flow)
Total Water Rod Flow (%):        2.8   (of total core flow)
Source Convergence           0.00045
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.458	45	13	28	1.538	0.917	45	13	28	8.44	0.868	47.4	42	13	30	17	8.49	0.881	57.8	42	19	40	15
1.441	45	13	32	1.562	0.903	45	13	32	8.47	0.868	47.2	42	15	32	17	8.56	0.879	57.4	41	13	16	15
1.428	43	15	30	1.567	0.900	45	9	26	8.50	0.862	46.2	42	15	28	17	8.60	0.877	57.1	41	15	40	15
1.424	45	11	30	1.581	0.892	45	11	30	8.33	0.861	48.0	42	13	34	17	8.64	0.869	56.6	42	11	22	15
1.422	45	9	28	1.602	0.880	45	27	44	8.40	0.859	47.0	42	11	28	17	9.35	0.866	52.0	42	13	30	17
1.406	43	17	32	1.612	0.875	45	21	40	8.33	0.859	47.7	42	17	34	17	8.98	0.866	54.9	42	11	28	15
1.404	45	25	40	1.615	0.873	44	13	36	8.27	0.854	48.0	42	19	36	17	8.46	0.863	57.1	42	21	42	15
1.403	45	21	40	1.620	0.870	43	15	30	8.27	0.854	48.0	42	21	38	17	8.88	0.861	55.1	42	13	34	15
1.403	43	15	34	1.630	0.865	45	25	40	8.23	0.852	48.2	42	23	40	17	9.30	0.858	51.6	42	15	32	17
1.398	43	17	36	1.631	0.865	45	11	34	8.32	0.851	47.0	42	17	30	17	8.71	0.856	55.6	42	23	40	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.57 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 18,740.2 MWd/MTU

```
Cycle:                          23                   Core Average Exposure: MWd/MTU    35608.3
Exposure: MWd/MTU (GWd)     18950.0 (1924.27 )
Delta E: MWd/MTU, (GWd)       209.8 (  21.30 )          Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)     N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7               Top 25  0.266   7.203    37  0.666 0.696   3 24
Inlet Subcooling: Btu/lbm    -23.68                   24  0.599  18.055    38  0.352 0.563   5 16
Flow: Mlb/hr                  80.46 (104.50 %)        23  0.992  25.926    39  0.380 0.741  17 48
                                                      22  1.168  30.533    40  0.435 0.885   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50            21  1.270  33.125    41  0.809 1.197   9 30
   51             -- -- -- -- -- --            51     20  1.344  35.016    42  1.111 1.211  15 28
   47       -- -- -- -- -- -- -- -- -- --      47     19  1.371  36.059    43  1.337 1.424  15 30
   43    -- -- -- -- -- -- -- -- -- -- -- --   43     18  1.388* 37.299    44  1.226 1.397  13 36
   39    -- -- -- -- -- -- -- -- -- -- -- --   39     17  1.378  38.236    45  1.312 1.458  13 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35     16  1.351  38.775
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31     15  1.347  39.273
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27     14  1.301  39.686
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23     13  1.327  39.551
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19     12  1.287  40.908
   15    -- -- -- -- -- -- -- -- -- -- -- --   15     11  1.216  41.751
   11    -- -- -- -- -- -- -- -- -- -- -- --   11     10  1.179  41.405
    7       -- -- -- -- -- -- -- -- -- --       7      9  1.116  42.121
    3             -- -- -- -- -- --             3      8  1.025  42.639
     2  6 10 14 18 22 26 30 34 38 42 46 50             7  0.924  43.152
                                                       6  0.818  43.941
                                                       5  0.703  43.959*
                                                       4  0.595  42.695
Control Rod Density: %         0.00                    3  0.511  39.983
                                                       2  0.407  31.472
k-effective:                0.99973            Bottom  1  0.119   9.268
Void Fraction:                0.361
Core Delta-P: psia           23.211             % AXIAL TILT  16.377 -10.170
Core Plate Delta-P: psia     18.666          AVG BOT 8ft/12ft  0.9233  1.0594
Coolant Temp: Deg-F           546.4
In Channel Flow: Mlb/hr       71.11   Active Channel Flow: Mlb/hr        68.86
Total Bypass Flow (%):         11.6   (of total core flow)
Total Water Rod Flow (%):       2.8   (of total core flow)
Source Convergence          0.00038
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.458	45	13	28	1.570	0.898	45	13	28	8.51	0.879	47.8	42	13	30	17	8.63	0.895	57.7	41	13	16	15
1.441	45	13	32	1.592	0.885	45	9	26	8.52	0.876	47.6	42	15	32	17	8.67	0.893	57.5	41	15	40	15
1.428	45	9	28	1.595	0.884	45	13	32	8.40	0.872	48.4	42	13	34	17	8.52	0.893	58.2	42	19	40	15
1.427	45	11	30	1.610	0.876	45	11	30	8.49	0.872	47.4	42	11	28	17	8.69	0.884	57.0	42	11	22	15
1.424	43	15	30	1.627	0.866	45	27	44	8.54	0.870	46.6	42	15	28	17	9.04	0.880	55.3	42	11	28	15
1.404	45	25	40	1.643	0.858	44	13	36	8.37	0.866	48.1	42	17	34	17	9.13	0.878	54.8	42	13	30	15
1.403	45	21	40	1.645	0.857	45	21	40	8.29	0.862	48.6	42	23	40	17	8.51	0.876	57.5	42	21	42	15
1.400	43	15	34	1.655	0.852	43	15	30	8.31	0.862	48.3	42	21	38	17	8.92	0.873	55.5	42	13	34	15
1.400	45	25	44	1.656	0.852	45	11	34	8.30	0.862	48.3	42	19	36	17	8.75	0.867	56.0	42	25	42	15
1.400	43	17	32	1.660	0.850	45	11	36	8.33	0.860	48.0	42	11	32	17	8.74	0.867	56.0	42	23	40	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.58 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 18,950.0 MWd/MTU

```
Cycle:                           23                        Core Average Exposure: MWd/MTU    35609.3
Exposure: MWd/MTU (GWd)     18951.0 (1924.38 )
Delta E: MWd/MTU, (GWd)         1.0 (   0.10 )
Power: MWt                   2923.0 (100.00 %)
Core Pressure: psia          1044.7
Inlet Subcooling: Btu/lbm    -28.45
Flow: Mlb/hr                  76.23 ( 99.00 %)

      2  6 10 14 18 22 26 30 34 38 42 46 50
   51             -- -- -- -- --             51
   47       -- -- -- -- -- -- -- -- -- --    47
   43    -- -- -- -- -- -- -- -- -- -- -- -- 43
   39    -- -- -- -- -- -- -- -- -- -- -- -- 39
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19
   15    -- -- -- -- -- -- -- -- -- -- -- -- 15
   11    -- -- -- -- -- -- -- -- -- -- -- -- 11
    7       -- -- -- -- -- -- -- -- -- --     7
    3             -- -- -- -- --              3
      2  6 10 14 18 22 26 30 34 38 42 46 50
```

N(PRA)	Axial Profile Power	Axial Profile Exposure
Top 25	0.261	7.204
24	0.586	18.056
23	0.969	25.928
22	1.142	30.534
21	1.242	33.127
20	1.315	35.017
19	1.343	36.060
18	1.362*	37.301
17	1.354	38.237
16	1.331	38.776
15	1.330	39.275
14	1.289	39.687
13	1.321	39.552
12	1.287	40.909
11	1.224	41.752
10	1.195	41.406
9	1.140	42.122
8	1.055	42.640
7	0.958	43.153
6	0.853	43.942
5	0.734	43.960*
4	0.622	42.696
3	0.536	39.983
2	0.426	31.472
Bottom 1	0.124	9.268
% AXIAL TILT	14.220	-10.169
AVG BOT 8ft/12ft	0.9353	1.0594

Edit Zone	Radial Power Avg.	Radial Power Max.	IR	JR
37	0.671	0.701	3	24
38	0.353	0.567	5	16
39	0.382	0.746	17	48
40	0.438	0.890	5	34
41	0.813	1.194	9	30
42	1.110	1.207	15	28
43	1.334	1.419	15	30
44	1.227	1.393	13	36
45	1.311	1.453	13	28

```
Control Rod Density: %         0.00

k-effective:                 0.99970
Void Fraction:                 0.359
Core Delta-P: psia            21.260
Core Plate Delta-P: psia      16.702
Coolant Temp: Deg-F            545.5
In Channel Flow: Mlb/hr        67.36   Active Channel Flow: Mlb/hr        65.22
Total Bypass Flow (%):          11.6   (of total core flow)
Total Water Rod Flow (%):        2.8   (of total core flow)
Source Convergence           0.00047
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.453	45	13	28	1.560	0.904	45	13	28	8.33	0.860	47.8	42	13	30	17	8.51	0.883	57.8	41	13	16	15
1.436	45	13	32	1.583	0.890	45	9	26	8.34	0.858	47.6	42	15	32	17	8.55	0.880	57.5	41	15	40	15
1.424	45	9	28	1.584	0.890	45	13	32	8.23	0.854	48.4	42	13	34	17	8.40	0.880	58.2	42	19	40	15
1.422	45	11	30	1.600	0.881	45	11	30	8.31	0.854	47.4	42	11	28	17	8.56	0.870	57.0	42	11	22	15
1.419	43	15	30	1.616	0.872	45	27	44	8.36	0.851	46.6	42	15	28	17	8.89	0.866	55.3	42	11	28	15
1.399	45	25	40	1.633	0.864	44	13	36	8.20	0.848	48.1	42	17	34	17	8.39	0.864	57.5	42	21	42	15
1.399	45	21	40	1.636	0.862	45	21	40	8.12	0.845	48.6	42	23	40	17	8.98	0.863	54.8	42	13	30	15
1.397	45	25	44	1.644	0.858	43	15	30	8.14	0.844	48.3	42	21	38	17	8.78	0.860	55.5	42	13	34	15
1.396	43	15	34	1.646	0.857	45	11	34	8.13	0.844	48.3	42	19	36	17	8.61	0.854	56.0	42	25	42	15
1.395	43	17	32	1.650	0.854	45	11	36	8.16	0.843	48.0	42	11	32	17	8.61	0.853	56.0	42	23	40	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.59 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 18,951.0 MWd/MTU

```
Cycle:                           23                   Core Average Exposure: MWd/MTU    35808.2
Exposure: MWd/MTU (GWd)     19150.0 (1944.58 )
Delta E: MWd/MTU, (GWd)       199.0 (  20.21 )             Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)       N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                 Top 25  0.265   7.260    37  0.671 0.701   3 24
Inlet Subcooling: Btu/lbm    -26.80                     24  0.598  18.183    38  0.352 0.567   5 16
Flow: Mlb/hr                  80.46 (104.50 %)          23  0.991  26.139    39  0.381 0.746  17 48
                                                        22  1.166  30.784    40  0.437 0.891   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50             21  1.268  33.399    41  0.813 1.199   9 30
   51             -- -- -- -- -- --             51      20  1.339  35.305    42  1.108 1.209  11 28
   47       -- -- -- -- -- -- -- -- -- --       47      19  1.363  36.353    43  1.329 1.417  15 30
   43    -- -- -- -- -- -- -- -- -- -- -- --    43      18  1.379* 37.598    44  1.230 1.396  13 36
   39    -- -- -- -- -- -- -- -- -- -- -- --    39      17  1.367  38.532    45  1.314 1.454  13 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 35      16  1.340  39.063
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31      15  1.338  39.554
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 27      14  1.294  39.957
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23      13  1.325  39.806
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 19      12  1.290  41.156
   15    -- -- -- -- -- -- -- -- -- -- -- --    15      11  1.224  41.987
   11    -- -- -- -- -- -- -- -- -- -- -- --    11      10  1.193  41.626
    7       -- -- -- -- -- -- -- -- -- --        7       9  1.133  42.331
    3             -- -- -- -- -- --              3       8  1.042  42.832
      2  6 10 14 18 22 26 30 34 38 42 46 50              7  0.937  43.327
                                                         6  0.825  44.096*
                                                         5  0.703  44.092
                                                         4  0.591  42.807
Control Rod Density: %         0.00                      3  0.507  40.079
                                                         2  0.403  31.548
k-effective:                0.99958              Bottom  1  0.118   9.292
Void Fraction:                0.348
Core Delta-P: psia           22.954              % AXIAL TILT  15.818  -9.988
Core Plate Delta-P: psia     18.397           AVG BOT 8ft/12ft  0.9256  1.0585
Coolant Temp: Deg-F           545.7
In Channel Flow: Mlb/hr       71.20  Active Channel Flow: Mlb/hr        68.97
Total Bypass Flow (%):         11.5  (of total core flow)
Total Water Rod Flow (%):       2.8  (of total core flow)
Source Convergence          0.00050
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.454	45	13	28	1.590	0.887	45	13	28	8.42	0.872	48.2	42	13	30	17	8.60	0.900	58.1	41	13	16	15
1.437	45	13	32	1.608	0.877	45	9	26	8.40	0.868	47.9	42	15	32	17	8.63	0.898	57.9	41	15	40	15
1.430	45	9	28	1.615	0.873	45	13	32	8.41	0.867	47.8	42	11	28	17	8.45	0.894	58.5	42	19	40	15
1.425	45	11	30	1.627	0.867	45	11	30	8.32	0.867	48.7	42	13	34	17	8.63	0.885	57.3	42	11	22	15
1.417	43	15	30	1.641	0.859	45	27	44	8.43	0.861	46.9	42	15	28	17	8.96	0.881	55.7	42	11	28	15
1.402	45	25	44	1.660	0.850	44	13	36	8.25	0.857	48.4	42	17	34	17	8.45	0.878	57.8	42	21	42	15
1.399	45	21	40	1.668	0.845	45	21	40	8.26	0.856	48.3	42	11	32	17	9.03	0.877	55.2	42	13	30	15
1.399	45	25	40	1.670	0.845	45	11	34	8.19	0.856	48.9	42	23	40	17	8.81	0.874	56.0	42	13	34	15
1.399	45	11	34	1.674	0.842	45	11	36	8.23	0.855	48.5	42	25	42	17	8.68	0.868	56.4	42	25	42	15
1.396	44	13	36	1.675	0.842	43	15	30	8.00	0.854	51.0	42	19	40	17	8.65	0.866	56.4	42	23	40	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.60 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 19,150.0 MWd/MTU

```
Cycle:                            23                   Core Average Exposure: MWd/MTU    35809.2
Exposure: MWd/MTU (GWd)      19151.0 (1944.68 )
Delta E: MWd/MTU, (GWd)          1.0 (   0.10 )              Axial Profile    Edit   Radial Power
Power: MWt                    2923.0 (100.00 %)         N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                    Top 25  0.259   7.260    37  0.676 0.705   3 24
Inlet Subcooling: Btu/lbm    -31.50                        24  0.585  18.183    38  0.354 0.571   5 16
Flow: Mlb/hr                   76.23 ( 99.00 %)            23  0.968  26.140    39  0.382 0.751  17 48
                                                           22  1.139  30.785    40  0.440 0.895   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50               21  1.239  33.400    41  0.817 1.196   9 30
   51              -- -- -- -- -- --           51          20  1.310  35.306    42  1.107 1.206  11 28
   47        -- -- -- -- -- -- -- -- -- --     47          19  1.335  36.355    43  1.326 1.412  15 30
   43     -- -- -- -- -- -- -- -- -- -- -- --  43          18  1.352* 37.599    44  1.231 1.392  13 36
   39     -- -- -- -- -- -- -- -- -- -- -- --  39          17  1.343  38.533    45  1.313 1.449  13 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 35         16  1.320  39.064
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31         15  1.321  39.555
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 27         14  1.283  39.959
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23         13  1.319  39.807
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 19         12  1.291  41.158
   15     -- -- -- -- -- -- -- -- -- -- -- --  15          11  1.232  41.988
   11     -- -- -- -- -- -- -- -- -- -- -- --  11          10  1.210  41.627
    7        -- -- -- -- -- -- -- -- -- --      7           9  1.158  42.332
    3              -- -- -- -- -- --            3           8  1.073  42.833
       2  6 10 14 18 22 26 30 34 38 42 46 50                7  0.972  43.328
                                                            6  0.860  44.096*
                                                            5  0.734  44.092
                                                            4  0.619  42.808
Control Rod Density: %          0.00                        3  0.532  40.079
                                                            2  0.423  31.549
k-effective:                 0.99942                Bottom  1  0.123   9.292
Void Fraction:                 0.347
Core Delta-P: psia            21.045             % AXIAL TILT  13.629  -9.987
Core Plate Delta-P: psia      16.476         AVG BOT 8ft/12ft  0.9379  1.0585
Coolant Temp: Deg-F            544.7
In Channel Flow: Mlb/hr        67.44   Active Channel Flow: Mlb/hr        65.32
Total Bypass Flow (%):          11.5   (of total core flow)
Total Water Rod Flow (%):        2.8   (of total core flow)
Source Convergence           0.00048
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power Value	FT	IR	JR	MCPR Value	Margin	FT	IR	JR	APLHGR Value	Margin	Exp.	FT	IR	JR	K	LHGR Value	Margin	Exp.	FT	IR	JR	K
1.449	45	13	28	1.579	0.893	45	13	28	8.24	0.853	48.2	42	13	30	17	8.47	0.887	58.1	41	13	16	15
1.433	45	13	32	1.598	0.882	45	9	26	8.23	0.850	47.9	42	15	32	17	8.51	0.885	57.9	41	15	40	15
1.426	45	9	28	1.604	0.879	45	13	32	8.23	0.849	47.8	42	11	28	17	8.33	0.881	58.5	42	19	40	15
1.420	45	11	30	1.616	0.872	45	11	30	8.15	0.849	48.7	42	13	34	17	8.50	0.872	57.3	42	11	22	15
1.412	43	15	30	1.630	0.865	45	27	44	8.25	0.843	46.9	42	15	28	17	8.81	0.867	55.7	42	11	28	15
1.399	45	25	44	1.649	0.855	44	13	36	8.08	0.839	48.4	42	17	34	17	8.33	0.866	57.8	42	21	42	15
1.395	45	21	40	1.658	0.851	45	21	14	8.09	0.839	48.3	42	11	32	17	8.88	0.862	55.2	42	13	30	15
1.395	45	11	34	1.659	0.850	45	11	34	8.02	0.838	48.9	42	23	40	17	8.67	0.860	56.0	42	13	34	15
1.395	45	25	40	1.664	0.847	43	15	30	8.05	0.837	48.5	42	25	42	17	8.54	0.854	56.4	42	25	42	15
1.392	44	13	36	1.665	0.847	45	11	36	7.84	0.837	51.0	42	19	40	17	8.52	0.853	56.4	42	23	40	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.61 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 19,151.0 MWd/MTU

```
Cycle:                          23                     Core Average Exposure: MWd/MTU    36002.0
Exposure: MWd/MTU (GWd)     19343.7 (1964.26 )
Delta E: MWd/MTU, (GWd)       192.7 (  19.57 )                Axial Profile    Edit   Radial Power
Power: MWt                   2923.0 (100.00 %)          N(PRA) Power Exposure  Zone  Avg.  Max.   IR JR
Core Pressure: psia          1044.7                    Top 25  0.264   7.314    37  0.676 0.705   3 24
Inlet Subcooling: Btu/lbm    -29.69                        24  0.598  18.306    38  0.353 0.570   5 16
Flow: Mlb/hr                  80.46 (104.50 %)             23  0.991  26.345    39  0.382 0.751  17 48
                                                           22  1.165  31.026    40  0.438 0.896   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50               21  1.265  33.663    41  0.817 1.200   9 30
   51              -- -- -- -- -- --           51          20  1.334  35.584    42  1.106 1.208  11 28
   47        -- -- -- -- -- -- -- -- -- --     47          19  1.356  36.637    43  1.322 1.411  15 30
   43     -- -- -- -- -- -- -- -- -- -- -- --  43          18  1.370* 37.885    44  1.234 1.395  13 36
   39     -- -- -- -- -- -- -- -- -- -- -- --  39          17  1.357  38.817    45  1.316 1.450  13 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 35          16  1.330  39.340
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31          15  1.330  39.824
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 27          14  1.289  40.220
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23          13  1.324  40.053
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 19          12  1.294  41.398
   15     -- -- -- -- -- -- -- -- -- -- -- --  15          11  1.233  42.217
   11     -- -- -- -- -- -- -- -- -- -- -- --  11          10  1.207  41.842
    7        -- -- -- -- -- -- -- -- -- --      7           9  1.150  42.537
    3              -- -- -- -- -- --            3           8  1.057  43.022
      2  6 10 14 18 22 26 30 34 38 42 46 50                 7  0.948  43.498
                                                            6  0.830  44.247*
                                                            5  0.701  44.220
                                                            4  0.587  42.915
Control Rod Density: %         0.00                         3  0.503  40.171
                                                            2  0.400  31.622
k-effective:                0.99926              Bottom  1  0.117   9.315
Void Fraction:                0.337
Core Delta-P: psia           22.727             % AXIAL TILT  15.301  -9.816
Core Plate Delta-P: psia     18.158         AVG BOT 8ft/12ft  0.9278  1.0576
Coolant Temp: Deg-F           544.9
In Channel Flow: Mlb/hr       71.28   Active Channel Flow: Mlb/hr        69.08
Total Bypass Flow (%):         11.4   (of total core flow)
Total Water Rod Flow (%):       2.7   (of total core flow)
Source Convergence          0.00046
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.450	45	13	28	1.608	0.877	45	13	28	8.33	0.866	48.5	42	13	30	17	8.57	0.905	58.5	41	13	16	15
1.434	45	13	32	1.623	0.869	45	9	26	8.34	0.863	48.1	42	11	28	17	8.60	0.902	58.2	41	15	40	15
1.432	45	9	28	1.634	0.863	45	13	32	8.24	0.862	49.1	42	13	34	17	8.37	0.896	58.9	42	19	40	15
1.423	45	11	30	1.643	0.858	45	11	30	8.30	0.861	48.3	42	15	32	17	8.57	0.887	57.7	42	11	22	15
1.411	43	15	30	1.655	0.852	45	27	44	8.32	0.853	47.3	42	15	28	17	8.89	0.882	56.1	42	11	28	15
1.403	45	25	44	1.675	0.842	44	13	36	8.19	0.853	48.6	42	11	32	17	8.40	0.881	58.2	42	21	42	15
1.399	45	11	34	1.683	0.838	45	11	34	8.15	0.850	48.9	42	25	42	17	8.95	0.876	55.5	42	13	30	15
1.396	45	21	40	1.688	0.835	45	11	36	7.92	0.850	51.4	42	19	40	17	8.74	0.875	56.4	42	13	34	15
1.395	45	25	40	1.688	0.835	45	21	14	8.11	0.850	49.3	42	23	40	17	8.61	0.869	56.7	42	25	42	15
1.395	44	13	36	1.690	0.834	45	9	32	8.15	0.849	48.8	42	17	34	17	8.37	0.866	57.7	42	9	34	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.62 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 19,343.7 MWd/MTU

```
Cycle:                           23                   Core Average Exposure: MWd/MTU    36404.9
Exposure: MWd/MTU (GWd)     19746.7 (2005.18 )
Delta E: MWd/MTU, (GWd)       403.0 (  40.92 )            Axial Profile    Edit   Radial Power
Power: MWt                   2649.7 ( 90.65 %)      N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                Top 25  0.274   7.430    37  0.674 0.704   3 24
Inlet Subcooling: Btu/lbm    -26.71                    24  0.626  18.572    38  0.351 0.568   5 16
Flow: Mlb/hr                  80.46 (104.50 %)         23  1.039  26.789    39  0.380 0.750  17 48
                                                       22  1.218  31.547    40  0.436 0.899   5 34
       2  6 10 14 18 22 26 30 34 38 42 46 50           21  1.319  34.229    41  0.818 1.210   9 30
   51             -- -- -- -- -- --           51       20  1.384  36.180    42  1.103 1.214  11 28
   47       -- -- -- -- -- -- -- -- -- --     47       19  1.397  37.241    43  1.315 1.410  15 30
   43    -- -- -- -- -- -- -- -- -- -- -- --  43       18  1.402* 38.493    44  1.242 1.401  13 36
   39    -- -- -- -- -- -- -- -- -- -- -- --  39       17  1.381  39.418    45  1.323 1.455  13 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35       16  1.346  39.922
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31       15  1.341  40.390
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27       14  1.296  40.767
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23       13  1.327  40.569
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19       12  1.293  41.901
   15    -- -- -- -- -- -- -- -- -- -- -- --  15       11  1.226  42.695
   11    -- -- -- -- -- -- -- -- -- -- -- --  11       10  1.194  42.290
    7       -- -- -- -- -- -- -- -- -- --      7        9  1.126  42.959
    3             -- -- -- -- -- --            3        8  1.021  43.408
      2  6 10 14 18 22 26 30 34 38 42 46 50             7  0.901  43.842
                                                        6  0.775  44.545*
                                                        5  0.646  44.470
                                                        4  0.537  43.124
Control Rod Density: %          0.00                    3  0.459  40.350
                                                        2  0.365  31.764
k-effective:                 0.99964           Bottom  1  0.107   9.359
Void Fraction:                 0.315
Core Delta-P: psia            22.223          % AXIAL TILT  18.473  -9.438
Core Plate Delta-P: psia      17.667      AVG BOT 8ft/12ft  0.9076  1.0557
Coolant Temp: Deg-F            545.2
In Channel Flow: Mlb/hr        71.52  Active Channel Flow: Mlb/hr       69.39
Total Bypass Flow (%):          11.1  (of total core flow)
Total Water Rod Flow (%):        2.6  (of total core flow)
Source Convergence           0.00043
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.455	45	13	28	1.751	0.805	45	13	28	7.74	0.807	48.8	42	11	28	17	7.90	0.851	59.2	41	13	16	15
1.445	45	9	28	1.769	0.797	45	9	26	7.70	0.806	49.2	42	13	30	17	7.93	0.849	58.9	41	15	40	15
1.438	45	13	32	1.785	0.790	45	13	32	7.63	0.804	49.8	42	13	34	17	7.67	0.838	59.7	42	19	40	15
1.431	45	11	30	1.788	0.789	45	11	30	7.65	0.799	49.0	42	15	32	17	7.87	0.831	58.4	42	11	22	15
1.414	45	25	44	1.798	0.784	45	27	44	7.60	0.797	49.3	42	11	32	17	8.18	0.827	56.8	42	11	28	15
1.410	43	15	30	1.821	0.774	44	13	36	7.55	0.794	49.6	42	25	42	17	7.71	0.825	58.9	42	21	42	15
1.409	45	11	34	1.823	0.773	45	11	34	7.44	0.793	50.8	42	19	40	18	8.03	0.819	57.1	42	13	34	15
1.401	44	13	36	1.829	0.771	45	11	36	7.74	0.792	47.0	42	15	28	18	8.20	0.818	56.3	42	13	30	15
1.398	45	21	40	1.835	0.768	45	9	32	7.57	0.790	48.8	42	23	40	18	8.32	0.816	55.6	41	9	30	15
1.396	45	25	40	1.847	0.763	45	21	14	7.58	0.788	48.6	42	17	34	18	7.72	0.815	58.4	42	9	34	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.63 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 19,746.7 MWd/MTU

```
Cycle:                          23                   Core Average Exposure: MWd/MTU    36858.2
Exposure: MWd/MTU (GWd)      20200.0 (2051.21 )
Delta E: MWd/MTU, (GWd)        453.3 (  46.03 )               Axial Profile    Edit   Radial Power
Power: MWt                    2389.7 ( 81.76 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia           1044.7                    Top 25  0.286   7.566    37  0.674 0.704   3 24
Inlet Subcooling: Btu/lbm     -23.87                        24  0.657  18.885    38  0.349 0.566   5 16
Flow: Mlb/hr                   80.46 (104.50 %)             23  1.094  27.314    39  0.379 0.750  17 48
                                                            22  1.279  32.162    40  0.434 0.902   5 34
     2  6 10 14 18 22 26 30 34 38 42 46 50                 21  1.378  34.895    41  0.819 1.219   9 30
  51             -- -- -- -- -- --             51           20  1.437  36.876    42  1.100 1.220  11 28
  47       -- -- -- -- -- -- -- -- -- --       47           19  1.439* 37.941    43  1.306 1.407  15 30
  43    -- -- -- -- -- -- -- -- -- -- -- --    43           18  1.435  39.193    44  1.249 1.408  13 36
  39    -- -- -- -- -- -- -- -- -- -- -- --    39           17  1.404  40.105    45  1.330 1.459   9 28
  35 -- -- -- -- -- -- -- -- -- -- -- -- -- 35             16  1.360  40.584
  31 -- -- -- -- -- -- -- -- -- -- -- -- -- 31             15  1.350  41.032
  27 -- -- -- -- -- -- -- -- -- -- -- -- -- 27             14  1.299  41.386
  23 -- -- -- -- -- -- -- -- -- -- -- -- -- 23             13  1.326  41.149
  19 -- -- -- -- -- -- -- -- -- -- -- -- -- 19             12  1.288  42.465
  15    -- -- -- -- -- -- -- -- -- -- -- --    15           11  1.214  43.229
  11    -- -- -- -- -- -- -- -- -- -- -- --    11           10  1.173  42.787
   7       -- -- -- -- -- -- -- -- -- --        7            9  1.095  43.424
   3             -- -- -- -- -- --              3            8  0.979  43.826
     2  6 10 14 18 22 26 30 34 38 42 46 50                  7  0.850  44.208
                                                             6  0.720  44.857*
                                                             5  0.595  44.730
                                                             4  0.492  43.339
Control Rod Density: %          0.00                         3  0.419  40.534
                                                             2  0.333  31.909
k-effective:                 0.99955                 Bottom  1  0.098   9.405
Void Fraction:                 0.293
Core Delta-P: psia            21.753              % AXIAL TILT  21.803  -8.983
Core Plate Delta-P: psia      17.209          AVG BOT 8ft/12ft  0.8856  1.0533
Coolant Temp: Deg-F            545.5
In Channel Flow: Mlb/hr        71.75  Active Channel Flow: Mlb/hr        69.69
Total Bypass Flow (%):          10.8  (of total core flow)
Total Water Rod Flow (%):        2.6  (of total core flow)
Source Convergence           0.00050
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.459	45	9	28	1.916	0.736	45	13	28	7.25	0.753	48.4	42	11	28	18	7.22	0.796	60.0	41	13	16	15
1.458	45	13	28	1.929	0.731	45	9	26	7.12	0.749	49.6	42	13	34	18	7.26	0.794	59.7	41	15	40	15
1.442	45	13	32	1.953	0.722	45	11	30	7.11	0.748	49.6	42	13	30	18	6.97	0.779	60.5	42	19	40	15
1.439	45	11	30	1.956	0.721	45	13	22	7.14	0.744	48.7	42	11	32	18	7.17	0.774	59.2	42	11	22	15
1.425	45	25	44	1.965	0.718	45	27	44	7.11	0.741	48.8	42	15	32	18	7.46	0.772	57.7	42	11	28	15
1.418	45	11	34	1.985	0.710	45	11	34	7.07	0.740	49.2	42	25	42	18	7.66	0.768	56.4	41	9	30	15
1.408	44	13	36	1.991	0.708	44	13	36	6.87	0.739	51.6	42	19	40	18	6.98	0.767	59.9	42	21	42	15
1.407	43	15	30	1.991	0.708	45	11	36	6.98	0.735	49.7	42	23	40	18	7.07	0.763	59.2	42	9	34	15
1.402	45	9	32	2.001	0.705	45	9	32	7.07	0.735	48.6	41	15	40	18	7.31	0.763	58.0	42	13	34	15
1.401	45	11	36	2.027	0.696	45	21	44	7.12	0.735	47.9	42	15	28	18	7.46	0.760	57.1	42	13	30	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.64 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 20,200.0 MWd/MTU

```
Cycle:                          23                  Core Average Exposure: MWd/MTU    37354.8
Exposure: MWd/MTU (GWd)     20696.6 (2101.64 )
Delta E: MWd/MTU, (GWd)       496.6 (  50.43 )             Axial Profile    Edit   Radial Power
Power: MWt                   2111.8 ( 72.25 %)          N(PRA) Power Exposure  Zone  Avg.  Max.  IR JR
Core Pressure: psia          1044.7                    Top 25  0.299   7.722    37  0.673 0.703   3 24
Inlet Subcooling: Btu/lbm    -20.83                        24  0.694  19.246    38  0.347 0.564   5 16
Flow: Mlb/hr                  80.46 (104.50 %)             23  1.158  27.921    39  0.378 0.750  17 48
                                                           22  1.348  32.870    40  0.432 0.905   5 34
      2  6 10 14 18 22 26 30 34 38 42 46 50                21  1.444  35.657    41  0.820 1.230   9 30
   51             -- -- -- -- --             51            20  1.496* 37.669    42  1.095 1.226  11 28
   47       -- -- -- -- -- -- -- -- -- --       47         19  1.485  38.732    43  1.295 1.404  15 30
   43    -- -- -- -- -- -- -- -- -- -- -- --    43         18  1.469  39.978    44  1.258 1.415  13 36
   39    -- -- -- -- -- -- -- -- -- -- -- --    39         17  1.427  40.871    45  1.339 1.474   9 28
   35 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 35         16  1.372  41.316
   31 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 31         15  1.356  41.738
   27 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 27         14  1.299  42.065
   23 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 23         13  1.322  41.784
   19 -- -- -- -- -- -- -- -- -- -- -- -- -- -- 19         12  1.278  43.080
   15    -- -- -- -- -- -- -- -- -- -- -- --    15         11  1.195  43.806
   11    -- -- -- -- -- -- -- -- -- -- -- --    11         10  1.144  43.319
    7       -- -- -- -- -- -- -- -- -- --       7           9  1.055  43.916
    3             -- -- -- -- --             3              8  0.929  44.263
      2  6 10 14 18 22 26 30 34 38 42 46 50                 7  0.794  44.584
                                                            6  0.665  45.174*
                                                            5  0.545  44.991
                                                            4  0.449  43.554
Control Rod Density: %         0.00                         3  0.383  40.717
                                                            2  0.304  32.055
k-effective:                0.99931                Bottom   1  0.090   9.451
Void Fraction:                0.269
Core Delta-P: psia           21.275              % AXIAL TILT  25.406  -8.450
Core Plate Delta-P: psia     16.744           AVG BOT 8ft/12ft  0.8611  1.0505
Coolant Temp: Deg-F           546.0
In Channel Flow: Mlb/hr       71.99   Active Channel Flow: Mlb/hr        70.01
Total Bypass Flow (%):         10.5   (of total core flow)
Total Water Rod Flow (%):       2.5   (of total core flow)
Source Convergence          0.00029
```

Top Ten Thermal Limits Summary - Sorted by Margin

Power				MCPR					APLHGR							LHGR						
Value	FT	IR	JR	Value	Margin	FT	IR	JR	Value	Margin	Exp.	FT	IR	JR	K	Value	Margin	Exp.	FT	IR	JR	K
1.474	45	9	28	2.138	0.660	45	13	28	6.59	0.692	49.4	42	11	28	18	6.46	0.731	60.9	41	13	16	15
1.462	45	13	28	2.145	0.657	45	9	26	6.46	0.686	50.5	42	13	34	18	6.54	0.730	60.4	41	15	40	15
1.446	45	11	30	2.171	0.649	45	11	30	6.43	0.684	50.6	42	13	30	18	6.19	0.710	61.4	42	19	40	15
1.445	45	13	32	2.370	0.647	42	11	28	6.49	0.683	49.7	42	11	32	18	6.90	0.709	57.4	41	9	30	15
1.436	45	25	44	2.185	0.645	45	13	22	6.41	0.678	50.1	42	25	42	18	6.38	0.706	60.2	42	11	22	15
1.428	45	11	34	2.188	0.644	45	27	44	6.61	0.676	47.1	41	9	30	18	6.65	0.706	58.6	42	11	28	15
1.415	45	9	32	2.205	0.639	45	11	34	6.22	0.676	52.5	42	19	40	18	6.21	0.701	60.8	42	21	42	15
1.415	44	13	36	2.405	0.638	42	13	30	6.50	0.676	48.5	41	13	38	18	6.33	0.700	60.1	42	9	34	15
1.414	45	11	36	2.211	0.638	45	11	36	6.43	0.676	49.5	41	15	40	18	6.51	0.697	58.9	42	13	34	15
1.404	43	15	30	2.216	0.636	44	13	36	6.41	0.675	49.8	42	15	32	18	6.63	0.693	58.1	42	13	30	15

* LHGR calculated with pin-power reconstruction
* CPR calculated with pin-power reconstruction & CPR limit type 3

Figure A.65 Brunswick Unit 1 Cycle 23 Control Rod Pattern and Axial Distributions at 20,696.6 MWd/MTU

Appendix B Elevation Views of the Brunswick Unit 1 Cycle 23 Fresh Reload Batch Fuel Assemblies

[ ]

Figure B.1 Elevation View for the Brunswick Unit 1 Cycle 23 Fresh Fuel Reload Batch BRK1-23 ATRIUM 11 [ ] Fuel Assembly Design

[ ]

Figure B.2 Elevation View for the Brunswick Unit 1 Cycle 23 Fresh Fuel Reload Batch BRK1-23 ATRIUM 11 [ ] Fuel Assembly Design

[ ]

Figure B.3 Elevation View for the Brunswick Unit 1 Cycle 23 Fresh Fuel Reload Batch BRK1-23 ATRIUM 11 [ ] Fuel Assembly Design

Appendix C Brunswick Unit 1 Cycle 23 Fresh Fuel Locations

Table C.1 Brunswick Unit 1 Cycle 23 Reload Fuel Identification and Locations ([ ])

[ ]

Table C.2 Brunswick Unit 1 Cycle 23 Reload Fuel Identification and Locations ([ ])

[ ]

Table C.3 Brunswick Unit 1 Cycle 23 Reload Fuel Identification and Locations ([ ])

[ ]

Appendix D Brunswick Unit 1 Cycle 23 Radial Exposure and Power Distributions

[ ]

Figure D.1 Brunswick Unit 1 Cycle 23 BOC Exposure Distribution (GWd/MTU)

Figure D.1 Brunswick Unit 1 Cycle 23 BOC Exposure Distribution (GWd/MTU) *(Continued)*

[ ]

Figure D.2 Brunswick Unit 1 Cycle 23 EOC Exposure Distribution (20.7 GWd/MTU)

[

]

Figure D.2 Brunswick Unit 1 Cycle 23 EOC Exposure Distribution (20.7 GWd/MTU) *(Continued)*

[ ]

[

]

Figure D.3 Brunswick Unit 1 Cycle 23 Radial Power Distribution at 0.0 MWd/MTU

[

]

Figure D.3 Brunswick Unit 1 Cycle 23 Radial Power Distribution at 0.0 MWd/MTU *(Continued)*

[

]

Figure D.4 Brunswick Unit 1 Cycle 23 Radial Power Distribution at 19,343.7 MWd/MTU (EOFP)

[ ]

Figure D.4 Brunswick Unit 1 Cycle 23 Radial Power Distribution at 19,343.7 MWd/MTU (EOFP) *(Continued)*

ANP-3758NP, *Brunswick Unit 1 Cycle 23 ATRIUM 11 Fuel Nuclear Fuel Design Report*, Revision 1

framatome

Brunswick Unit 1 Cycle 23 ATRIUM 11 Fuel

ANP-3758NP
Revision 1

Nuclear Fuel Design Report

September 2019

Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	1-1	Last paragraph updated number of assemblies and changed Reference 7 to “per Brunswick Unit 1 Cycle 23 redesign”.
2	3-1	Updated Reference 1 and removed Reference 7

Contents

List of Tables

List of Figures

Nomenclature

Acronym	Definition
[ ]	Square brackets enclose information that is proprietary to Framatome.
BOL	beginning of life
BWR	boiling water reactor
EVC	plenum region in a fuel pin modeled as an evacuated section
GWd/MTU	gigawatt days per metric ton of initial uranium
kg/MTU	kilograms per metric ton of initial uranium
LHGR	linear heat generation rate
LPF	local peaking factor
MCPR	minimum critical power ratio
MWd/MTU	megawatt days per metric ton of initial uranium
NRC	(United States) Nuclear Regulatory Commission
PLFR	part length fuel rod
Z4B	Zirconium-based alloy proprietary to Framatome Inc.

1.0 INTRODUCTION

This report provides results of the neutronic design analyses performed by Framatome Inc. for the Brunswick Unit 1 fabrication batch BRK1-23 ATRIUM 11 boiling water reactor (BWR) fuel assemblies scheduled to be loaded in Cycle 23. The mechanical design parameters for the fuel are from Reference 1 and are shown in Table 2.1.

Applicable neutronic design criteria are provided in the approved topical report ANF-89-98(P)(A) Revision 1 and Supplement 1 (Reference 2). Neutronic design analysis methodology used to determine conformance to design criteria has been reviewed and approved by the NRC in the topical report EMF-2158(P)(A) (Reference 3).

The fuel design includes Framatome Inc. advanced fuel channels. Mechanical design criteria applicable to the design of these channels have been reviewed and approved by the NRC. Reference 1 provides details of the application of the advanced channel for Brunswick Unit 1. The fuel design assumes advanced fuel channels made of Zircaloy-4 and/or Z4B with a beta quench treatment.

The neutronic design for the fabrication batch includes axially-varying enrichment and gadolinia designs with natural UO_2 blankets at the top and bottom of the assembly. The fabrication batch consists of **[**

] assemblies (per Brunswick Unit 1 Cycle 23 redesign). Pertinent fuel and reactor core design information associated with this fabrication batch is given in Section 2.0 and in Appendices A through D.

2.0 NEUTRONIC DESIGN

The results of the Brunswick Unit 1 fabrication batch BRK1-23 ATRIUM 11 neutronic design analyses are presented in this section. The fuel was designed to meet applicable design criteria, as well as reactivity and control requirements. Reactor core loading patterns and the number of assemblies to be loaded will depend upon final cycle energy requirements as specified by the utility. Applicable neutronic design criteria outlined in Reference 2 are summarized below:

- **Power Distribution.** The local power distribution in the fuel assembly combined with the core power distribution shall result in Linear Heat Generation Rate (LHGR) and Minimum Critical Power Ratio (MCPR) values that are within the limits established for each fuel design.
- **Kinetics Parameters.** The moderator void reactivity coefficient due to boiling in the active channels and the Doppler fuel temperature reactivity coefficient shall be negative. The negative void and Doppler reactivity coefficients ensure a negative power coefficient during reactor operation. Additional calculations were performed to show that the assembly average Doppler and void reactivity coefficients remain negative for the life of the assembly. These results demonstrate that the Reference 2 kinetics criteria are met on a bundle average basis.
- **Control Blade Reactivity.** The design of the fuel assembly and the reactor core loading shall be such that the technical specification shutdown margin requirement is met for all reactor conditions.

2.1 *Neutronic Design Description*

The neutronic design parameters for fabrication batch BRK1-23 are presented in Table 2.1. The key ATRIUM 11 reload assembly nuclear design characteristics are summarized below:

[ ]

- Each fuel assembly has top and bottom natural uranium blankets.
- The plenum region above the PLFRs will be explicitly modeled.
- The enrichments are designed to yield a local power distribution which results in a balanced design relative to MCPR, LHGR, and other reactor operating requirements, e.g., power peaking.
- Gadolinia (Gd_2O_3 blended with UO_2) rods are designed to control assembly reactivity in order to meet reactivity control requirements in the reactor, e.g. cold shutdown margin.
- The reload batch consists of 3 assembly designs which vary axially in enrichment and/or gadolinia. The axial distributions of the lattices in the assemblies are shown in Figures 2.1, 2.2, and 2.3. The fuel rod distribution and axial descriptions are presented in Figures 2.4 through 2.7. The enrichment and gadolinia distribution maps for each of the reload assembly lattices are displayed in Appendix D.

- The fuel assembly incorporates the Framatome Inc. advanced fuel channel which improves uranium utilization. For D-lattice plants, the fuel assembly is offset 40 mils toward the control blade.

2.2 *Lattice Control Blade Worths and Kinetics Parameters*

Beginning of life (BOL) lattice reactivities (k_∞) have been calculated for moderator and fuel conditions ranging from cold to hot operating conditions. From these reactivities, BOL control blade worths and kinetics parameters have been determined based on GE Original Equipment, Duralife 160, Westinghouse-ABB CR82M-1, Westinghouse-ABB CR82M-1 HF TIP, Westinghouse-ABB CR99 TIP, and Westinghouse-ABB CR99 control blades. Kinetics parameters are calculated for fuel temperature (Doppler), moderator void, and moderator temperature. The Doppler reactivity was calculated over a fuel temperature range from hot standby to hot operating. The moderator void reactivity was evaluated between the 0% and 40% voided hot operating cases, and the moderator temperature reactivity was calculated from the cold to hot standby condition. The calculations neglect the spacer material and assume zero void in the coolant outside the fuel assembly channel as well as inside the internal water channel. The results of these calculations are presented in Tables 2.2 through 2.127.

2.3 *Enriched Lattice Uncontrolled Reactivities and Isotopic Data*

The enriched lattice exposure-dependent uncontrolled reactivities calculated at three void fractions are presented graphically in Appendix A, and in tabular format in Appendix B. The enriched lattice exposure-dependent isotopic data calculated at three void fractions are presented in Appendix C.

2.4 *Criticality Compliance*

The Brunswick Unit 1 fabrication batch BRK1-23 ATRIUM 11 fuel assemblies satisfy the fuel design critical safety limits established for new and spent fuel storage at the Brunswick Unit 1 facility per References 4 and 5. Additionally, these reload assemblies conform to the nuclear criticality requirements as provided to the NRC for the Reference 6 shipping container.

Table 2.1 Neutronic Design Parameters

Table 2.1 Neutronic Design Parameters *(Continued)*

Table 2.1 Neutronic Design Parameters *(Continued)*

[ ]

Table 2.1 Neutronic Design Parameters *(Continued)*

Parameter	Design Value
Control Blade Data for Westinghouse-ABB CR82M-1	
Total span, cm	Westinghouse Proprietary
Total support span, cm	"
Total thickness, cm	"
Total face-to-face internal dimension, inch	"
B_4C rod absorber Number of rods Diameter of rod, cm Diameter of sheath, inch Theoretical density B_4C, % B_4C zone span, cm	"
Control Blade Data for Westinghouse-ABB CR82M-1 HF TIP	
Total span, cm	Westinghouse Proprietary
Total support span, cm	"
Total thickness, cm	"
Total face-to-face internal dimension, inch	"
Hafnium rod absorber Number of rods Diameter of rod, cm Diameter of sheath, inch Hafnium rod zone span, cm	"

Table 2.1 Neutronic Design Parameters *(Continued)*

Parameter	Design Value
Control Blade Data for Westinghouse-ABB CR99 TIP	
Total span, cm	Westinghouse Proprietary
Total support span, cm	ʻʼ
Total thickness, cm	ʻʼ
Total face-to-face internal dimension, inch	ʻʼ
B_4C rod absorber Number of rods Diameter of rod, cm Diameter of sheath, inch Theoretical density B_4C, % B_4C zone span, cm	ʻʼ
Control Blade Data for Westinghouse-ABB CR99	
Total span, cm	Westinghouse Proprietary
Total support span, cm	ʻʼ
Total thickness, cm	ʻʼ
Total face-to-face internal dimension, inch	ʻʼ
B_4C rod absorber Number of rods Diameter of rod, cm Diameter of sheath, inch Theoretical density B_4C, % B_4C zone span, cm	ʻʼ

Table 2.1 Neutronic Design Parameters *(Continued)*

Parameter	Design Value
Core Data*	
Number of fuel assemblies in the core	560
Rated thermal power level, MWt	2923.0
Rated core flow, Mlbm/hr	77.00
Inlet subcooling, Btu/lbm	21.3
Dome pressure, psia	1045.0
Boron concentration, PPM	720.0
Intermediate temperature, °F	200.00
Warm temperature, °F	360.00

* Some values are representative of rated conditions and may vary depending on the core statepoint.

Table 2.2 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92137	1.09637	-0.1596
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90804	1.08820	-0.1656
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85765	1.05923	-0.1903
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.85373	1.05445	-0.1904
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.85380	1.05445	-0.1903
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.81623	1.03844	-0.2140
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.77229	1.02081	-0.2434

Table 2.3 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

$\text{Blade Worth} = \dfrac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92090	1.09637	-0.1600
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90764	1.08820	-0.1659
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85725	1.05923	-0.1907
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.85333	1.05445	-0.1907
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.85339	1.05445	-0.1907
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.81537	1.03844	-0.2148
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.77065	1.02081	-0.2451

Table 2.4 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91571	1.09637	-0.1648
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90244	1.08820	-0.1707
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85087	1.05923	-0.1967
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.84700	1.05445	-0.1967
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.84708	1.05445	-0.1967
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.80802	1.03844	-0.2219
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.76160	1.02081	-0.2539

Table 2.5 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93767	1.09637	-0.1447
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92512	1.08820	-0.1499
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87855	1.05923	-0.1706
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.87451	1.05445	-0.1706
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.87451	1.05445	-0.1706
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.84053	1.03844	-0.1906
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.80093	1.02081	-0.2154

Table 2.6 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91329	1.09637	-0.1670
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89982	1.08820	-0.1731
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84716	1.05923	-0.2002
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.84330	1.05445	-0.2003
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.84338	1.05445	-0.2002
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.80268	1.03844	-0.2270
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.75378	1.02081	-0.2616

Table 2.7 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91151	1.09637	-0.1686
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89798	1.08820	-0.1748
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84493	1.05923	-0.2023
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.84108	1.05445	-0.2024
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.84117	1.05445	-0.2023
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.80005	1.03844	-0.2296
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.75060	1.02081	-0.2647

Table 2.8 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter ($\Delta k/k$)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.05445	1.05923	-0.0045
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.03844	1.05445	-0.0152
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.05923	1.09637	-0.0339

Table 2.9 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.97979	1.16169	-0.1566
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.96573	1.15364	-0.1629
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90847	1.12049	-0.1892
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.90424	1.11537	-0.1893
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.90432	1.11537	-0.1892
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.85962	1.09453	-0.2146
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.80532	1.07061	-0.2478

Table 2.10 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.97914	1.16169	-0.1571
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.96517	1.15364	-0.1634
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90795	1.12049	-0.1897
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.90372	1.11537	-0.1898
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.90379	1.11537	-0.1897
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.85865	1.09453	-0.2155
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.80361	1.07061	-0.2494

Table 2.11 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.97375	1.16169	-0.1618
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.95974	1.15364	-0.1681
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90109	1.12049	-0.1958
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.89691	1.11537	-0.1959
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.89701	1.11537	-0.1958
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.85072	1.09453	-0.2228
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.79405	1.07061	-0.2583

Table 2.12 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.99779	1.16169	-0.1411
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.98452	1.15364	-0.1466
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.93104	1.12049	-0.1691
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.92668	1.11537	-0.1692
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.92668	1.11537	-0.1692
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.88565	1.09453	-0.1908
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.83586	1.07061	-0.2193

Table 2.13 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.97110	1.16169	-0.1641
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.95687	1.15364	-0.1706
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.89718	1.12049	-0.1993
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.89302	1.11537	-0.1993
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.89311	1.11537	-0.1993
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.84517	1.09453	-0.2278
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.78594	1.07061	-0.2659

Table 2.14 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.96909	1.16169	-0.1658
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.95481	1.15364	-0.1724
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.89471	1.12049	-0.2015
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.89057	1.11537	-0.2016
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.89066	1.11537	-0.2015
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.84227	1.09453	-0.2305
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.78245	1.07061	-0.2692

Table 2.15 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.11537	1.12049	-0.0046
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.09453	1.11537	-0.0187
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.12049	1.16169	-0.0355

Table 2.16 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93860	1.12073	-0.1625
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92572	1.11425	-0.1692
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87499	1.08892	-0.1965
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87082	1.08383	-0.1965
Hot $Operating_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87089	1.08383	-0.1965
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82958	1.06735	-0.2228
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.77724	1.04750	-0.2580

Table 2.17 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93810	1.12073	-0.1630
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92533	1.11425	-0.1696
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87467	1.08892	-0.1968
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87051	1.08383	-0.1968
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87057	1.08383	-0.1968
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82880	1.06735	-0.2235
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.77564	1.04750	-0.2595

Table 2.18 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93248	1.12073	-0.1680
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91970	1.11425	-0.1746
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86781	1.08892	-0.2031
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86370	1.08383	-0.2031
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86379	1.08383	-0.2030
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82089	1.06735	-0.2309
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76601	1.04750	-0.2687

Table 2.19 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.95578	1.12073	-0.1472
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.94380	1.11425	-0.1530
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.89725	1.08892	-0.1760
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.89296	1.08383	-0.1761
Hot $Operating_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.89296	1.08383	-0.1761
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.85550	1.06735	-0.1985
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.80802	1.04750	-0.2286

Table 2.20 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93021	1.12073	-0.1700
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91720	1.11425	-0.1769
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86420	1.08892	-0.2064
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86011	1.08383	-0.2064
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86019	1.08383	-0.2063
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.81564	1.06735	-0.2358
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.75824	1.04750	-0.2761

Table 2.21 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92825	1.12073	-0.1718
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91518	1.11425	-0.1787
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86177	1.08892	-0.2086
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.85769	1.08383	-0.2087
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.85777	1.08383	-0.2086
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.81276	1.06735	-0.2385
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.75472	1.04750	-0.2795

Table 2.22 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.08383	1.08892	-0.0047
Moderator$_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.06735	1.08383	-0.0152
Moderator$_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.08892	1.12073	-0.0284

Table 2.23 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93065	1.10611	-0.1586
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91749	1.09947	-0.1655
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86667	1.07495	-0.1938
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86258	1.06997	-0.1938
Hot $Operating_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86265	1.06997	-0.1938
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82119	1.05387	-0.2208
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76782	1.03366	-0.2572

Table 2.24 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93023	1.10611	-0.1590
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91717	1.09947	-0.1658
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86646	1.07495	-0.1940
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86238	1.06997	-0.1940
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86244	1.06997	-0.1940
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82053	1.05387	-0.2214
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76633	1.03366	-0.2586

Table 2.25 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92451	1.10611	-0.1642
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91144	1.09947	-0.1710
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85954	1.07495	-0.2004
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.85552	1.06997	-0.2004
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.85560	1.06997	-0.2004
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.81258	1.05387	-0.2290
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.75669	1.03366	-0.2680

Table 2.26 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94669	1.10611	-0.1441
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93442	1.09947	-0.1501
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.88790	1.07495	-0.1740
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.88369	1.06997	-0.1741
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.88369	1.06997	-0.1741
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.84619	1.05387	-0.1971
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.79786	1.03366	-0.2281

Table 2.27 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92270	1.10611	-0.1658
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90940	1.09947	-0.1729
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85637	1.07495	-0.2033
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.85235	1.06997	-0.2034
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.85243	1.06997	-0.2033
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.80774	1.05387	-0.2336
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.74924	1.03366	-0.2752

Table 2.28 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92084	1.10611	-0.1675
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90748	1.09947	-0.1746
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85404	1.07495	-0.2055
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.85004	1.06997	-0.2056
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.85012	1.06997	-0.2055
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.80496	1.05387	-0.2362
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.74581	1.03366	-0.2785

Table 2.29 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.06997	1.07495	-0.0046
Moderator$_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.05387	1.06997	-0.0150
Moderator$_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.07495	1.10611	-0.0282

Table 2.30 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90274	1.08035	-0.1644
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88906	1.07315	-0.1715
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83846	1.04869	-0.2005
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83437	1.04366	-0.2005
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83444	1.04366	-0.2005
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79501	1.02973	-0.2279
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74285	1.01135	-0.2655

Table 2.31 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90236	1.08035	-0.1648
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88881	1.07315	-0.1718
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83833	1.04869	-0.2006
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83425	1.04366	-0.2006
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83431	1.04366	-0.2006
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79443	1.02973	-0.2285
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74145	1.01135	-0.2669

Table 2.32 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.89675	1.08035	-0.1699
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88319	1.07315	-0.1770
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83160	1.04869	-0.2070
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.82757	1.04366	-0.2071
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.82765	1.04366	-0.2070
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.78668	1.02973	-0.2360
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73202	1.01135	-0.2762

Table 2.33 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91877	1.08035	-0.1496
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90602	1.07315	-0.1557
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85978	1.04869	-0.1801
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85557	1.04366	-0.1802
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85557	1.04366	-0.1802
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.82014	1.02973	-0.2035
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.77316	1.01135	-0.2355

Table 2.34 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.89486	1.08035	-0.1717
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88109	1.07315	-0.1790
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.82845	1.04869	-0.2100
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.82443	1.04366	-0.2101
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.82451	1.04366	-0.2100
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.78192	1.02973	-0.2407
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.72467	1.01135	-0.2835

Table 2.35 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.89300	1.08035	-0.1734
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.87918	1.07315	-0.1807
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.82612	1.04869	-0.2122
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.82212	1.04366	-0.2123
Hot $Operating_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.82220	1.04366	-0.2122
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.77913	1.02973	-0.2434
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.72122	1.01135	-0.2869

Table 2.36 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.04366	1.04869	-0.0048
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.02973	1.04366	-0.0134
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.04869	1.08035	-0.0293

Table 2.37 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90236	1.07395	-0.1598
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88855	1.06673	-0.1670
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83876	1.04367	-0.1963
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83477	1.03879	-0.1964
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83484	1.03879	-0.1963
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79554	1.02603	-0.2246
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74201	1.00830	-0.2641

Table 2.38 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90200	1.07395	-0.1601
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88832	1.06673	-0.1673
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83868	1.04367	-0.1964
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83469	1.03879	-0.1965
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83475	1.03879	-0.1964
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79502	1.02603	-0.2251
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74067	1.00830	-0.2654

Table 2.39 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.89670	1.07395	-0.1650
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88300	1.06673	-0.1722
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83228	1.04367	-0.2025
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.82834	1.03879	-0.2026
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.82842	1.03879	-0.2025
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.78757	1.02603	-0.2324
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73144	1.00830	-0.2746

Table 2.40 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91773	1.07395	-0.1455
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90484	1.06673	-0.1518
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85947	1.04367	-0.1765
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85537	1.03879	-0.1766
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85537	1.03879	-0.1766
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.82024	1.02603	-0.2006
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.77222	1.00830	-0.2341

Table 2.41 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.89493	1.07395	-0.1667
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88104	1.06673	-0.1741
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.82932	1.04367	-0.2054
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.82539	1.03879	-0.2054
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.82547	1.03879	-0.2054
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.78303	1.02603	-0.2368
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.72427	1.00830	-0.2817

Table 2.42 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.89315	1.07395	-0.1683
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.87920	1.06673	-0.1758
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.82707	1.04367	-0.2075
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.82316	1.03879	-0.2076
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.82323	1.03879	-0.2075
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.78030	1.02603	-0.2395
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.72084	1.00830	-0.2851

Table 2.43 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.03879	1.04367	-0.0047
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.02603	1.03879	-0.0123
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.04367	1.07395	-0.0282

Table 2.44 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91327	1.08519	-0.1584
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90015	1.07886	-0.1656
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85388	1.06074	-0.1950
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84989	1.05587	-0.1951
Hot $Operating_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84996	1.05587	-0.1950
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81208	1.04582	-0.2235
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75962	1.03154	-0.2636

Table 2.45 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91289	1.08519	-0.1588
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89990	1.07886	-0.1659
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85378	1.06074	-0.1951
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84980	1.05587	-0.1952
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84986	1.05587	-0.1951
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81152	1.04582	-0.2240
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75821	1.03154	-0.2650

Table 2.46 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90754	1.08519	-0.1637
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89453	1.07886	-0.1709
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84727	1.06074	-0.2013
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84334	1.05587	-0.2013
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84342	1.05587	-0.2012
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80389	1.04582	-0.2313
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74868	1.03154	-0.2742

Table 2.47 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92876	1.08519	-0.1442
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91657	1.07886	-0.1504
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87487	1.06074	-0.1752
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.87078	1.05587	-0.1753
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.87078	1.05587	-0.1753
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.83724	1.04582	-0.1994
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.79062	1.03154	-0.2336

Table 2.48 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90581	1.08519	-0.1653
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89260	1.07886	-0.1726
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84433	1.06074	-0.2040
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84041	1.05587	-0.2041
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84048	1.05587	-0.2040
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79935	1.04582	-0.2357
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74145	1.03154	-0.2812

Table 2.49 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90401	1.08519	-0.1670
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89075	1.07886	-0.1744
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84205	1.06074	-0.2062
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83814	1.05587	-0.2062
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83822	1.05587	-0.2061
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79657	1.04582	-0.2383
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73793	1.03154	-0.2846

Table 2.50 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.05587	1.06074	-0.0046
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.04582	1.05587	-0.0095
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.06074	1.08519	-0.0225

Table 2.51 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92837	1.10682	-0.1612
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91521	1.09887	-0.1671
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86467	1.06903	-0.1912
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.86072	1.06422	-0.1912
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.86079	1.06422	-0.1911
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.82314	1.04771	-0.2143
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.77929	1.02961	-0.2431

Table 2.52 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92788	1.10682	-0.1617
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91480	1.09887	-0.1675
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86423	1.06903	-0.1916
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.86029	1.06422	-0.1916
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.86035	1.06422	-0.1916
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.82226	1.04771	-0.2152
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.77763	1.02961	-0.2447

Table 2.53 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92270	1.10682	-0.1663
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90963	1.09887	-0.1722
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85792	1.06903	-0.1975
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.85402	1.06422	-0.1975
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.85410	1.06422	-0.1974
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.81499	1.04771	-0.2221
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.76870	1.02961	-0.2534

Table 2.54 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94515	1.10682	-0.1461
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93280	1.09887	-0.1511
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.88605	1.06903	-0.1712
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.88198	1.06422	-0.1712
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.88198	1.06422	-0.1712
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.84788	1.04771	-0.1907
Hot Operating$_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.80829	1.02961	-0.2150

Table 2.55 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92000	1.10682	-0.1688
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90670	1.09887	-0.1749
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85385	1.06903	-0.2013
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.84996	1.06422	-0.2013
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.85004	1.06422	-0.2013
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.80926	1.04771	-0.2276
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.76045	1.02961	-0.2614

Table 2.56 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91818	1.10682	-0.1704
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90483	1.09887	-0.1766
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85158	1.06903	-0.2034
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.84771	1.06422	-0.2034
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.84779	1.06422	-0.2034
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.80659	1.04771	-0.2301
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.75724	1.02961	-0.2645

Table 2.57 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.06422	1.06903	-0.0045
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.04771	1.06422	-0.0155
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.06903	1.10682	-0.0341

Table 2.58 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.98654	1.17158	-0.1579
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.97264	1.16367	-0.1642
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.91508	1.12937	-0.1897
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.91081	1.12421	-0.1898
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.91089	1.12421	-0.1898
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.86602	1.10266	-0.2146
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.81179	1.07803	-0.2470

Table 2.59 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.98587	1.17158	-0.1585
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.97205	1.16367	-0.1647
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.91452	1.12937	-0.1902
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.91027	1.12421	-0.1903
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.91033	1.12421	-0.1903
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.86503	1.10266	-0.2155
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.81006	1.07803	-0.2486

Table 2.60 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.98051	1.17158	-0.1631
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.96667	1.16367	-0.1693
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90773	1.12937	-0.1963
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.90353	1.12421	-0.1963
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.90362	1.12421	-0.1962
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.85718	1.10266	-0.2226
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.80060	1.07803	-0.2574

Table 2.61 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	1.00499	1.17158	-0.1422
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.99190	1.16367	-0.1476
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.93807	1.12937	-0.1694
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.93368	1.12421	-0.1695
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.93368	1.12421	-0.1695
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.89241	1.10266	-0.1907
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.84258	1.07803	-0.2184

Table 2.62 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

$\text{Blade Worth} = \frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.97756	1.17158	-0.1656
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.96348	1.16367	-0.1720
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90347	1.12937	-0.2000
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.89928	1.12421	-0.2001
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.89937	1.12421	-0.2000
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.85125	1.10266	-0.2280
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.79209	1.07803	-0.2652

Table 2.63 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\dfrac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.97552	1.17158	-0.1673
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.96139	1.16367	-0.1738
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90096	1.12937	-0.2023
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void, No xenon	0.89679	1.12421	-0.2023
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=932° F 0% Void	0.89688	1.12421	-0.2022
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 40% Void	0.84833	1.10266	-0.2306
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=932° F 80% Void	0.78859	1.07803	-0.2685

Table 2.64 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\dfrac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\dfrac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.12421	1.12937	-0.0046
Moderator$_{Void}$ = $\dfrac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.10266	1.12421	-0.0192
Moderator$_{Temperature}$ = $\dfrac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.12937	1.17158	-0.0360

Table 2.65 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94744	1.13334	-0.1640
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93473	1.12704	-0.1706
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.88358	1.10042	-0.1971
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87937	1.09528	-0.1971
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87945	1.09528	-0.1971
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.83783	1.07797	-0.2228
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.78532	1.05714	-0.2571

Table 2.66 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94692	1.13334	-0.1645
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93431	1.12704	-0.1710
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.88323	1.10042	-0.1974
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87903	1.09528	-0.1974
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87909	1.09528	-0.1974
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.83702	1.07797	-0.2235
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.78369	1.05714	-0.2587

Table 2.67 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94137	1.13334	-0.1694
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92878	1.12704	-0.1759
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87649	1.10042	-0.2035
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87234	1.09528	-0.2036
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87243	1.09528	-0.2035
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82924	1.07797	-0.2307
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.77420	1.05714	-0.2676

Table 2.68 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.96519	1.13334	-0.1484
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.95341	1.12704	-0.1541
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90641	1.10042	-0.1763
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.90208	1.09528	-0.1764
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.90208	1.09528	-0.1764
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.86426	1.07797	-0.1983
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.81648	1.05714	-0.2276

Table 2.69 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93873	1.13334	-0.1717
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92587	1.12704	-0.1785
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87242	1.10042	-0.2072
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86829	1.09528	-0.2072
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86838	1.09528	-0.2072
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82352	1.07797	-0.2361
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76595	1.05714	-0.2754

Table 2.70 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93673	1.13334	-0.1735
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92381	1.12704	-0.1803
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86995	1.10042	-0.2094
Hot Operating_{NoXe}	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86584	1.09528	-0.2095
Hot Operating_{0}	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86592	1.09528	-0.2094
Hot Operating_{40}	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82060	1.07797	-0.2387
Hot Operating_{80}	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76241	1.05714	-0.2788

Table 2.71 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.09528	1.10042	-0.0047
Moderator_{Void} = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.07797	1.09528	-0.0158
$\text{Moderator}_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.10042	1.13334	-0.0290

Table 2.72 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

$\text{Blade Worth} = \dfrac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94748	1.13120	-0.1624
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93475	1.12507	-0.1692
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.88432	1.09975	-0.1959
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.88018	1.09471	-0.1960
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.88026	1.09471	-0.1959
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.83858	1.07777	-0.2219
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.78506	1.05677	-0.2571

Table 2.73 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

$\text{Blade Worth} = \dfrac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94700	1.13120	-0.1628
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93439	1.12507	-0.1695
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.88405	1.09975	-0.1961
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87992	1.09471	-0.1962
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87998	1.09471	-0.1961
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.83784	1.07777	-0.2226
Hot Operating$_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.78350	1.05677	-0.2586

Table 2.74 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94144	1.13120	-0.1678
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92884	1.12507	-0.1744
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87740	1.09975	-0.2022
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87332	1.09471	-0.2022
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87340	1.09471	-0.2022
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.83017	1.07777	-0.2297
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.77410	1.05677	-0.2675

Table 2.75 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.96479	1.13120	-0.1471
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.95301	1.12507	-0.1529
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90689	1.09975	-0.1754
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.90262	1.09471	-0.1755
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.90262	1.09471	-0.1755
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.86485	1.07777	-0.1976
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.81622	1.05677	-0.2276

Table 2.76 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93886	1.13120	-0.1700
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92598	1.12507	-0.1770
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87329	1.09975	-0.2059
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86922	1.09471	-0.2060
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86930	1.09471	-0.2059
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82435	1.07777	-0.2351
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76568	1.05677	-0.2754

Table 2.77 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

$\text{Blade Worth} = \frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93691	1.13120	-0.1718
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92398	1.12507	-0.1787
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87087	1.09975	-0.2081
Hot Operating_{NoXe}	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86681	1.09471	-0.2082
Hot Operating_0	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86690	1.09471	-0.2081
Hot Operating_{40}	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82148	1.07777	-0.2378
Hot Operating_{80}	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76217	1.05677	-0.2788

Table 2.78 Lattice [ ] Kinetics Parameters at BOL

$\text{Kinetics Parameter} = \frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
$\text{Doppler} = \frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.09471	1.09975	-0.0046
$\text{Moderator}_{Void} = \frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.07777	1.09471	-0.0155
$\text{Moderator}_{Temperature} = \frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.09975	1.13120	-0.0278

Table 2.79 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92064	1.10682	-0.1682
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90748	1.10025	-0.1752
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85748	1.07528	-0.2026
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85333	1.07017	-0.2026
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85341	1.07017	-0.2026
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81384	1.05560	-0.2290
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.76163	1.03672	-0.2653

Table 2.80 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92021	1.10682	-0.1686
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90718	1.10025	-0.1755
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85728	1.07528	-0.2027
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85314	1.07017	-0.2028
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85320	1.07017	-0.2027
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81319	1.05560	-0.2296
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.76016	1.03672	-0.2668

Table 2.81 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

$\text{Blade Worth} = \frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91476	1.10682	-0.1735
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90174	1.10025	-0.1804
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85081	1.07528	-0.2087
Hot Operating_{NoXe}	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84672	1.07017	-0.2088
Hot Operating_{0}	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84680	1.07017	-0.2087
Hot Operating_{40}	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80571	1.05560	-0.2367
Hot Operating_{80}	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75095	1.03672	-0.2757

Table 2.82 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93801	1.10682	-0.1525
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92582	1.10025	-0.1585
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.88022	1.07528	-0.1814
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.87594	1.07017	-0.1815
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.87594	1.07017	-0.1815
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.84032	1.05560	-0.2039
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.79317	1.03672	-0.2349

Table 2.83 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91208	1.10682	-0.1759
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89881	1.10025	-0.1831
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84670	1.07528	-0.2126
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84262	1.07017	-0.2126
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84271	1.07017	-0.2125
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79993	1.05560	-0.2422
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74258	1.03672	-0.2837

Table 2.84 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91013	1.10682	-0.1777
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89680	1.10025	-0.1849
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84427	1.07528	-0.2148
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84021	1.07017	-0.2149
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84030	1.07017	-0.2148
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79706	1.05560	-0.2449
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73905	1.03672	-0.2871

Table 2.85 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_{\alpha} - k_{\beta}}{k_{\beta}}$	k_{α}	k_{β}	Kinetics Parameter ($\Delta k/k$)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.07017	1.07528	-0.0047
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.05560	1.07017	-0.0136
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.07528	1.10682	-0.0285

Table 2.86 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91342	1.08896	-0.1612
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89981	1.08200	-0.1684
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84976	1.05821	-0.1970
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84573	1.05327	-0.1970
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84580	1.05327	-0.1970
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80602	1.03972	-0.2248
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75200	1.02116	-0.2636

Table 2.87 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91303	1.08896	-0.1616
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89954	1.08200	-0.1686
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84963	1.05821	-0.1971
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84561	1.05327	-0.1972
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84566	1.05327	-0.1971
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80545	1.03972	-0.2253
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75061	1.02116	-0.2649

Table 2.88 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90802	1.08896	-0.1662
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89454	1.08200	-0.1732
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84359	1.05821	-0.2028
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83961	1.05327	-0.2029
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83969	1.05327	-0.2028
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79837	1.03972	-0.2321
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74173	1.02116	-0.2736

Table 2.89 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92963	1.08896	-0.1463
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91695	1.08200	-0.1525
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87134	1.05821	-0.1766
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.86719	1.05327	-0.1767
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.86719	1.05327	-0.1767
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.83156	1.03972	-0.2002
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.78299	1.02116	-0.2332

Table 2.90 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90571	1.08896	-0.1683
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89200	1.08200	-0.1756
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83998	1.05821	-0.2062
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83601	1.05327	-0.2063
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83609	1.05327	-0.2062
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79314	1.03972	-0.2372
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73388	1.02116	-0.2813

Table 2.91 Lattice [A11T-4497L-13G85] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90388	1.08896	-0.1700
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89011	1.08200	-0.1774
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83767	1.05821	-0.2084
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83372	1.05327	-0.2084
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83380	1.05327	-0.2084
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79037	1.03972	-0.2398
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73041	1.02116	-0.2847

Table 2.92 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.05327	1.05821	-0.0047
Moderator$_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.03972	1.05327	-0.0129
Moderator$_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.05821	1.08896	-0.0282

Table 2.93 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92670	1.10289	-0.1598
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91388	1.09694	-0.1669
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86789	1.07875	-0.1955
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.86386	1.07383	-0.1955
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.86393	1.07383	-0.1955
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.82583	1.06337	-0.2234
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.77301	1.04873	-0.2629

Table 2.94 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92629	1.10289	-0.1601
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91359	1.09694	-0.1671
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86774	1.07875	-0.1956
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.86372	1.07383	-0.1957
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.86378	1.07383	-0.1956
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.82523	1.06337	-0.2240
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.77155	1.04873	-0.2643

Table 2.95 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92116	1.10289	-0.1648
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90847	1.09694	-0.1718
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86148	1.07875	-0.2014
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85751	1.07383	-0.2014
Hot $Operating_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85759	1.07383	-0.2014
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81784	1.06337	-0.2309
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.76221	1.04873	-0.2732

Table 2.96 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94301	1.10289	-0.1450
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93114	1.09694	-0.1512
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.88976	1.07875	-0.1752
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.88561	1.07383	-0.1753
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.88561	1.07383	-0.1753
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.85186	1.06337	-0.1989
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.80486	1.04873	-0.2325

Table 2.97 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91891	1.10289	-0.1668
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90599	1.09694	-0.1741
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85794	1.07875	-0.2047
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85398	1.07383	-0.2047
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85406	1.07383	-0.2047
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81267	1.06337	-0.2358
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75435	1.04873	-0.2807

Table 2.98 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91707	1.10289	-0.1685
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90408	1.09694	-0.1758
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85560	1.07875	-0.2069
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85165	1.07383	-0.2069
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85173	1.07383	-0.2068
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80983	1.06337	-0.2384
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75077	1.04873	-0.2841

Table 2.99 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter ($\Delta k/k$)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.07383	1.07875	-0.0046
Moderator$_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.06337	1.07383	-0.0097
Moderator$_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.07875	1.10289	-0.0219

Table 2.100 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

$\text{Blade Worth} = \frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94396	1.12760	-0.1629
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93107	1.12127	-0.1696
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87971	1.09465	-0.1964
Hot Operating_{NoXe}	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87557	1.08960	-0.1964
Hot Operating_{0}	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87564	1.08960	-0.1964
Hot Operating_{40}	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.83346	1.07180	-0.2224
Hot Operating_{80}	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.77974	1.04997	-0.2574

Table 2.101 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94348	1.12760	-0.1633
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93071	1.12127	-0.1699
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87945	1.09465	-0.1966
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.87531	1.08960	-0.1967
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.87537	1.08960	-0.1966
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.83274	1.07180	-0.2230
Hot Operating$_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.77820	1.04997	-0.2588

Table 2.102 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93795	1.12760	-0.1682
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92519	1.12127	-0.1749
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87284	1.09465	-0.2026
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86876	1.08960	-0.2027
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86884	1.08960	-0.2026
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.82513	1.07180	-0.2301
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76890	1.04997	-0.2677

Table 2.103 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.96124	1.12760	-0.1475
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.94930	1.12127	-0.1534
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.90220	1.09465	-0.1758
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.89794	1.08960	-0.1759
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.89794	1.08960	-0.1759
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.85961	1.07180	-0.1980
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.81069	1.04997	-0.2279

Table 2.104 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93535	1.12760	-0.1705
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92232	1.12127	-0.1774
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86871	1.09465	-0.2064
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86464	1.08960	-0.2065
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86473	1.08960	-0.2064
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.81930	1.07180	-0.2356
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.76049	1.04997	-0.2757

Table 2.105 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93340	1.12760	-0.1722
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92031	1.12127	-0.1792
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86630	1.09465	-0.2086
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void, No xenon	0.86225	1.08960	-0.2087
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=979° F 0% Void	0.86233	1.08960	-0.2086
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 40% Void	0.81645	1.07180	-0.2382
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=979° F 80% Void	0.75701	1.04997	-0.2790

Table 2.106 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter ($\Delta k/k$)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.08960	1.09465	-0.0046
Moderator$_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.07180	1.08960	-0.0163
Moderator$_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.09465	1.12760	-0.0292

Table 2.107 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91716	1.10327	-0.1687
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90384	1.09648	-0.1757
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85287	1.07015	-0.2030
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84872	1.06503	-0.2031
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84879	1.06503	-0.2030
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80869	1.04956	-0.2295
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75622	1.02975	-0.2656

Table 2.108 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91674	1.10327	-0.1691
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90354	1.09648	-0.1760
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85268	1.07015	-0.2032
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84853	1.06503	-0.2033
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84859	1.06503	-0.2032
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80805	1.04956	-0.2301
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75478	1.02975	-0.2670

Table 2.109 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91131	1.10327	-0.1740
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89813	1.09648	-0.1809
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84625	1.07015	-0.2092
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84216	1.06503	-0.2093
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84224	1.06503	-0.2092
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80065	1.04956	-0.2372
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74568	1.02975	-0.2759

Table 2.110 Lattice [ ] Control Blade Worths at BOL for Control Block Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.93450	1.10327	-0.1530
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.92215	1.09648	-0.1590
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.87553	1.07015	-0.1819
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.87125	1.06503	-0.1820
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.87125	1.06503	-0.1820
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.83505	1.04956	-0.2044
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.78755	1.02975	-0.2352

Table 2.111 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90862	1.10327	-0.1764
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89518	1.09648	-0.1836
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84212	1.07015	-0.2131
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83804	1.06503	-0.2131
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83813	1.06503	-0.2130
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79486	1.04956	-0.2427
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73731	1.02975	-0.2840

Table 2.112 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90667	1.10327	-0.1782
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89318	1.09648	-0.1854
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83971	1.07015	-0.2153
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83565	1.06503	-0.2154
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83573	1.06503	-0.2153
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79200	1.04956	-0.2454
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73381	1.02975	-0.2874

Table 2.113 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter ($\Delta k/k$)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.06503	1.07015	-0.0048
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.04956	1.06503	-0.0145
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.07015	1.10327	-0.0300

Table 2.114 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91183	1.08855	-0.1623
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89811	1.08145	-0.1695
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84728	1.05634	-0.1979
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84324	1.05139	-0.1980
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84330	1.05139	-0.1979
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80306	1.03692	-0.2255
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74877	1.01740	-0.2640

Table 2.115 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91145	1.08855	-0.1627
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89785	1.08145	-0.1698
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84716	1.05634	-0.1980
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.84312	1.05139	-0.1981
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.84318	1.05139	-0.1980
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.80250	1.03692	-0.2261
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.74741	1.01740	-0.2654

Table 2.116 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90637	1.08855	-0.1674
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89278	1.08145	-0.1745
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.84106	1.05634	-0.2038
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83707	1.05139	-0.2038
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83715	1.05139	-0.2038
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79538	1.03692	-0.2329
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73852	1.01740	-0.2741

Table 2.117 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth ($\Delta k/k$)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92809	1.08855	-0.1474
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91531	1.08145	-0.1536
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86887	1.05634	-0.1775
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.86471	1.05139	-0.1776
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.86471	1.05139	-0.1776
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.82854	1.03692	-0.2010
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.77960	1.01740	-0.2337

Table 2.118 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	**Blade Worth (Δk/k)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90406	1.08855	-0.1695
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.89024	1.08145	-0.1768
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83743	1.05634	-0.2072
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83346	1.05139	-0.2073
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83354	1.05139	-0.2072
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.79014	1.03692	-0.2380
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.73066	1.01740	-0.2818

Table 2.119 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.90221	1.08855	-0.1712
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.88834	1.08145	-0.1786
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.83512	1.05634	-0.2094
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.83116	1.05139	-0.2095
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.83124	1.05139	-0.2094
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.78736	1.03692	-0.2407
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.72720	1.01740	-0.2852

Table 2.120 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.05139	1.05634	-0.0047
$Moderator_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.03692	1.05139	-0.0138
$Moderator_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.05634	1.08855	-0.0296

Table 2.121 Lattice [ ] Control Blade Worths at BOL for Control Blade Type GE Original Equipment

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92796	1.10503	-0.1602
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91519	1.09915	-0.1674
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86936	1.08101	-0.1958
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.86533	1.07609	-0.1959
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.86540	1.07609	-0.1958
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.82738	1.06566	-0.2236
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.77460	1.05106	-0.2630

Table 2.122 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Duralife 160

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92755	1.10503	-0.1606
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.91491	1.09915	-0.1676
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86922	1.08101	-0.1959
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.86519	1.07609	-0.1960
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.86525	1.07609	-0.1959
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.82678	1.06566	-0.2242
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.77314	1.05106	-0.2644

Table 2.123 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		**$k_{Controlled}$**	**$k_{Uncontrolled}$**	**Blade Worth ($\Delta k/k$)**
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92237	1.10503	-0.1653
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90972	1.09915	-0.1723
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.86290	1.08101	-0.2018
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85893	1.07609	-0.2018
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85901	1.07609	-0.2017
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81933	1.06566	-0.2311
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.76373	1.05106	-0.2734

Table 2.124 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR82M-1 HF TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.94434	1.10503	-0.1454
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.93253	1.09915	-0.1516
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.89131	1.08101	-0.1755
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.88716	1.07609	-0.1756
Hot Operating$_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.88716	1.07609	-0.1756
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.85348	1.06566	-0.1991
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.80650	1.05106	-0.2327

Table 2.125 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99 TIP

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.92012	1.10503	-0.1673
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90725	1.09915	-0.1746
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85935	1.08101	-0.2051
Hot $Operating_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85539	1.07609	-0.2051
Hot $Operating_{0}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85547	1.07609	-0.2050
Hot $Operating_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81414	1.06566	-0.2360
Hot $Operating_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75586	1.05106	-0.2809

Table 2.126 Lattice [ ] Control Blade Worths at BOL for Control Blade Type Westinghouse-ABB CR99

Blade Worth = $\frac{k_{Controlled} - k_{Uncontrolled}}{k_{Uncontrolled}}$		$k_{Controlled}$	$k_{Uncontrolled}$	Blade Worth (Δk/k)
Cold	$T_{Moderator}$=68° F T_{Fuel}=68° F 0% Void, No xenon	0.91827	1.10503	-0.1690
Intermediate	$T_{Moderator}$=200° F T_{Fuel}=200° F 0% Void, No xenon	0.90533	1.09915	-0.1763
Hot Standby	$T_{Moderator}$=550° F T_{Fuel}=550° F 0% Void, No xenon	0.85700	1.08101	-0.2072
Hot Operating$_{NoXe}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void, No xenon	0.85305	1.07609	-0.2073
Hot Operating$_0$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 0% Void	0.85313	1.07609	-0.2072
Hot Operating$_{40}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 40% Void	0.81129	1.06566	-0.2387
Hot Operating $_{80}$	$T_{Moderator}$=550° F T_{Fuel}=1017° F 80% Void	0.75226	1.05106	-0.2843

Table 2.127 Lattice [ ] Kinetics Parameters at BOL

Kinetics Parameter = $\frac{k_\alpha - k_\beta}{k_\beta}$	k_α	k_β	Kinetics Parameter (Δk/k)
Doppler = $\frac{k_{HotOperatingNoXe} - k_{HotStandby}}{k_{HotStandby}}$	1.07609	1.08101	-0.0046
Moderator$_{Void}$ = $\frac{k_{HotOperating40} - k_{HotOperating0}}{k_{HotOperating0}}$	1.06566	1.07609	-0.0097
Moderator$_{Temperature}$ = $\frac{k_{HotStandby} - k_{Cold}}{k_{Cold}}$	1.08101	1.10503	-0.0217

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Figure 2.1 Assembly Type [ ]

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Figure 2.2 Assembly Type [ ]

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Figure 2.3 Assembly Type [ ]

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Figure 2.4 [ ] Fuel Rod Distribution

[ ]

Figure 2.5 [ ] Fuel Rod Distribution

[ ]

Figure 2.6 [ ] Fuel Rod Distribution

Figure 2.7 Fuel Rod Axial Description

[ ]

Figure 2.7 Fuel Rod Axial Description *(Continued)*

[ ]

Figure 2.7 Fuel Rod Axial Description *(Continued)*

3.0 REFERENCES

1. FS1-0031299 Revision 4.0, Brunswick Unit 1 Cycle 23 Reload BRK1-23 ATRIUM 11 Specific Fuel Assembly Mechanical Data for Core Engineering, August 2019.

2. ANF-89-98(P)(A) Revision 1 and Supplement 1, *Generic Mechanical Design Criteria for BWR Fuel Designs*, Advanced Nuclear Fuels Corporation, May 1995.

3. EMF-2158(P)(A), Revision 0, *Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2*, Siemens Power Corporation, October 1999.

4. ANP-3672P, Revision 0, Brunswick Nuclear Plant New Fuel Storage Vault Criticality Safety Analysis for ATRIUM 11 Fuel, August 2018.

5. ANP-3671P, Revision 0, Brunswick Nuclear Plant Spent Fuel Storage Pool Criticality Safety Analysis for ATRIUM 11 Fuel, December 2018.

6. Certificate of Compliance No. 9372 Revision No. 1 For the Model No. TN-B1 Transportation Package, March 27, 2018.

Appendix A Enriched Lattice Hot Uncontrolled Reactivity and LPF Plots

The results in this appendix are based on hot operating and equilibrium xenon conditions.

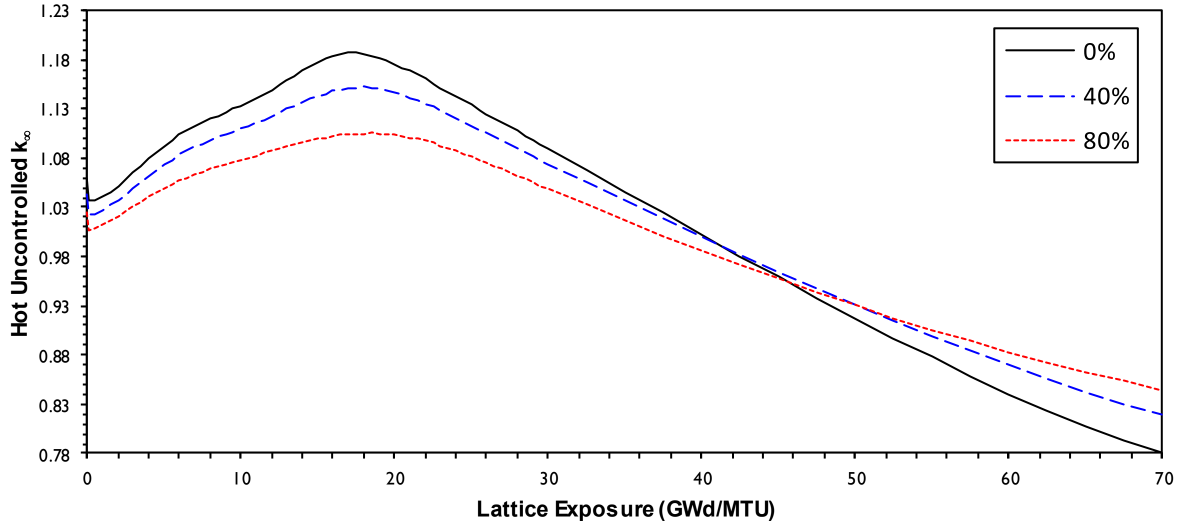

Figure A.1 [ ] Hot Uncontrolled k_∞

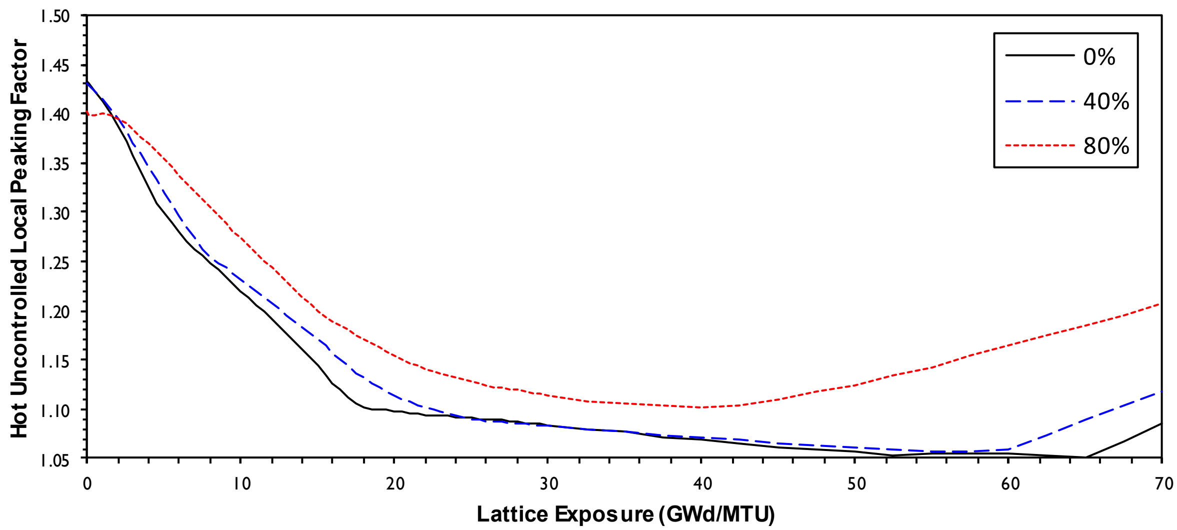

Figure A.2 [ ] Hot Uncontrolled LPF

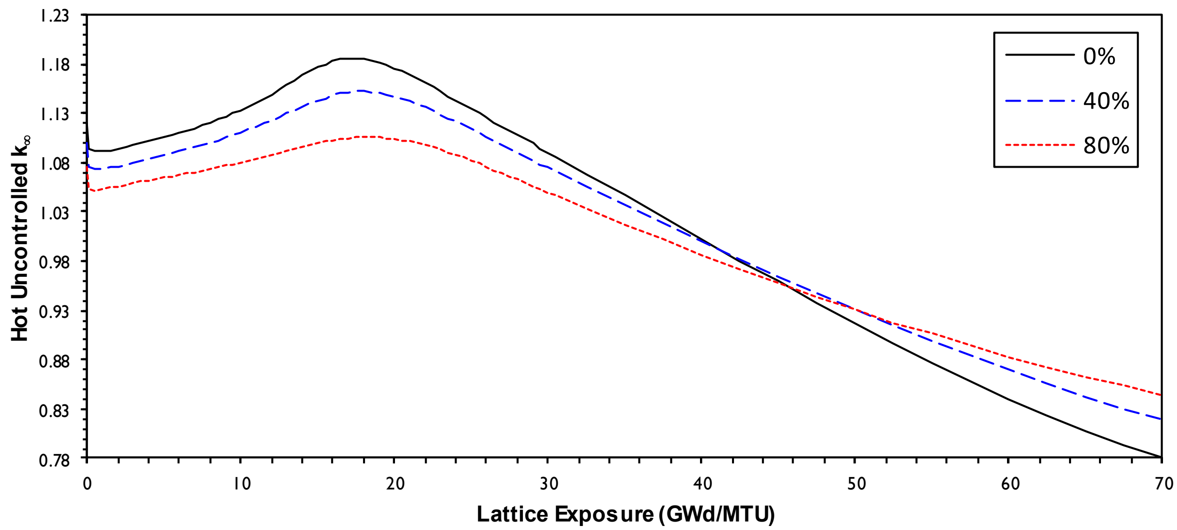

Figure A.3 [ ] Hot Uncontrolled k_∞

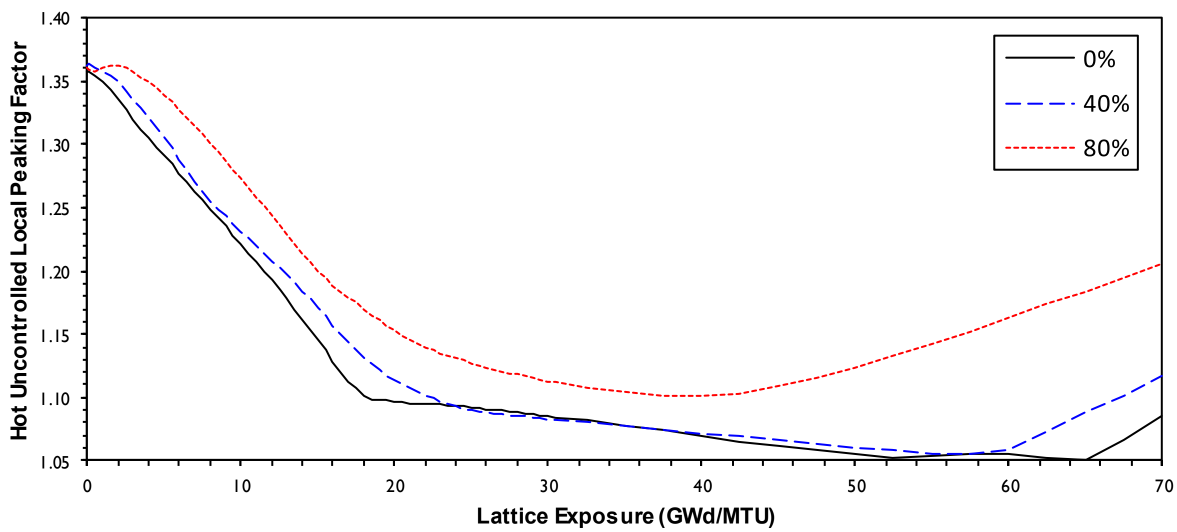

Figure A.4 [ ] Hot Uncontrolled LPF

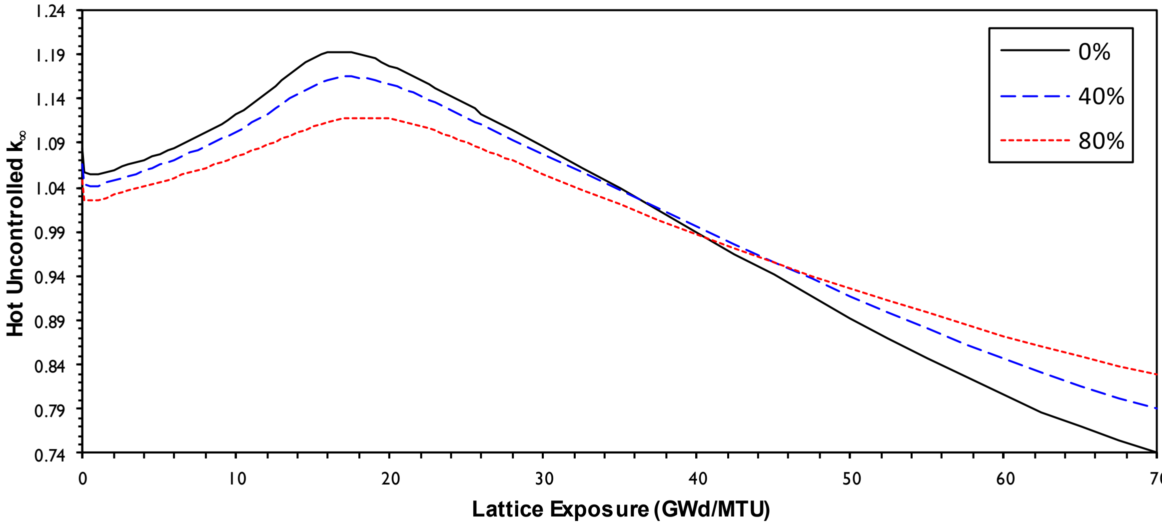

Figure A.5 [ ] Hot Uncontrolled k_∞

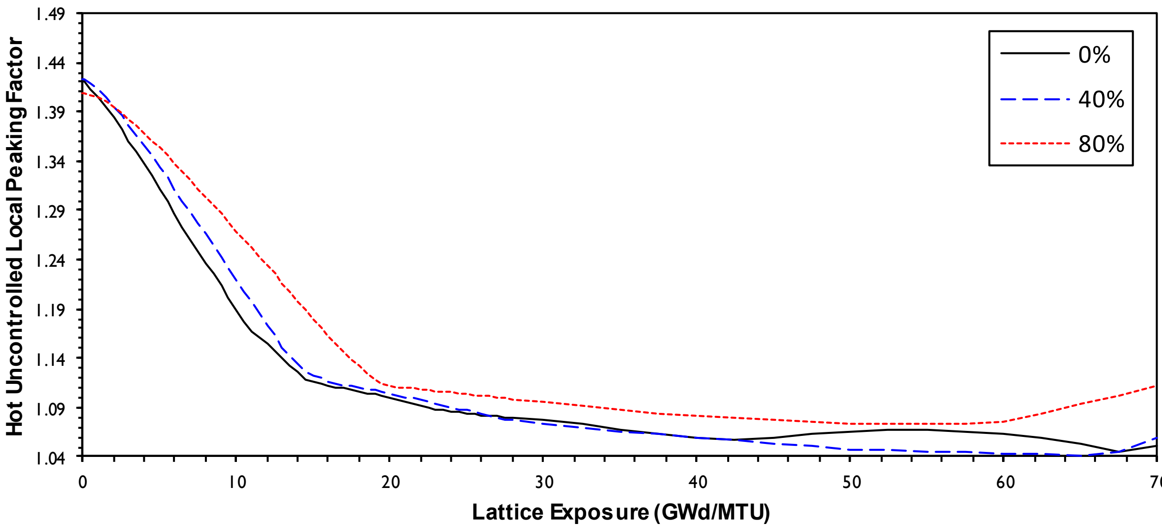

Figure A.6 [ ] Hot Uncontrolled LPF

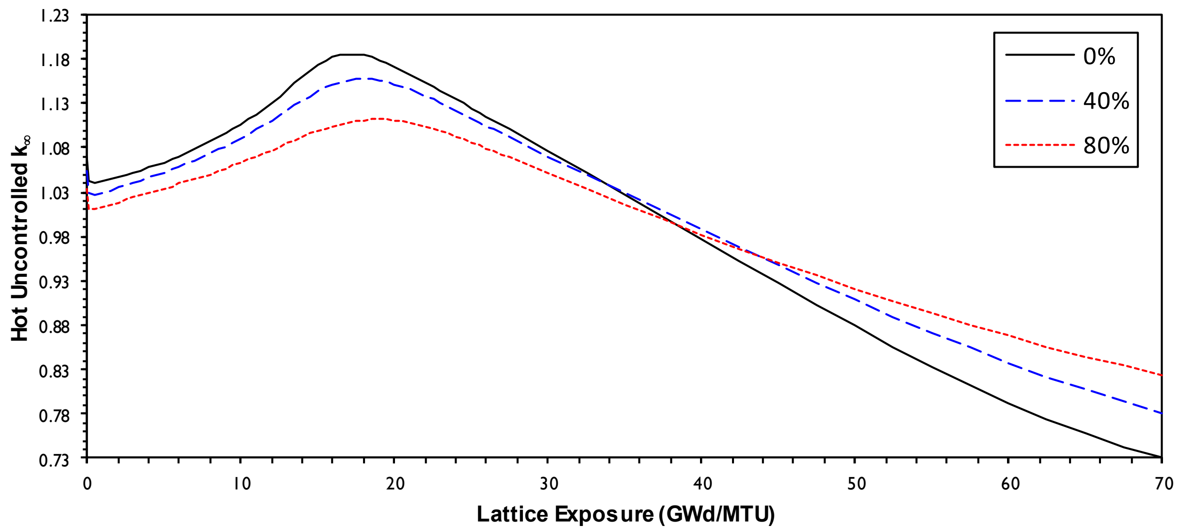

Figure A.7 [ ] Hot Uncontrolled k_∞

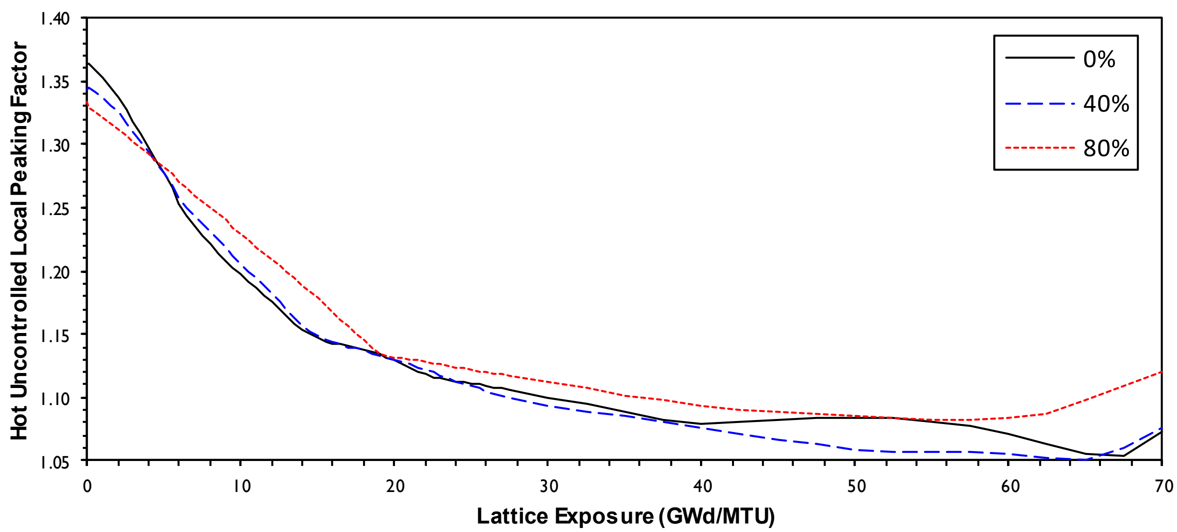

Figure A.8 [ ] Hot Uncontrolled LPF

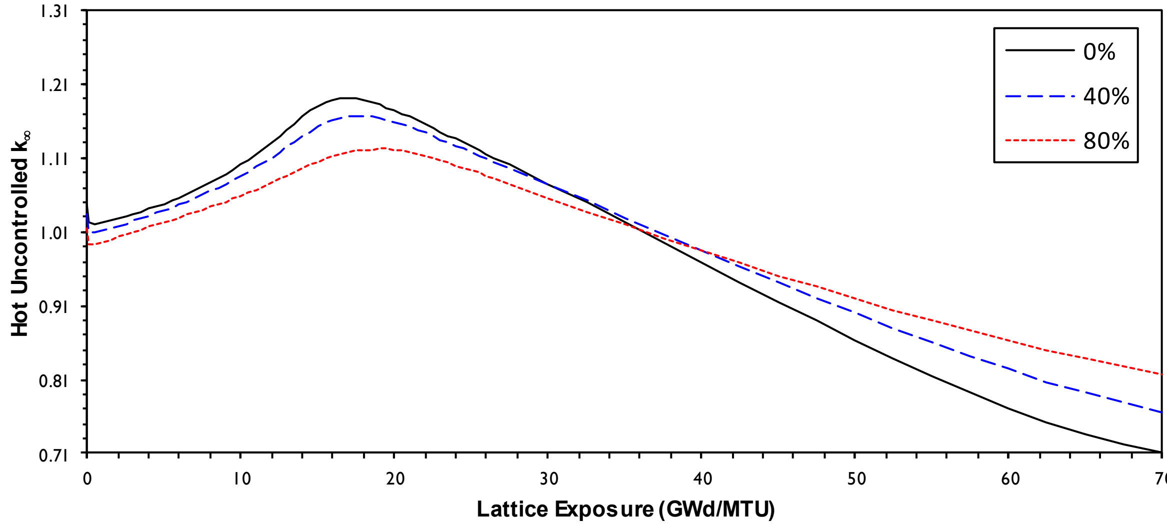

Figure A.9 [ ] Hot Uncontrolled k_∞

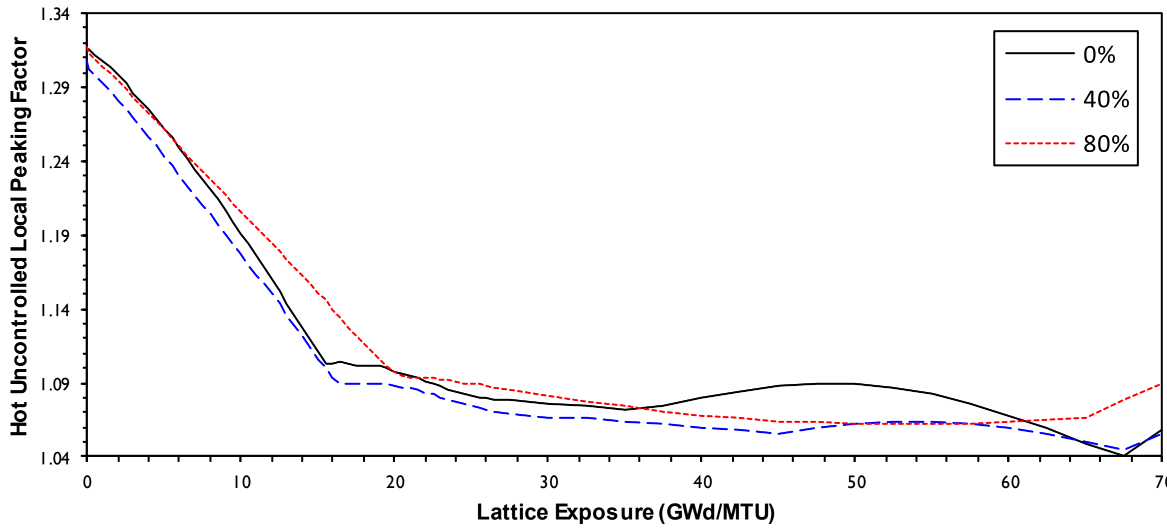

Figure A.10 [ ] Hot Uncontrolled LPF

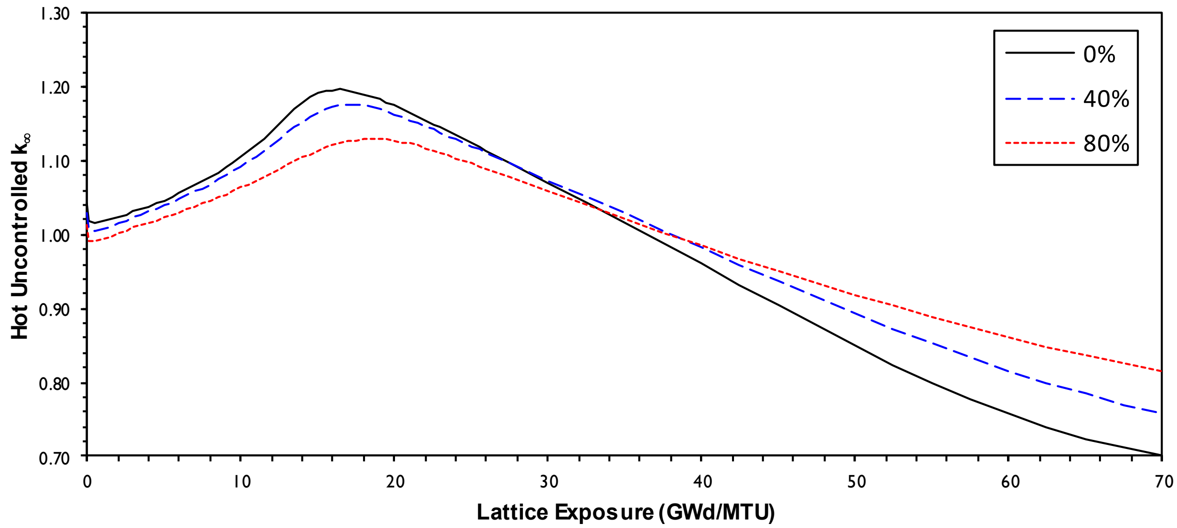

Figure A.11 [ ] Hot Uncontrolled k_∞

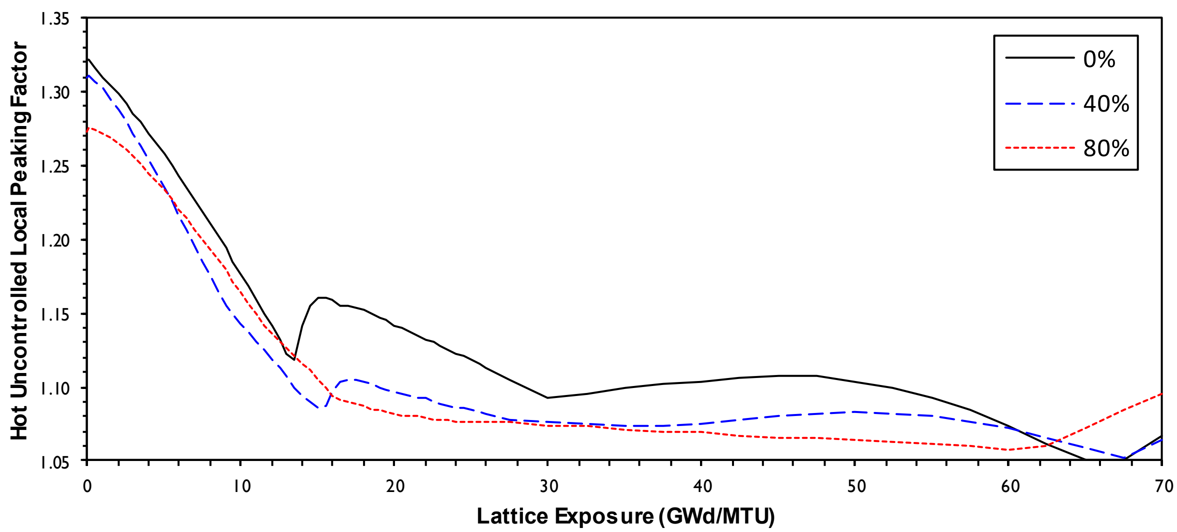

Figure A.12 [ ] Hot Uncontrolled LPF

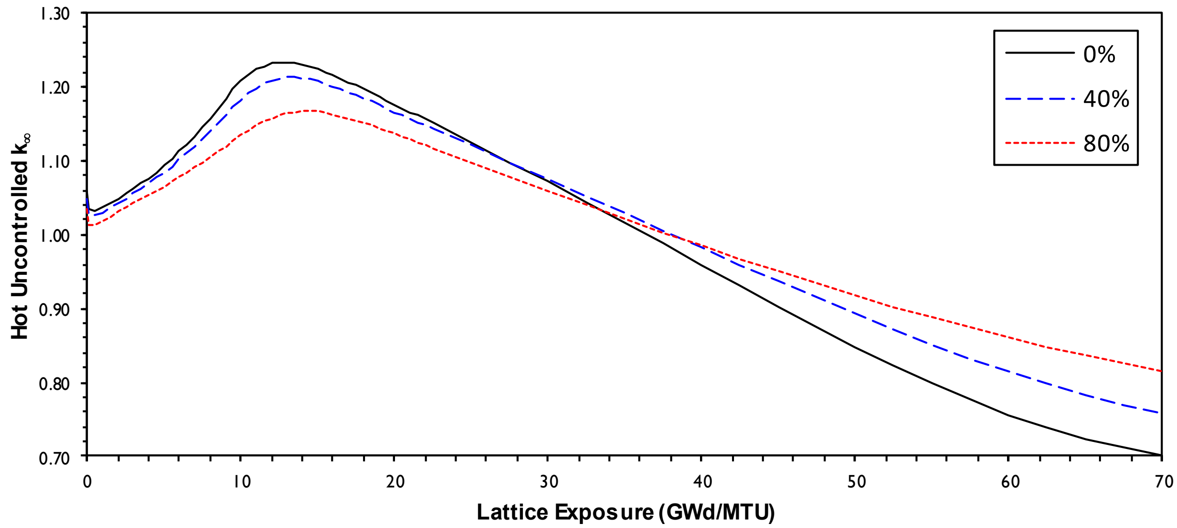

Figure A.13 [ ] Hot Uncontrolled k$_\infty$

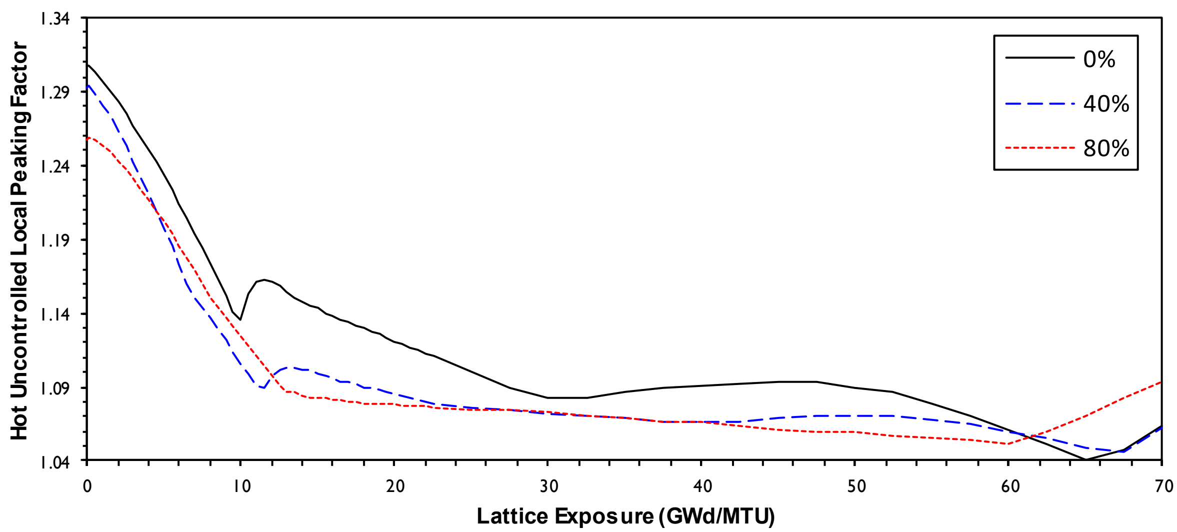

Figure A.14 [ ] Hot Uncontrolled LPF

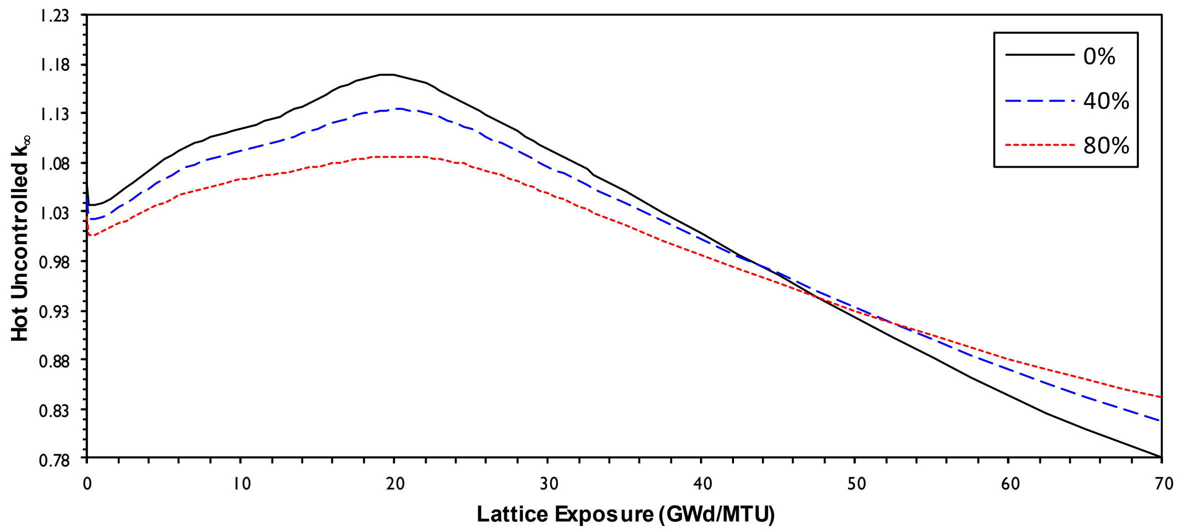

Figure A.15 [ ] Hot Uncontrolled k_∞

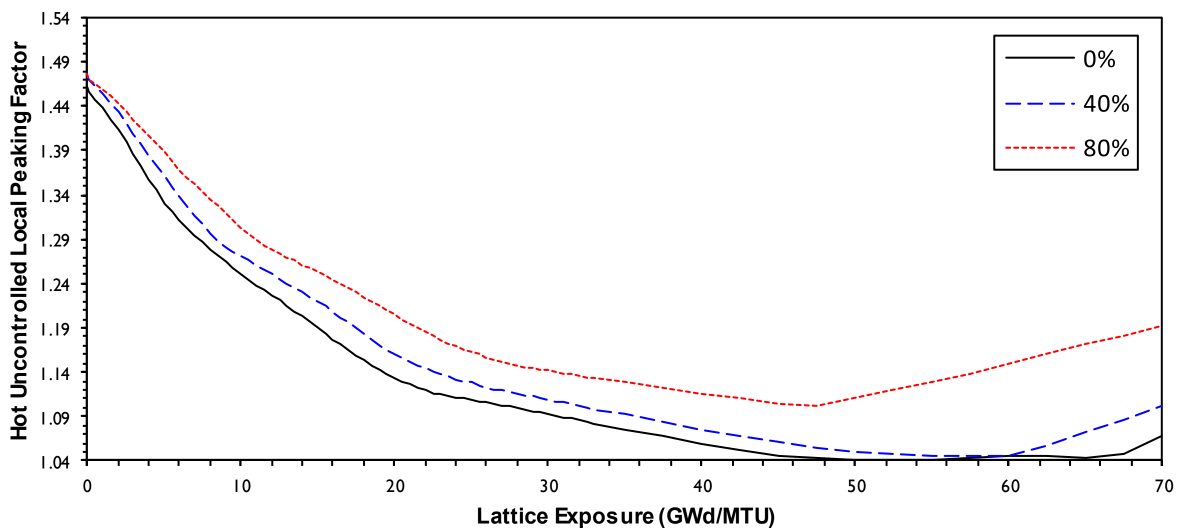

Figure A.16 [ ] Hot Uncontrolled LPF

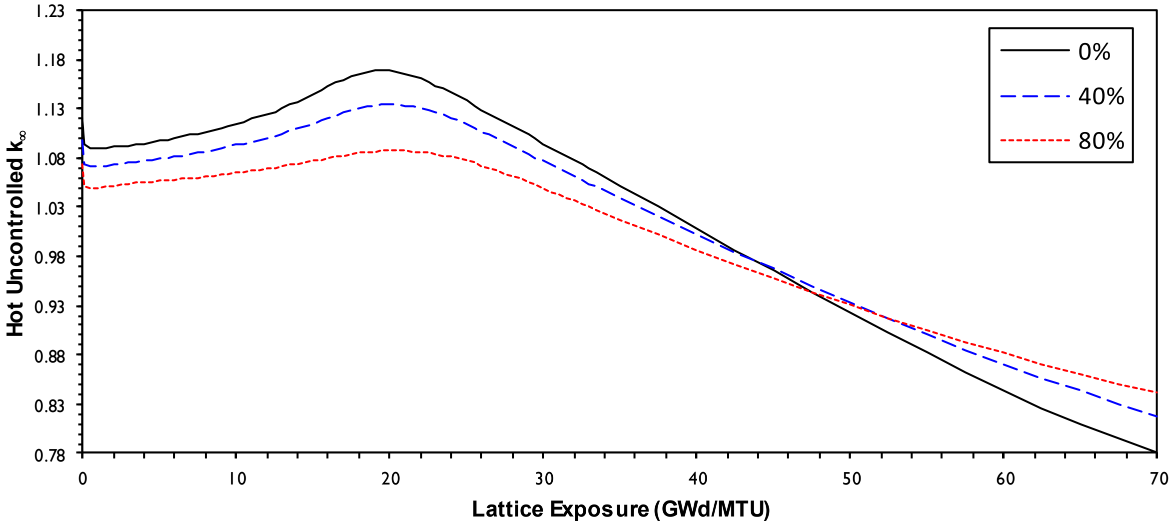

Figure A.17 [ ] Hot Uncontrolled k∞

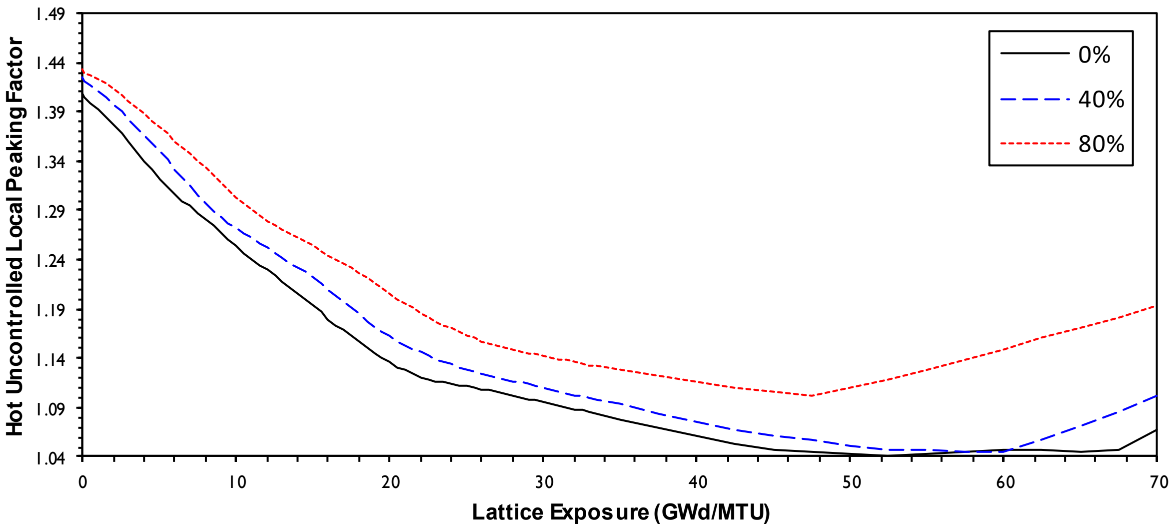

Figure A.18 [ ] Hot Uncontrolled LPF

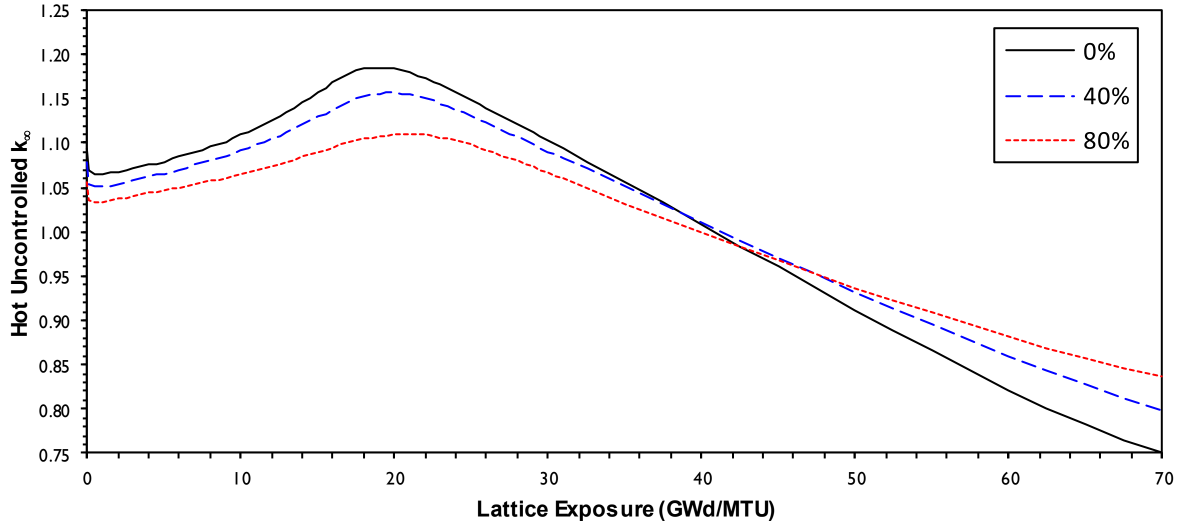

Figure A.19 [ ] Hot Uncontrolled k_∞

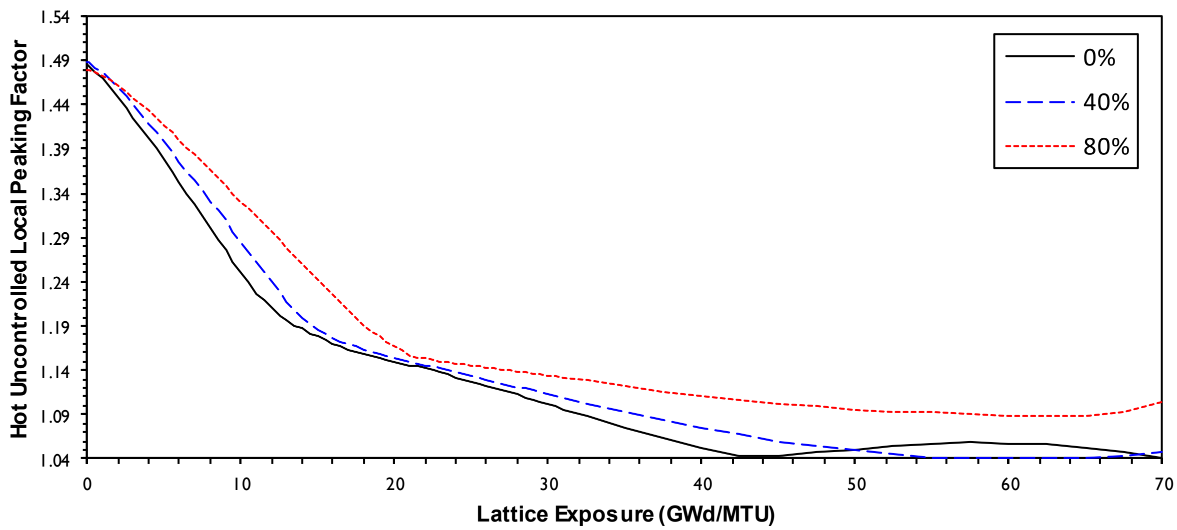

Figure A.20 [ ] Hot Uncontrolled LPF

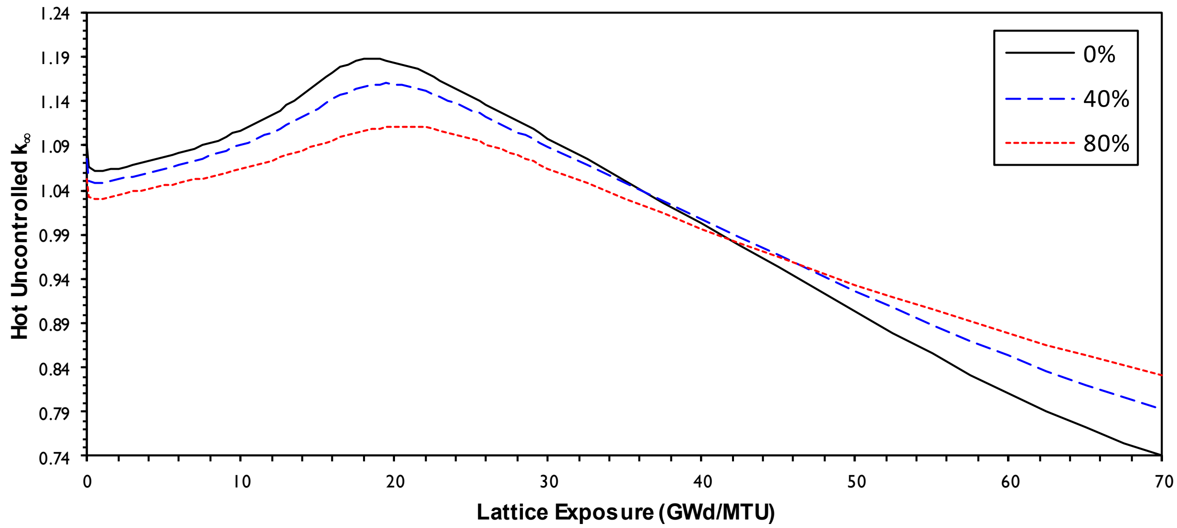

Figure A.21 [ ] Hot Uncontrolled k_∞

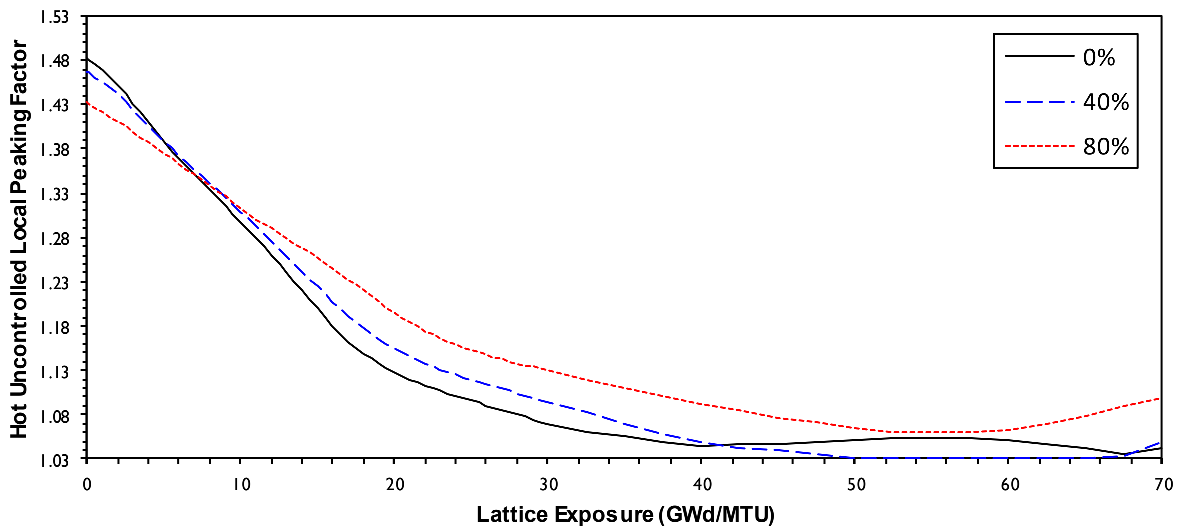

Figure A.22 [ ] Hot Uncontrolled LPF

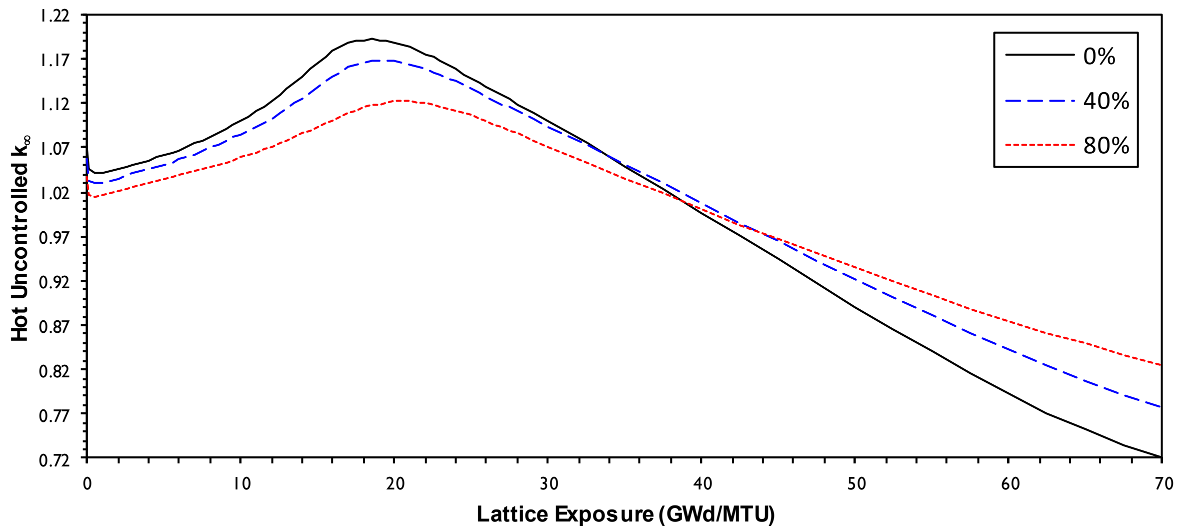

Figure A.23 [ ] Hot Uncontrolled k_∞

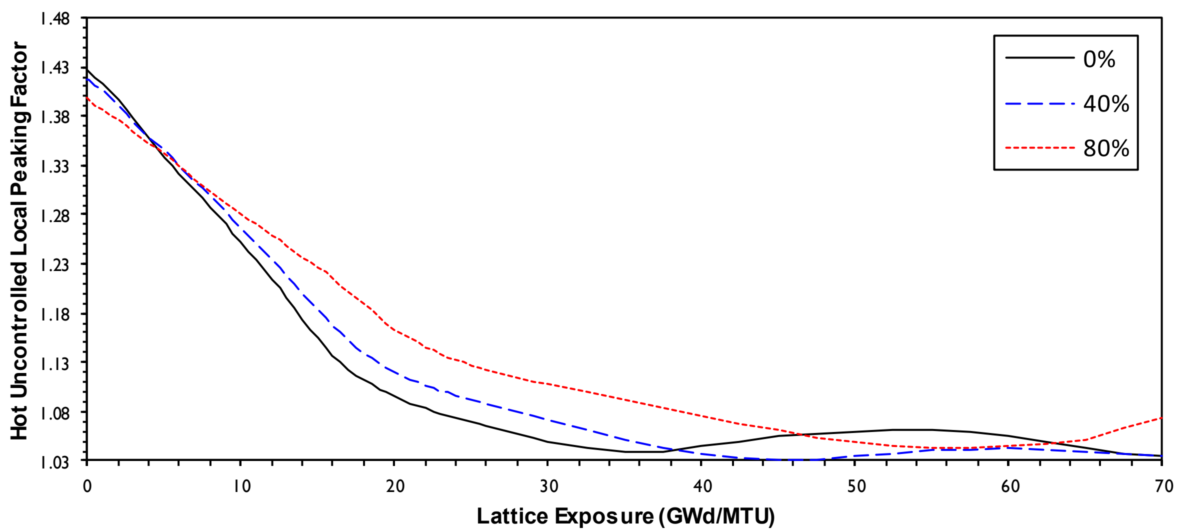

Figure A.24 [ ] Hot Uncontrolled LPF

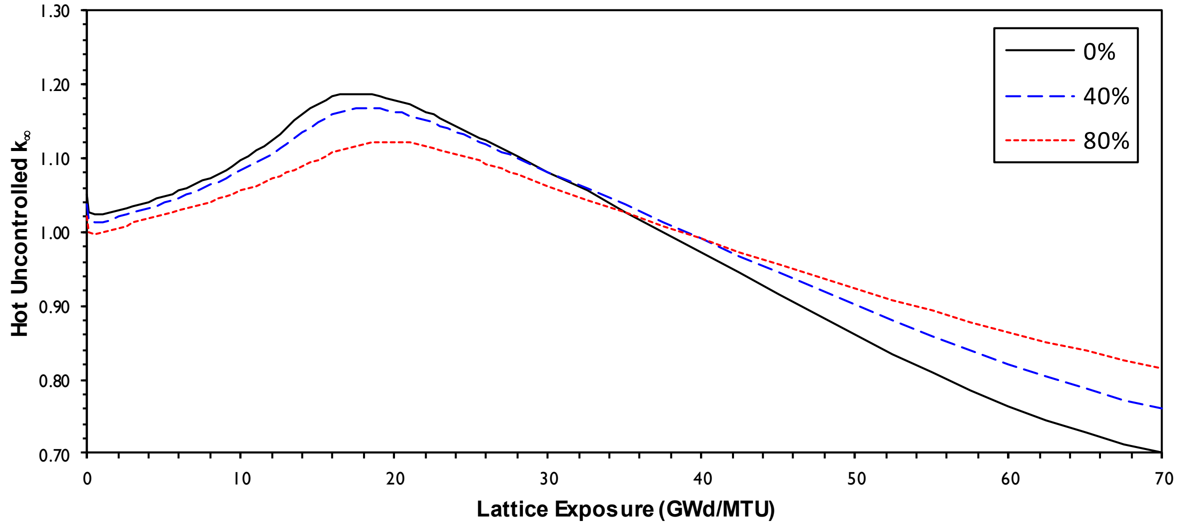

Figure A.25 [ ] Hot Uncontrolled k_∞

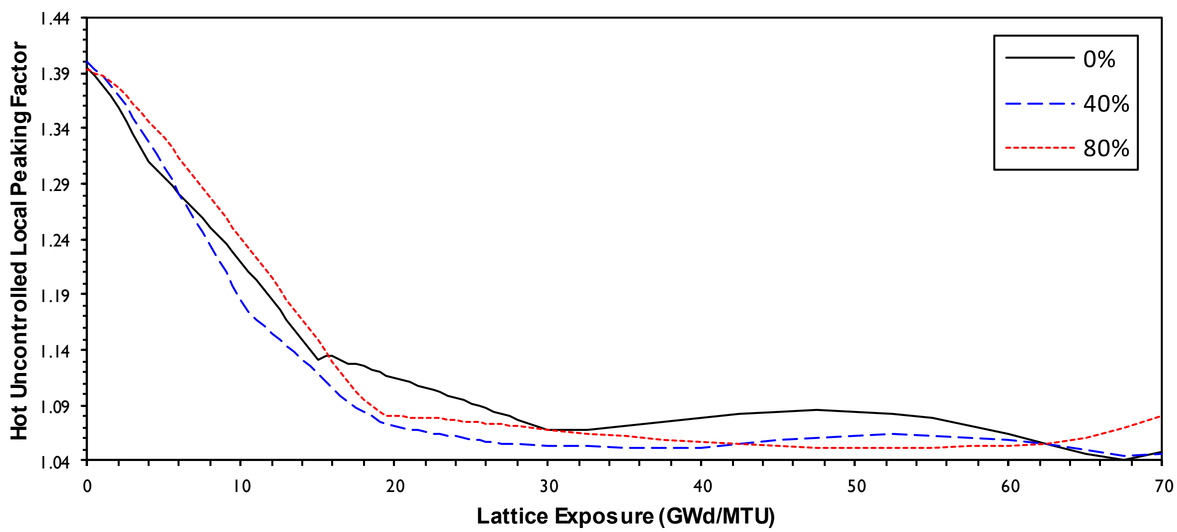

Figure A.26 [ ] Hot Uncontrolled LPF

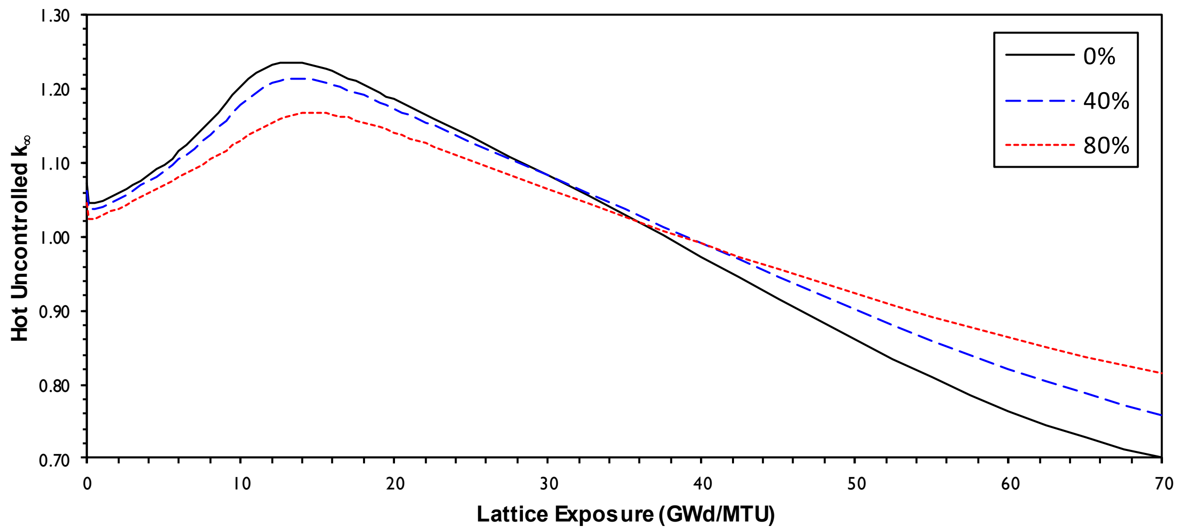

Figure A.27 [ ] Hot Uncontrolled k_∞

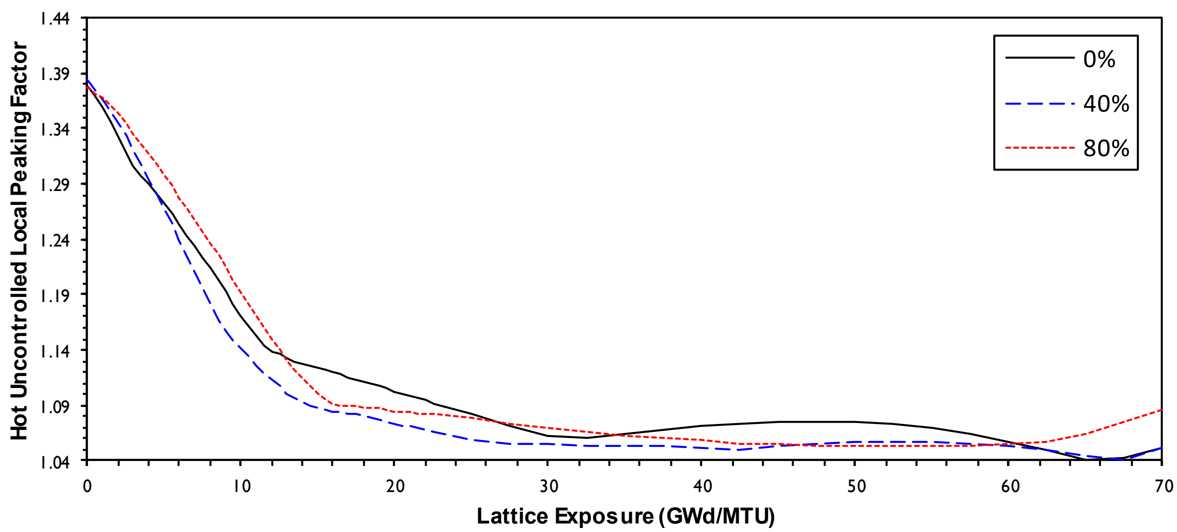

Figure A.28 [ ] Hot Uncontrolled LPF

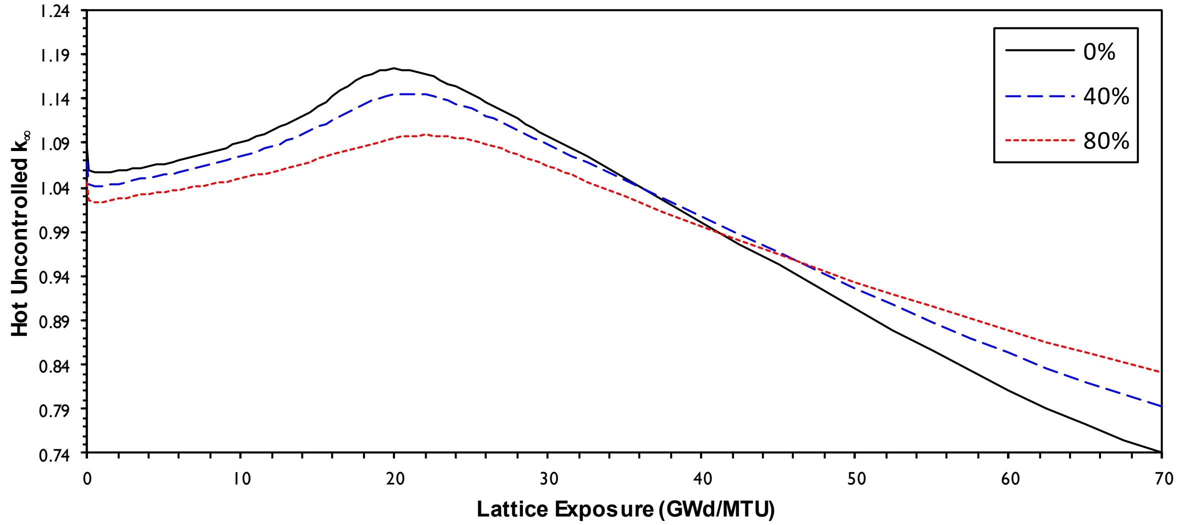

Figure A.29 [ ] Hot Uncontrolled k$_\infty$

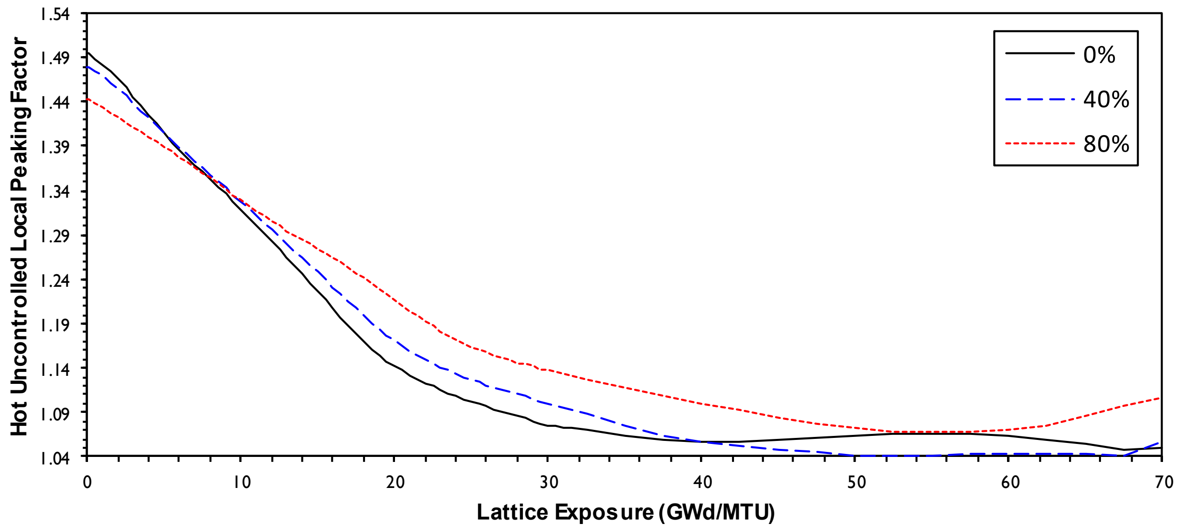

Figure A.30 [ ] Hot Uncontrolled LPF

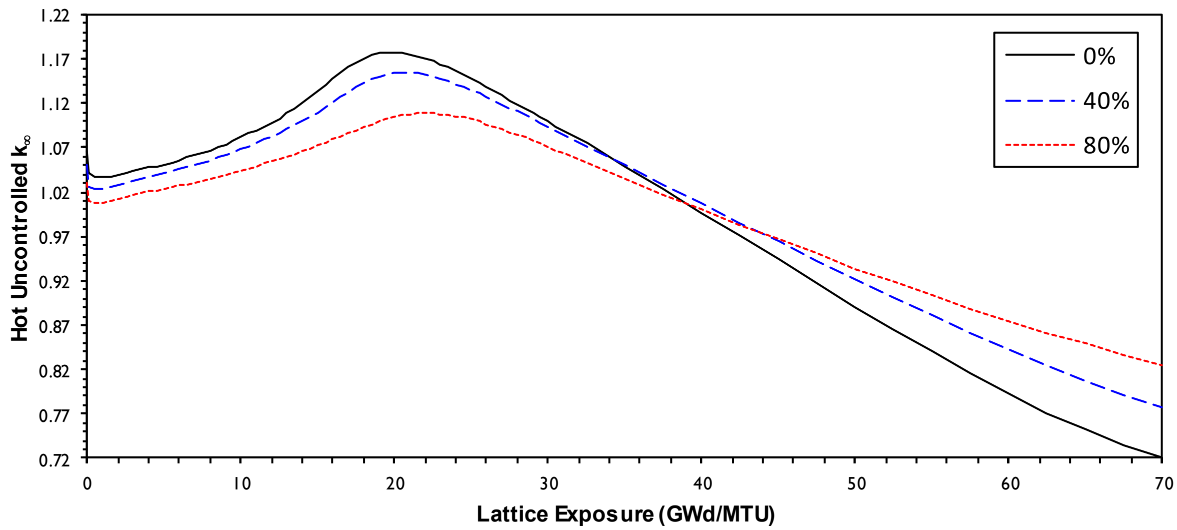

Figure A.31 [ ] Hot Uncontrolled k_∞

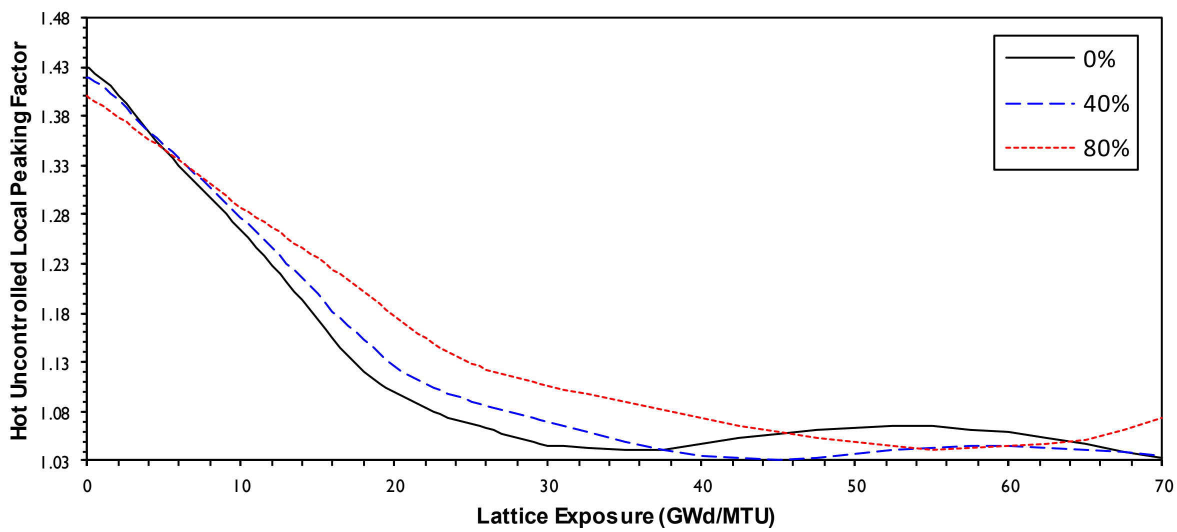

Figure A.32 [ ] Hot Uncontrolled LPF

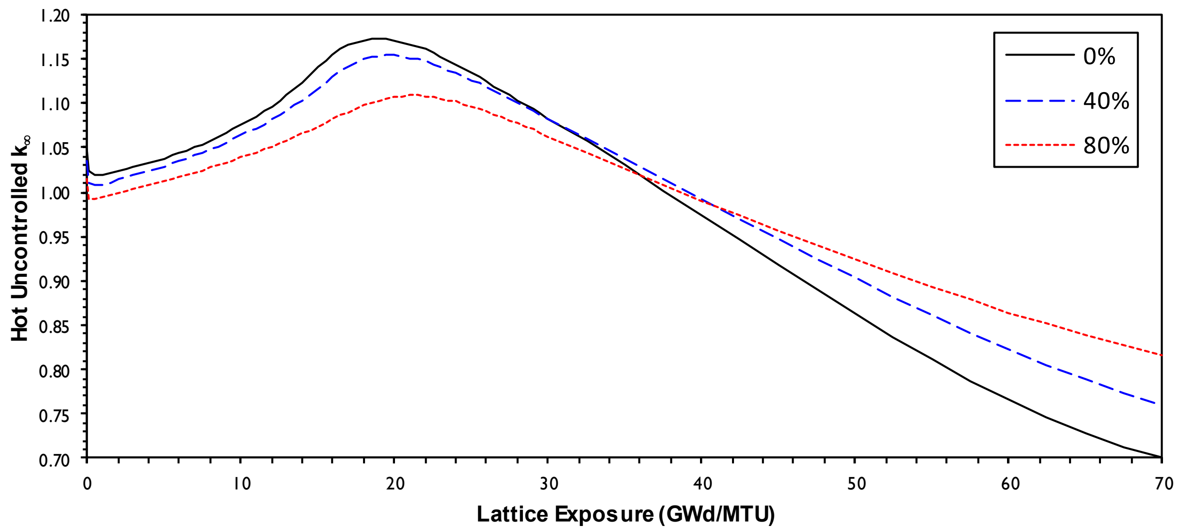

Figure A.33 [ ] Hot Uncontrolled k∞

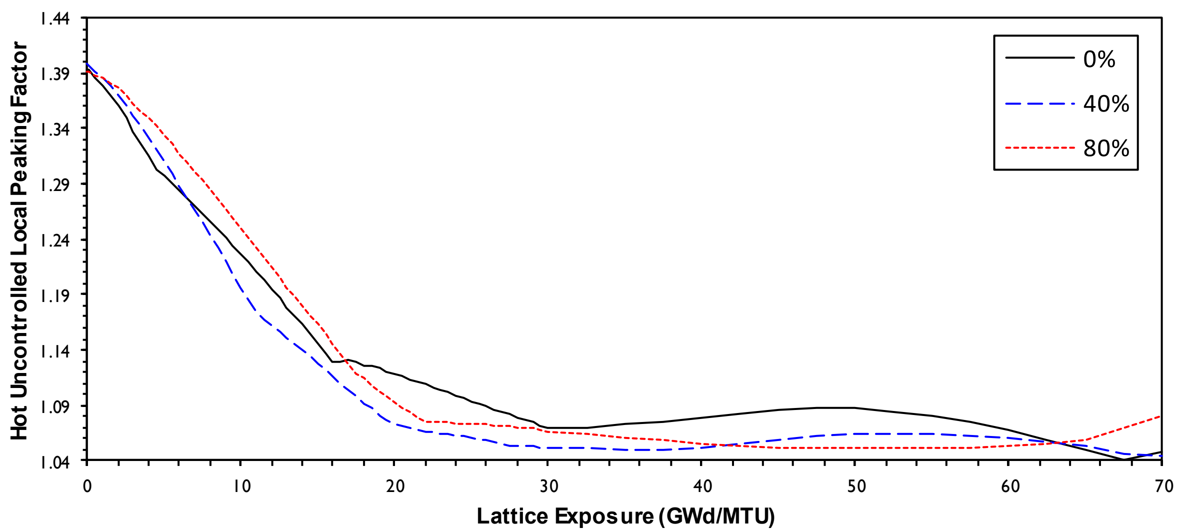

Figure A.34 [ ] Hot Uncontrolled LPF

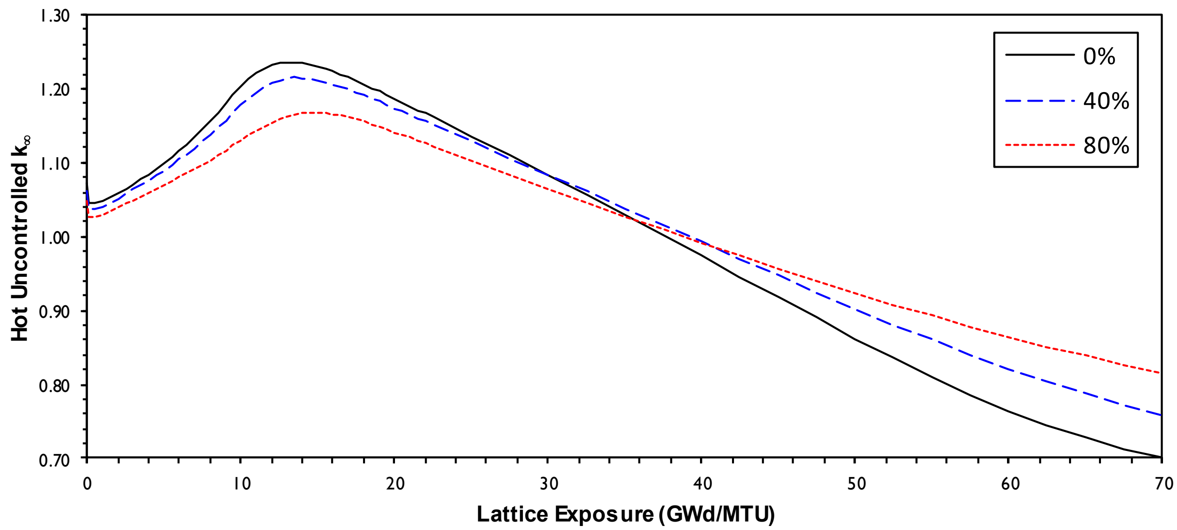

Figure A.35 [ ] Hot Uncontrolled k_∞

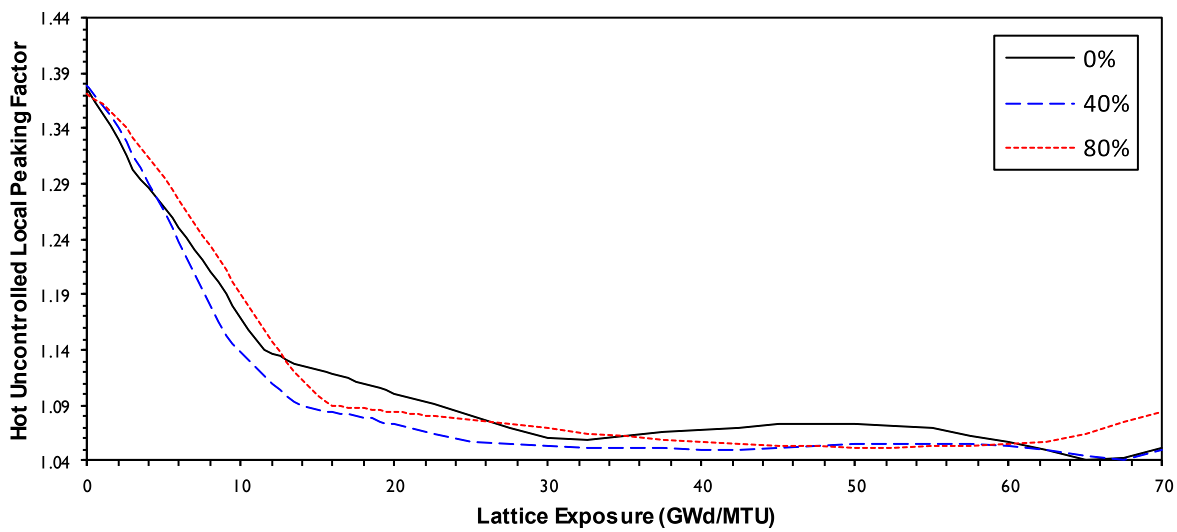

Figure A.36 [ ] Hot Uncontrolled LPF

Appendix B Enriched Lattice Hot Uncontrolled Reactivity and LPF Tables

The results in this appendix are based on hot operating and equilibrium xenon conditions.

Table B.1 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.05445	1.03844	1.02081
100.	1.03179	1.01754	1.00234
500.	1.03170	1.01802	1.00330
1000.	1.03581	1.02224	1.00735
1500.	1.04130	1.02751	1.01206
2000.	1.04731	1.03312	1.01687
2500.	1.05362	1.03884	1.02161
3000.	1.06020	1.04465	1.02626
3500.	1.06704	1.05053	1.03083
4000.	1.07407	1.05648	1.03534
4500.	1.08104	1.06239	1.03977
5000.	1.08757	1.06810	1.04408
5500.	1.09343	1.07337	1.04818
6000.	1.09861	1.07813	1.05199
6500.	1.10323	1.08241	1.05546
7000.	1.10738	1.08631	1.05861
7500.	1.11116	1.08987	1.06151
8000.	1.11472	1.09318	1.06420
8500.	1.11816	1.09629	1.06673
9000.	1.12158	1.09929	1.06912
9500.	1.12504	1.10223	1.07140
10000.	1.12860	1.10517	1.07359
10500.	1.13233	1.10818	1.07573
11000.	1.13625	1.11128	1.07784
11500.	1.14040	1.11449	1.07997
12000.	1.14477	1.11781	1.08211
12500.	1.14935	1.12123	1.08427
13000.	1.15410	1.12472	1.08642
13500.	1.15891	1.12820	1.08852
14000.	1.16366	1.13163	1.09055
14500.	1.16821	1.13490	1.09245
15000.	1.17233	1.13795	1.09420
15500.	1.17588	1.14068	1.09577
16000.	1.17866	1.14301	1.09714
16500.	1.18057	1.14486	1.09829
17000.	1.18156	1.14617	1.09919
17500.	1.18165	1.14691	1.09983
18000.	1.18084	1.14706	1.10020
18500.	1.17922	1.14662	1.10027
19000.	1.17693	1.14563	1.10003
19500.	1.17410	1.14410	1.09949
20000.	1.17084	1.14208	1.09863
20500.	1.16727	1.13964	1.09749
21000.	1.16344	1.13685	1.09605
21500.	1.15942	1.13377	1.09435
22000.	1.15527	1.13047	1.09238
22500.	1.15102	1.12700	1.09018
23000.	1.14660	1.12339	1.08776
23500.	1.14217	1.11969	1.08515
24000.	1.13775	1.11590	1.08239
24500.	1.13332	1.11207	1.07949
25000.	1.12890	1.10821	1.07649
25500.	1.12452	1.10428	1.07340
26000.	1.12014	1.10035	1.07025
26500.	1.11575	1.09643	1.06704
27000.	1.11137	1.09250	1.06379
27500.	1.10699	1.08857	1.06052
28000.	1.10261	1.08472	1.05723
28500.	1.09823	1.08087	1.05393
29000.	1.09385	1.07703	1.05062
29500.	1.08947	1.07318	1.04732
30000.	1.08509	1.06933	1.04402
32500.	1.06320	1.05034	1.02764
35000.	1.04132	1.03162	1.01174
37500.	1.01947	1.01316	0.99626
40000.	0.99768	0.99499	0.98121
42500.	0.97602	0.97714	0.96662
45000.	0.95454	0.95964	0.95248
47500.	0.93336	0.94254	0.93884
50000.	0.91257	0.92587	0.92569
52500.	0.89229	0.90969	0.91307
55000.	0.87266	0.89406	0.90097
57500.	0.85380	0.87902	0.88941
60000.	0.83584	0.86463	0.87840
62500.	0.81892	0.85093	0.86794
65000.	0.80312	0.83796	0.85803
67500.	0.78855	0.82577	0.84866
70000.	0.77524	0.81436	0.83985

Table B.2 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.429	1.425	1.398
100.	1.427	1.423	1.394
500.	1.418	1.417	1.394
1000.	1.408	1.410	1.395
1500.	1.395	1.400	1.394
2000.	1.382	1.390	1.390
2500.	1.367	1.378	1.385
3000.	1.352	1.366	1.379
3500.	1.336	1.354	1.372
4000.	1.320	1.341	1.365
4500.	1.305	1.328	1.357
5000.	1.294	1.315	1.349
5500.	1.284	1.303	1.340
6000.	1.275	1.291	1.332
6500.	1.266	1.280	1.324
7000.	1.258	1.269	1.316
7500.	1.251	1.258	1.308
8000.	1.244	1.250	1.300
8500.	1.236	1.244	1.292
9000.	1.229	1.238	1.284
9500.	1.222	1.232	1.276
10000.	1.215	1.226	1.269
10500.	1.208	1.220	1.261
11000.	1.201	1.214	1.254
11500.	1.194	1.209	1.246
12000.	1.186	1.203	1.239
12500.	1.179	1.197	1.231
13000.	1.172	1.191	1.224
13500.	1.164	1.185	1.216
14000.	1.156	1.179	1.209
14500.	1.147	1.172	1.202
15000.	1.139	1.165	1.194
15500.	1.130	1.159	1.189
16000.	1.122	1.152	1.185
16500.	1.114	1.145	1.180
17000.	1.107	1.139	1.175
17500.	1.101	1.132	1.170
18000.	1.096	1.127	1.166
18500.	1.094	1.121	1.161
19000.	1.094	1.117	1.157
19500.	1.094	1.112	1.153
20000.	1.093	1.109	1.149
20500.	1.092	1.105	1.145
21000.	1.091	1.102	1.142
21500.	1.090	1.099	1.139
22000.	1.089	1.097	1.136
22500.	1.089	1.095	1.133
23000.	1.088	1.093	1.131
23500.	1.088	1.091	1.129
24000.	1.087	1.089	1.127
24500.	1.087	1.087	1.125
25000.	1.086	1.085	1.123
25500.	1.085	1.084	1.121
26000.	1.085	1.083	1.120
26500.	1.084	1.083	1.118
27000.	1.084	1.082	1.117
27500.	1.083	1.081	1.115
28000.	1.082	1.080	1.114
28500.	1.081	1.080	1.113
29000.	1.081	1.079	1.111
29500.	1.080	1.079	1.110
30000.	1.079	1.078	1.109
32500.	1.075	1.075	1.103
35000.	1.072	1.072	1.100
37500.	1.067	1.069	1.098
40000.	1.064	1.066	1.097
42500.	1.060	1.064	1.099
45000.	1.057	1.061	1.105
47500.	1.054	1.059	1.112
50000.	1.051	1.056	1.120
52500.	1.048	1.054	1.129
55000.	1.050	1.053	1.138
57500.	1.050	1.051	1.149
60000.	1.050	1.055	1.159
62500.	1.048	1.069	1.170
65000.	1.045	1.084	1.181
67500.	1.063	1.099	1.191
70000.	1.081	1.113	1.202

Table B.3 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.11537	1.09453	1.07061
100.	1.08955	1.07059	1.04923
500.	1.08637	1.06816	1.04758
1000.	1.08653	1.06878	1.04851
1500.	1.08784	1.07035	1.05011
2000.	1.08946	1.07213	1.05178
2500.	1.09116	1.07394	1.05337
3000.	1.09292	1.07571	1.05486
3500.	1.09474	1.07748	1.05628
4000.	1.09667	1.07928	1.05766
4500.	1.09871	1.08112	1.05902
5000.	1.10085	1.08303	1.06037
5500.	1.10309	1.08499	1.06173
6000.	1.10544	1.08701	1.06310
6500.	1.10790	1.08910	1.06450
7000.	1.11047	1.09128	1.06595
7500.	1.11318	1.09354	1.06746
8000.	1.11603	1.09588	1.06904
8500.	1.11902	1.09831	1.07067
9000.	1.12216	1.10083	1.07236
9500.	1.12545	1.10345	1.07410
10000.	1.12890	1.10619	1.07588
10500.	1.13255	1.10905	1.07772
11000.	1.13643	1.11206	1.07963
11500.	1.14054	1.11521	1.08159
12000.	1.14489	1.11850	1.08362
12500.	1.14945	1.12189	1.08569
13000.	1.15417	1.12535	1.08777
13500.	1.15895	1.12882	1.08983
14000.	1.16367	1.13221	1.09180
14500.	1.16819	1.13547	1.09366
15000.	1.17229	1.13849	1.09537
15500.	1.17583	1.14121	1.09690
16000.	1.17862	1.14354	1.09823
16500.	1.18057	1.14537	1.09934
17000.	1.18162	1.14669	1.10021
17500.	1.18178	1.14744	1.10083
18000.	1.18108	1.14761	1.10118
18500.	1.17958	1.14720	1.10123
19000.	1.17740	1.14624	1.10097
19500.	1.17467	1.14476	1.10042
20000.	1.17150	1.14279	1.09956
20500.	1.16800	1.14040	1.09841
21000.	1.16423	1.13765	1.09698
21500.	1.16027	1.13461	1.09527
22000.	1.15615	1.13135	1.09332
22500.	1.15192	1.12790	1.09112
23000.	1.14749	1.12432	1.08871
23500.	1.14307	1.12063	1.08612
24000.	1.13864	1.11686	1.08336
24500.	1.13422	1.11303	1.08047
25000.	1.12979	1.10917	1.07747
25500.	1.12540	1.10524	1.07439
26000.	1.12100	1.10130	1.07124
26500.	1.11661	1.09737	1.06803
27000.	1.11221	1.09343	1.06478
27500.	1.10782	1.08950	1.06150
28000.	1.10343	1.08564	1.05821
28500.	1.09904	1.08178	1.05490
29000.	1.09464	1.07792	1.05159
29500.	1.09025	1.07406	1.04828
30000.	1.08586	1.07020	1.04497
30500.	1.08147	1.06639	1.04167
32500.	1.06391	1.05115	1.02852
35000.	1.04197	1.03237	1.01257
37500.	1.02006	1.01386	0.99705
40000.	0.99821	0.99564	0.98196
42500.	0.97649	0.97774	0.96732
45000.	0.95497	0.96020	0.95315
47500.	0.93374	0.94305	0.93947
50000.	0.91291	0.92635	0.92630
52500.	0.89260	0.91013	0.91364
55000.	0.87294	0.89447	0.90152
57500.	0.85406	0.87941	0.88995
60000.	0.83610	0.86500	0.87892
62500.	0.81917	0.85129	0.86844
65000.	0.80338	0.83832	0.85852
67500.	0.78882	0.82612	0.84914
70000.	0.77553	0.81472	0.84032

Table B.4 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.354	1.358	1.357
100.	1.354	1.359	1.355
500.	1.350	1.357	1.353
1000.	1.345	1.354	1.357
1500.	1.339	1.350	1.358
2000.	1.332	1.345	1.358
2500.	1.324	1.338	1.356
3000.	1.315	1.332	1.353
3500.	1.308	1.325	1.349
4000.	1.301	1.317	1.345
4500.	1.294	1.309	1.340
5000.	1.287	1.301	1.335
5500.	1.280	1.293	1.330
6000.	1.273	1.284	1.324
6500.	1.266	1.276	1.317
7000.	1.259	1.267	1.311
7500.	1.252	1.258	1.304
8000.	1.245	1.250	1.297
8500.	1.238	1.244	1.290
9000.	1.231	1.239	1.283
9500.	1.224	1.233	1.276
10000.	1.217	1.227	1.269
10500.	1.210	1.222	1.262
11000.	1.203	1.216	1.254
11500.	1.196	1.210	1.247
12000.	1.189	1.204	1.240
12500.	1.181	1.199	1.232
13000.	1.174	1.193	1.225
13500.	1.166	1.187	1.218
14000.	1.158	1.180	1.210
14500.	1.149	1.174	1.203
15000.	1.141	1.167	1.195
15500.	1.133	1.160	1.190
16000.	1.124	1.153	1.185
16500.	1.116	1.146	1.180
17000.	1.109	1.140	1.175
17500.	1.103	1.134	1.171
18000.	1.097	1.128	1.166
18500.	1.094	1.123	1.161
19000.	1.094	1.118	1.157
19500.	1.094	1.113	1.153
20000.	1.093	1.110	1.149
20500.	1.092	1.106	1.145
21000.	1.091	1.103	1.142
21500.	1.091	1.100	1.139
22000.	1.091	1.098	1.136
22500.	1.091	1.095	1.133
23000.	1.090	1.093	1.131
23500.	1.090	1.091	1.129
24000.	1.089	1.089	1.127
24500.	1.089	1.087	1.125
25000.	1.088	1.086	1.123
25500.	1.087	1.085	1.121
26000.	1.087	1.084	1.120
26500.	1.086	1.084	1.118
27000.	1.086	1.083	1.117
27500.	1.085	1.082	1.115
28000.	1.084	1.081	1.114
28500.	1.083	1.081	1.113
29000.	1.083	1.080	1.111
29500.	1.082	1.080	1.110
30000.	1.081	1.079	1.109
30500.	1.080	1.078	1.108
32500.	1.078	1.076	1.103
35000.	1.074	1.073	1.100
37500.	1.070	1.071	1.098
40000.	1.066	1.068	1.098
42500.	1.061	1.065	1.099
45000.	1.057	1.062	1.105
47500.	1.054	1.059	1.112
50000.	1.051	1.056	1.120
52500.	1.048	1.054	1.129
55000.	1.050	1.052	1.138
57500.	1.051	1.051	1.148
60000.	1.051	1.055	1.159
62500.	1.049	1.069	1.170
65000.	1.046	1.084	1.180
67500.	1.063	1.098	1.191
70000.	1.081	1.113	1.202

Table B.5 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.08383	1.06735	1.04750
100.	1.05812	1.04337	1.02595
500.	1.05532	1.04136	1.02475
1000.	1.05604	1.04263	1.02640
1500.	1.05808	1.04501	1.02886
2000.	1.06050	1.04769	1.03148
2500.	1.06308	1.05045	1.03405
3000.	1.06578	1.05325	1.03657
3500.	1.06864	1.05611	1.03904
4000.	1.07168	1.05907	1.04151
4500.	1.07490	1.06213	1.04398
5000.	1.07829	1.06529	1.04648
5500.	1.08183	1.06856	1.04899
6000.	1.08551	1.07192	1.05154
6500.	1.08936	1.07540	1.05414
7000.	1.09340	1.07900	1.05682
7500.	1.09763	1.08273	1.05959
8000.	1.10207	1.08658	1.06243
8500.	1.10671	1.09057	1.06536
9000.	1.11156	1.09469	1.06836
9500.	1.11664	1.09897	1.07144
10000.	1.12199	1.10343	1.07461
10500.	1.12767	1.10810	1.07787
11000.	1.13370	1.11299	1.08125
11500.	1.14011	1.11811	1.08473
12000.	1.14687	1.12342	1.08829
12500.	1.15392	1.12890	1.09189
13000.	1.16113	1.13445	1.09548
13500.	1.16822	1.13996	1.09901
14000.	1.17490	1.14527	1.10240
14500.	1.18081	1.15023	1.10562
15000.	1.18575	1.15466	1.10860
15500.	1.18948	1.15840	1.11131
16000.	1.19190	1.16137	1.11368
16500.	1.19303	1.16349	1.11568
17000.	1.19302	1.16471	1.11726
17500.	1.19204	1.16507	1.11841
18000.	1.19028	1.16463	1.11909
18500.	1.18788	1.16347	1.11932
19000.	1.18499	1.16169	1.11908
19500.	1.18171	1.15938	1.11840
20000.	1.17809	1.15666	1.11731
20500.	1.17420	1.15360	1.11582
21000.	1.17008	1.15029	1.11397
21500.	1.16578	1.14677	1.11179
22000.	1.16137	1.14307	1.10933
22500.	1.15676	1.13923	1.10664
23000.	1.15208	1.13529	1.10374
23500.	1.14740	1.13128	1.10069
24000.	1.14272	1.12721	1.09751
24500.	1.13804	1.12301	1.09423
25000.	1.13336	1.11880	1.09087
25500.	1.12869	1.11464	1.08744
26000.	1.12403	1.11047	1.08397
26500.	1.11936	1.10631	1.08047
27000.	1.11470	1.10214	1.07694
27500.	1.11003	1.09798	1.07341
28000.	1.10532	1.09386	1.06986
30000.	1.08650	1.07740	1.05555
32500.	1.06275	1.05692	1.03813
35000.	1.03877	1.03653	1.02104
37500.	1.01459	1.01624	1.00429
40000.	0.99026	0.99608	0.98788
42500.	0.96586	0.97610	0.97185
45000.	0.94149	0.95636	0.95622
47500.	0.91731	0.93691	0.94102
50000.	0.89349	0.91782	0.92629
52500.	0.87022	0.89920	0.91206
55000.	0.84771	0.88114	0.89836
57500.	0.82620	0.86375	0.88521
60000.	0.80590	0.84711	0.87264
62500.	0.78702	0.83131	0.86066
65000.	0.76971	0.81645	0.84930
67500.	0.75409	0.80258	0.83858
70000.	0.74021	0.78976	0.82849

Table B.6 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.420	1.423	1.408
100.	1.419	1.422	1.408
500.	1.412	1.417	1.406
1000.	1.404	1.411	1.403
1500.	1.394	1.403	1.399
2000.	1.383	1.394	1.394
2500.	1.372	1.385	1.388
3000.	1.360	1.375	1.381
3500.	1.349	1.365	1.375
4000.	1.336	1.354	1.367
4500.	1.324	1.344	1.360
5000.	1.311	1.333	1.352
5500.	1.298	1.322	1.344
6000.	1.285	1.311	1.336
6500.	1.272	1.299	1.328
7000.	1.259	1.288	1.320
7500.	1.248	1.276	1.311
8000.	1.236	1.265	1.303
8500.	1.224	1.253	1.294
9000.	1.212	1.242	1.286
9500.	1.200	1.230	1.277
10000.	1.188	1.219	1.268
10500.	1.176	1.207	1.259
11000.	1.166	1.196	1.251
11500.	1.159	1.184	1.242
12000.	1.153	1.173	1.233
12500.	1.146	1.161	1.224
13000.	1.139	1.149	1.215
13500.	1.132	1.141	1.206
14000.	1.125	1.134	1.197
14500.	1.118	1.126	1.188
15000.	1.115	1.121	1.179
15500.	1.113	1.119	1.170
16000.	1.111	1.116	1.162
16500.	1.110	1.114	1.153
17000.	1.108	1.112	1.145
17500.	1.107	1.111	1.138
18000.	1.105	1.109	1.131
18500.	1.103	1.107	1.124
19000.	1.102	1.106	1.118
19500.	1.100	1.104	1.114
20000.	1.098	1.103	1.111
20500.	1.096	1.101	1.109
21000.	1.094	1.099	1.108
21500.	1.092	1.098	1.108
22000.	1.090	1.096	1.107
22500.	1.088	1.095	1.106
23000.	1.087	1.093	1.105
23500.	1.086	1.091	1.105
24000.	1.085	1.089	1.104
24500.	1.084	1.087	1.103
25000.	1.083	1.086	1.102
25500.	1.082	1.084	1.101
26000.	1.081	1.082	1.101
26500.	1.081	1.081	1.100
27000.	1.080	1.079	1.099
27500.	1.079	1.077	1.098
28000.	1.078	1.076	1.097
30000.	1.076	1.072	1.094
32500.	1.072	1.069	1.090
35000.	1.067	1.065	1.086
37500.	1.063	1.062	1.083
40000.	1.059	1.059	1.080
42500.	1.056	1.056	1.078
45000.	1.058	1.053	1.076
47500.	1.062	1.050	1.074
50000.	1.065	1.047	1.073
52500.	1.066	1.045	1.073
55000.	1.066	1.044	1.073
57500.	1.065	1.043	1.073
60000.	1.063	1.042	1.074
62500.	1.058	1.041	1.082
65000.	1.052	1.039	1.092
67500.	1.044	1.044	1.101
70000.	1.050	1.059	1.111

Table B.7 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.06997	1.05387	1.03366
100.	1.04445	1.03004	1.01226
500.	1.04178	1.02822	1.01134
1000.	1.04276	1.02985	1.01342
1500.	1.04508	1.03263	1.01634
2000.	1.04775	1.03566	1.01938
2500.	1.05043	1.03863	1.02227
3000.	1.05310	1.04150	1.02497
3500.	1.05584	1.04434	1.02753
4000.	1.05867	1.04720	1.03002
4500.	1.06161	1.05012	1.03249
5000.	1.06472	1.05312	1.03496
5500.	1.06805	1.05627	1.03747
6000.	1.07164	1.05960	1.04006
6500.	1.07545	1.06311	1.04275
7000.	1.07946	1.06677	1.04553
7500.	1.08363	1.07055	1.04840
8000.	1.08798	1.07444	1.05134
8500.	1.09254	1.07846	1.05435
9000.	1.09734	1.08264	1.05744
9500.	1.10237	1.08700	1.06064
10000.	1.10765	1.09153	1.06393
10500.	1.11318	1.09624	1.06733
11000.	1.11900	1.10114	1.07082
11500.	1.12514	1.10624	1.07440
12000.	1.13166	1.11158	1.07808
12500.	1.13859	1.11713	1.08184
13000.	1.14582	1.12284	1.08566
13500.	1.15314	1.12855	1.08948
14000.	1.16036	1.13409	1.09318
14500.	1.16724	1.13936	1.09666
15000.	1.17345	1.14426	1.09986
15500.	1.17865	1.14864	1.10277
16000.	1.18261	1.15230	1.10536
16500.	1.18524	1.15519	1.10760
17000.	1.18651	1.15730	1.10944
17500.	1.18645	1.15859	1.11087
18000.	1.18519	1.15901	1.11190
18500.	1.18296	1.15859	1.11252
19000.	1.17998	1.15738	1.11275
19500.	1.17646	1.15546	1.11258
20000.	1.17253	1.15294	1.11198
20500.	1.16831	1.14993	1.11095
21000.	1.16389	1.14656	1.10949
21500.	1.15934	1.14290	1.10765
22000.	1.15454	1.13904	1.10546
22500.	1.14974	1.13504	1.10297
23000.	1.14493	1.13094	1.10021
23500.	1.14012	1.12665	1.09724
24000.	1.13530	1.12236	1.09409
24500.	1.13049	1.11808	1.09081
25000.	1.12568	1.11379	1.08741
25500.	1.12087	1.10955	1.08394
26000.	1.11607	1.10532	1.08042
26500.	1.11126	1.10108	1.07687
27000.	1.10646	1.09685	1.07329
27500.	1.10165	1.09261	1.06965
30000.	1.07741	1.07156	1.05163
32500.	1.05294	1.05062	1.03405
35000.	1.02826	1.02978	1.01681
37500.	1.00341	1.00907	0.99994
40000.	0.97844	0.98851	0.98344
42500.	0.95345	0.96817	0.96734
45000.	0.92860	0.94811	0.95167
47500.	0.90404	0.92839	0.93647
50000.	0.87998	0.90910	0.92176
52500.	0.85662	0.89036	0.90757
55000.	0.83420	0.87226	0.89395
57500.	0.81297	0.85490	0.88090
60000.	0.79314	0.83839	0.86846
62500.	0.77490	0.82282	0.85664
65000.	0.75838	0.80825	0.84546
67500.	0.74367	0.79477	0.83494
70000.	0.73075	0.78239	0.82508

Table B.8 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.361	1.340	1.330
100.	1.361	1.341	1.326
500.	1.356	1.338	1.322
1000.	1.350	1.334	1.318
1500.	1.342	1.328	1.313
2000.	1.334	1.322	1.309
2500.	1.324	1.314	1.304
3000.	1.315	1.307	1.299
3500.	1.305	1.299	1.294
4000.	1.294	1.291	1.289
4500.	1.284	1.282	1.283
5000.	1.273	1.273	1.278
5500.	1.262	1.264	1.273
6000.	1.250	1.255	1.268
6500.	1.241	1.247	1.263
7000.	1.233	1.241	1.257
7500.	1.225	1.234	1.252
8000.	1.218	1.228	1.247
8500.	1.210	1.222	1.242
9000.	1.204	1.215	1.237
9500.	1.199	1.209	1.231
10000.	1.194	1.203	1.226
10500.	1.189	1.197	1.221
11000.	1.183	1.191	1.216
11500.	1.178	1.185	1.211
12000.	1.172	1.179	1.206
12500.	1.166	1.173	1.201
13000.	1.161	1.167	1.196
13500.	1.155	1.160	1.191
14000.	1.151	1.154	1.186
14500.	1.147	1.149	1.181
15000.	1.144	1.146	1.176
15500.	1.141	1.143	1.170
16000.	1.140	1.141	1.165
16500.	1.139	1.139	1.159
17000.	1.138	1.137	1.154
17500.	1.136	1.136	1.148
18000.	1.135	1.134	1.143
18500.	1.133	1.132	1.137
19000.	1.131	1.130	1.132
19500.	1.129	1.129	1.130
20000.	1.126	1.127	1.129
20500.	1.124	1.125	1.128
21000.	1.121	1.123	1.127
21500.	1.118	1.121	1.126
22000.	1.115	1.119	1.125
22500.	1.113	1.117	1.124
23000.	1.112	1.114	1.123
23500.	1.111	1.112	1.122
24000.	1.110	1.110	1.121
24500.	1.109	1.108	1.120
25000.	1.108	1.106	1.119
25500.	1.107	1.104	1.118
26000.	1.106	1.102	1.117
26500.	1.105	1.100	1.116
27000.	1.104	1.098	1.115
27500.	1.103	1.096	1.114
30000.	1.097	1.090	1.109
32500.	1.092	1.086	1.104
35000.	1.086	1.082	1.099
37500.	1.079	1.078	1.095
40000.	1.076	1.073	1.091
42500.	1.077	1.069	1.088
45000.	1.079	1.064	1.086
47500.	1.081	1.060	1.084
50000.	1.081	1.056	1.082
52500.	1.081	1.054	1.081
55000.	1.078	1.054	1.080
57500.	1.074	1.054	1.080
60000.	1.068	1.052	1.081
62500.	1.061	1.050	1.084
65000.	1.053	1.047	1.095
67500.	1.051	1.057	1.106
70000.	1.070	1.073	1.118

Table B.9 [ ] Hot Uncontrolled k_{∞}

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.04366	1.02973	1.01135
100.	1.01839	1.00607	0.99001
500.	1.01598	1.00452	0.98940
1000.	1.01734	1.00660	0.99199
1500.	1.02013	1.00989	0.99547
2000.	1.02328	1.01345	0.99910
2500.	1.02645	1.01697	1.00258
3000.	1.02966	1.02041	1.00586
3500.	1.03297	1.02386	1.00902
4000.	1.03640	1.02735	1.01213
4500.	1.03999	1.03092	1.01522
5000.	1.04379	1.03462	1.01833
5500.	1.04786	1.03850	1.02149
6000.	1.05223	1.04260	1.02475
6500.	1.05686	1.04691	1.02813
7000.	1.06173	1.05140	1.03163
7500.	1.06679	1.05602	1.03522
8000.	1.07207	1.06079	1.03890
8500.	1.07761	1.06572	1.04267
9000.	1.08343	1.07084	1.04654
9500.	1.08955	1.07618	1.05052
10000.	1.09599	1.08174	1.05464
10500.	1.10276	1.08753	1.05888
11000.	1.10990	1.09355	1.06324
11500.	1.11751	1.09985	1.06773
12000.	1.12567	1.10647	1.07234
12500.	1.13438	1.11341	1.07707
13000.	1.14350	1.12058	1.08190
13500.	1.15265	1.12778	1.08674
14000.	1.16143	1.13484	1.09146
14500.	1.16948	1.14154	1.09595
15000.	1.17627	1.14768	1.10017
15500.	1.18139	1.15300	1.10407
16000.	1.18476	1.15730	1.10758
16500.	1.18648	1.16044	1.11063
17000.	1.18672	1.16242	1.11316
17500.	1.18572	1.16330	1.11514
18000.	1.18375	1.16314	1.11657
18500.	1.18104	1.16203	1.11744
19000.	1.17775	1.16010	1.11774
19500.	1.17401	1.15754	1.11747
20000.	1.16990	1.15449	1.11663
20500.	1.16551	1.15108	1.11528
21000.	1.16093	1.14738	1.11343
21500.	1.15599	1.14347	1.11118
22000.	1.15106	1.13939	1.10856
22500.	1.14612	1.13520	1.10567
23000.	1.14114	1.13092	1.10255
23500.	1.13616	1.12646	1.09926
24000.	1.13119	1.12200	1.09583
24500.	1.12621	1.11753	1.09230
25000.	1.12123	1.11307	1.08869
25500.	1.11621	1.10867	1.08504
26000.	1.11118	1.10426	1.08135
26500.	1.10616	1.09986	1.07765
27500.	1.09611	1.09105	1.07006
30000.	1.07062	1.06906	1.05144
32500.	1.04475	1.04707	1.03318
35000.	1.01850	1.02506	1.01522
37500.	0.99191	1.00307	0.99757
40000.	0.96509	0.98113	0.98024
42500.	0.93817	0.95932	0.96326
45000.	0.91133	0.93773	0.94668
47500.	0.88482	0.91645	0.93053
50000.	0.85888	0.89560	0.91487
52500.	0.83384	0.87534	0.89973
55000.	0.81000	0.85581	0.88517
57500.	0.78768	0.83716	0.87121
60000.	0.76715	0.81952	0.85789
62500.	0.74862	0.80302	0.84525
65000.	0.73221	0.78775	0.83333
67500.	0.71794	0.77379	0.82214
70000.	0.70573	0.76118	0.81169

Table B.10 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.318	1.309	1.319
100.	1.317	1.304	1.315
500.	1.313	1.300	1.311
1000.	1.309	1.294	1.306
1500.	1.305	1.289	1.301
2000.	1.300	1.283	1.296
2500.	1.294	1.277	1.290
3000.	1.288	1.271	1.285
3500.	1.283	1.265	1.280
4000.	1.277	1.258	1.274
4500.	1.270	1.252	1.269
5000.	1.264	1.245	1.263
5500.	1.258	1.239	1.257
6000.	1.251	1.232	1.252
6500.	1.244	1.226	1.246
7000.	1.237	1.219	1.241
7500.	1.230	1.212	1.235
8000.	1.223	1.206	1.230
8500.	1.216	1.199	1.224
9000.	1.208	1.192	1.219
9500.	1.201	1.186	1.213
10000.	1.193	1.179	1.208
10500.	1.186	1.172	1.202
11000.	1.178	1.165	1.197
11500.	1.170	1.159	1.191
12000.	1.162	1.152	1.186
12500.	1.154	1.145	1.181
13000.	1.146	1.138	1.175
13500.	1.138	1.131	1.170
14000.	1.129	1.124	1.165
14500.	1.121	1.116	1.159
15000.	1.113	1.108	1.153
15500.	1.105	1.102	1.148
16000.	1.105	1.096	1.142
16500.	1.106	1.092	1.136
17000.	1.105	1.092	1.130
17500.	1.103	1.092	1.124
18000.	1.104	1.092	1.118
18500.	1.104	1.092	1.113
19000.	1.103	1.092	1.108
19500.	1.102	1.091	1.104
20000.	1.100	1.090	1.100
20500.	1.098	1.089	1.097
21000.	1.097	1.088	1.096
21500.	1.095	1.087	1.096
22000.	1.093	1.085	1.095
22500.	1.091	1.084	1.095
23000.	1.089	1.082	1.094
23500.	1.088	1.081	1.094
24000.	1.086	1.079	1.093
24500.	1.085	1.077	1.092
25000.	1.083	1.076	1.091
25500.	1.082	1.075	1.091
26000.	1.082	1.074	1.090
26500.	1.081	1.073	1.089
27500.	1.080	1.071	1.087
30000.	1.078	1.069	1.083
32500.	1.076	1.068	1.079
35000.	1.074	1.066	1.076
37500.	1.076	1.064	1.073
40000.	1.082	1.062	1.070
42500.	1.086	1.060	1.068
45000.	1.090	1.058	1.066
47500.	1.091	1.061	1.065
50000.	1.091	1.064	1.064
52500.	1.089	1.065	1.064
55000.	1.085	1.065	1.064
57500.	1.078	1.064	1.064
60000.	1.070	1.061	1.065
62500.	1.061	1.057	1.067
65000.	1.051	1.052	1.069
67500.	1.042	1.046	1.081
70000.	1.060	1.058	1.092

Table B.11 [ ] Hot Uncontrolled k_{∞}

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.03879	1.02603	1.00830
100.	1.01353	1.00231	0.98693
500.	1.01120	1.00090	0.98651
1000.	1.01282	1.00329	0.98946
1500.	1.01589	1.00695	0.99330
2000.	1.01932	1.01087	0.99729
2500.	1.02277	1.01473	1.00110
3000.	1.02631	1.01854	1.00471
3500.	1.02997	1.02238	1.00821
4000.	1.03378	1.02629	1.01167
4500.	1.03779	1.03031	1.01512
5000.	1.04206	1.03449	1.01861
5500.	1.04666	1.03890	1.02217
6000.	1.05159	1.04356	1.02584
6500.	1.05681	1.04844	1.02965
7000.	1.06227	1.05351	1.03356
7500.	1.06797	1.05873	1.03758
8000.	1.07394	1.06412	1.04168
8500.	1.08021	1.06971	1.04589
9000.	1.08682	1.07554	1.05023
9500.	1.09380	1.08161	1.05470
10000.	1.10116	1.08794	1.05931
10500.	1.10895	1.09453	1.06407
11000.	1.11727	1.10142	1.06895
11500.	1.12622	1.10868	1.07398
12000.	1.13582	1.11632	1.07914
12500.	1.14592	1.12429	1.08444
13000.	1.15604	1.13239	1.08977
13500.	1.16570	1.14036	1.09502
14000.	1.17434	1.14790	1.10004
14500.	1.18142	1.15481	1.10477
15000.	1.18663	1.16075	1.10917
15500.	1.18990	1.16544	1.11315
16000.	1.19143	1.16875	1.11662
16500.	1.19155	1.17076	1.11952
17000.	1.19057	1.17157	1.12181
17500.	1.18870	1.17129	1.12350
18000.	1.18611	1.17004	1.12457
18500.	1.18291	1.16799	1.12501
19000.	1.17921	1.16534	1.12482
19500.	1.17510	1.16221	1.12403
20000.	1.17065	1.15872	1.12267
20500.	1.16596	1.15493	1.12080
21000.	1.16085	1.15092	1.11848
21500.	1.15573	1.14673	1.11579
22000.	1.15062	1.14241	1.11281
22500.	1.14551	1.13800	1.10960
23000.	1.14035	1.13340	1.10622
23500.	1.13519	1.12880	1.10270
24000.	1.13003	1.12420	1.09908
24500.	1.12487	1.11960	1.09539
25000.	1.11971	1.11500	1.09165
25500.	1.11447	1.11045	1.08788
26000.	1.10923	1.10591	1.08408
27500.	1.09351	1.09227	1.07245
30000.	1.06684	1.06947	1.05353
32500.	1.03971	1.04662	1.03494
35000.	1.01213	1.02372	1.01664
37500.	0.98419	1.00081	0.99865
40000.	0.95601	0.97795	0.98099
42500.	0.92777	0.95523	0.96369
45000.	0.89970	0.93274	0.94681
47500.	0.87211	0.91062	0.93038
50000.	0.84532	0.88902	0.91448
52500.	0.81969	0.86812	0.89913
55000.	0.79559	0.84809	0.88438
57500.	0.77336	0.82909	0.87028
60000.	0.75326	0.81127	0.85686
62500.	0.73545	0.79477	0.84417
65000.	0.72000	0.77967	0.83224
67500.	0.70685	0.76604	0.82108
70000.	0.69582	0.75387	0.81070

Table B.12 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.318	1.307	1.270
100.	1.318	1.308	1.272
500.	1.313	1.304	1.271
1000.	1.306	1.299	1.269
1500.	1.301	1.292	1.266
2000.	1.295	1.285	1.262
2500.	1.289	1.277	1.258
3000.	1.282	1.269	1.253
3500.	1.276	1.260	1.248
4000.	1.269	1.251	1.242
4500.	1.262	1.242	1.236
5000.	1.255	1.232	1.230
5500.	1.247	1.223	1.224
6000.	1.240	1.213	1.217
6500.	1.232	1.203	1.211
7000.	1.224	1.192	1.204
7500.	1.216	1.182	1.197
8000.	1.208	1.172	1.190
8500.	1.199	1.161	1.183
9000.	1.191	1.152	1.176
9500.	1.182	1.146	1.168
10000.	1.174	1.140	1.161
10500.	1.165	1.134	1.153
11000.	1.156	1.128	1.146
11500.	1.147	1.122	1.138
12000.	1.138	1.116	1.133
12500.	1.129	1.110	1.128
13000.	1.120	1.104	1.123
13500.	1.115	1.097	1.118
14000.	1.138	1.091	1.113
14500.	1.152	1.087	1.108
15000.	1.158	1.083	1.102
15500.	1.158	1.084	1.097
16000.	1.156	1.094	1.091
16500.	1.152	1.100	1.088
17000.	1.152	1.102	1.087
17500.	1.151	1.102	1.085
18000.	1.149	1.100	1.084
18500.	1.147	1.099	1.082
19000.	1.144	1.097	1.081
19500.	1.142	1.095	1.080
20000.	1.139	1.093	1.079
20500.	1.137	1.092	1.078
21000.	1.135	1.091	1.077
21500.	1.132	1.090	1.077
22000.	1.129	1.089	1.076
22500.	1.127	1.087	1.075
23000.	1.125	1.086	1.075
23500.	1.122	1.085	1.075
24000.	1.120	1.083	1.074
24500.	1.117	1.082	1.074
25000.	1.115	1.081	1.074
25500.	1.112	1.080	1.074
26000.	1.110	1.079	1.073
27500.	1.102	1.075	1.073
30000.	1.090	1.074	1.071
32500.	1.092	1.072	1.070
35000.	1.096	1.071	1.068
37500.	1.099	1.070	1.067
40000.	1.101	1.072	1.066
42500.	1.103	1.075	1.064
45000.	1.105	1.078	1.063
47500.	1.104	1.079	1.062
50000.	1.101	1.080	1.061
52500.	1.097	1.079	1.060
55000.	1.090	1.077	1.058
57500.	1.081	1.073	1.057
60000.	1.071	1.069	1.055
62500.	1.059	1.063	1.057
65000.	1.048	1.056	1.069
67500.	1.047	1.049	1.081
70000.	1.064	1.061	1.092

Table B.13 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.05587	1.04582	1.03154
100.	1.03059	1.02198	1.01000
500.	1.02991	1.02211	1.01086
1000.	1.03405	1.02683	1.01569
1500.	1.03981	1.03298	1.02152
2000.	1.04594	1.03936	1.02741
2500.	1.05225	1.04579	1.03314
3000.	1.05886	1.05234	1.03877
3500.	1.06589	1.05912	1.04442
4000.	1.07343	1.06623	1.05015
4500.	1.08152	1.07372	1.05603
5000.	1.09011	1.08154	1.06207
5500.	1.09918	1.08968	1.06827
6000.	1.10879	1.09816	1.07461
6500.	1.11904	1.10705	1.08114
7000.	1.13002	1.11640	1.08787
7500.	1.14175	1.12621	1.09483
8000.	1.15421	1.13647	1.10198
8500.	1.16727	1.14710	1.10930
9000.	1.18039	1.15793	1.11669
9500.	1.19292	1.16860	1.12402
10000.	1.20406	1.17867	1.13113
10500.	1.21330	1.18772	1.13788
11000.	1.22037	1.19537	1.14410
11500.	1.22524	1.20136	1.14962
12000.	1.22816	1.20562	1.15432
12500.	1.22948	1.20823	1.15810
13000.	1.22952	1.20938	1.16090
13500.	1.22845	1.20929	1.16275
14000.	1.22648	1.20819	1.16368
14500.	1.22377	1.20629	1.16376
15000.	1.22046	1.20376	1.16306
15500.	1.21666	1.20072	1.16168
16000.	1.21247	1.19729	1.15971
16500.	1.20799	1.19355	1.15727
17000.	1.20331	1.18955	1.15445
17500.	1.19848	1.18536	1.15134
18000.	1.19336	1.18104	1.14800
18500.	1.18825	1.17662	1.14448
19000.	1.18313	1.17213	1.14083
19500.	1.17802	1.16748	1.13707
20000.	1.17290	1.16284	1.13324
20500.	1.16780	1.15823	1.12935
21000.	1.16270	1.15361	1.12543
21500.	1.15759	1.14900	1.12149
22000.	1.15249	1.14438	1.11754
22500.	1.14739	1.13977	1.11352
25000.	1.12147	1.11690	1.09371
27500.	1.09509	1.09399	1.07437
30000.	1.06823	1.07101	1.05534
32500.	1.04089	1.04798	1.03660
35000.	1.01311	1.02490	1.01815
37500.	0.98496	1.00180	1.00000
40000.	0.95659	0.97876	0.98219
42500.	0.92817	0.95587	0.96475
45000.	0.89995	0.93324	0.94774
47500.	0.87225	0.91099	0.93121
50000.	0.84539	0.88930	0.91521
52500.	0.81975	0.86833	0.89979
55000.	0.79569	0.84827	0.88498
57500.	0.77356	0.82928	0.87083
60000.	0.75360	0.81151	0.85740
62500.	0.73597	0.79509	0.84471
65000.	0.72072	0.78010	0.83280
67500.	0.70775	0.76660	0.82168
70000.	0.69692	0.75458	0.81135

Table B.14 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.307	1.292	1.257
100.	1.306	1.293	1.258
500.	1.302	1.287	1.256
1000.	1.296	1.280	1.252
1500.	1.289	1.272	1.248
2000.	1.282	1.262	1.242
2500.	1.274	1.252	1.236
3000.	1.266	1.242	1.230
3500.	1.258	1.231	1.223
4000.	1.250	1.220	1.216
4500.	1.241	1.208	1.208
5000.	1.232	1.196	1.201
5500.	1.222	1.184	1.193
6000.	1.213	1.172	1.184
6500.	1.203	1.159	1.176
7000.	1.193	1.149	1.168
7500.	1.183	1.143	1.159
8000.	1.172	1.136	1.150
8500.	1.162	1.128	1.142
9000.	1.151	1.121	1.136
9500.	1.140	1.113	1.130
10000.	1.135	1.105	1.123
10500.	1.152	1.098	1.117
11000.	1.160	1.090	1.110
11500.	1.161	1.088	1.103
12000.	1.160	1.097	1.097
12500.	1.157	1.101	1.090
13000.	1.153	1.102	1.086
13500.	1.150	1.102	1.085
14000.	1.146	1.101	1.083
14500.	1.144	1.100	1.082
15000.	1.142	1.098	1.082
15500.	1.139	1.096	1.081
16000.	1.137	1.095	1.080
16500.	1.135	1.093	1.080
17000.	1.133	1.092	1.079
17500.	1.131	1.091	1.079
18000.	1.129	1.089	1.078
18500.	1.127	1.088	1.078
19000.	1.124	1.087	1.077
19500.	1.122	1.086	1.077
20000.	1.120	1.084	1.077
20500.	1.118	1.083	1.076
21000.	1.116	1.082	1.076
21500.	1.114	1.080	1.076
22000.	1.112	1.079	1.076
22500.	1.110	1.078	1.075
25000.	1.099	1.075	1.074
27500.	1.088	1.073	1.073
30000.	1.081	1.071	1.072
32500.	1.082	1.070	1.070
35000.	1.085	1.068	1.068
37500.	1.088	1.066	1.066
40000.	1.090	1.065	1.065
42500.	1.091	1.066	1.063
45000.	1.093	1.068	1.060
47500.	1.092	1.069	1.059
50000.	1.089	1.070	1.058
52500.	1.085	1.069	1.056
55000.	1.078	1.067	1.055
57500.	1.070	1.064	1.053
60000.	1.060	1.059	1.051
62500.	1.050	1.054	1.058
65000.	1.039	1.048	1.070
67500.	1.046	1.045	1.081
70000.	1.062	1.061	1.093

Table B.15 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.06422	1.04771	1.02961
100.	1.04133	1.02662	1.01099
500.	1.04064	1.02646	1.01126
1000.	1.04386	1.02976	1.01435
1500.	1.04842	1.03410	1.01814
2000.	1.05350	1.03877	1.02204
2500.	1.05887	1.04357	1.02591
3000.	1.06446	1.04842	1.02970
3500.	1.07025	1.05332	1.03341
4000.	1.07620	1.05824	1.03705
4500.	1.08214	1.06316	1.04062
5000.	1.08774	1.06793	1.04409
5500.	1.09274	1.07235	1.04742
6000.	1.09709	1.07632	1.05052
6500.	1.10086	1.07981	1.05334
7000.	1.10414	1.08290	1.05586
7500.	1.10701	1.08565	1.05811
8000.	1.10958	1.08811	1.06014
8500.	1.11197	1.09036	1.06199
9000.	1.11426	1.09246	1.06369
9500.	1.11653	1.09446	1.06527
10000.	1.11883	1.09642	1.06676
10500.	1.12119	1.09836	1.06817
11000.	1.12364	1.10033	1.06952
11500.	1.12620	1.10233	1.07084
12000.	1.12890	1.10441	1.07215
12500.	1.13174	1.10657	1.07346
13000.	1.13477	1.10883	1.07480
13500.	1.13798	1.11121	1.07617
14000.	1.14139	1.11369	1.07759
14500.	1.14501	1.11626	1.07903
15000.	1.14879	1.11892	1.08050
15500.	1.15272	1.12163	1.08197
16000.	1.15667	1.12434	1.08342
16500.	1.16055	1.12699	1.08481
17000.	1.16417	1.12953	1.08612
17500.	1.16736	1.13187	1.08731
18000.	1.17000	1.13395	1.08837
18500.	1.17193	1.13568	1.08928
19000.	1.17307	1.13698	1.09002
19500.	1.17338	1.13782	1.09057
20000.	1.17291	1.13816	1.09091
20500.	1.17167	1.13798	1.09103
21000.	1.16975	1.13730	1.09090
21500.	1.16728	1.13613	1.09053
22000.	1.16436	1.13449	1.08989
22500.	1.16109	1.13244	1.08899
23000.	1.15754	1.13001	1.08784
23500.	1.15378	1.12728	1.08644
24000.	1.14984	1.12429	1.08481
24500.	1.14577	1.12111	1.08296
25000.	1.14163	1.11776	1.08089
25500.	1.13730	1.11428	1.07862
26000.	1.13296	1.11070	1.07619
26500.	1.12863	1.10705	1.07359
27000.	1.12429	1.10335	1.07086
27500.	1.11996	1.09960	1.06803
28000.	1.11567	1.09578	1.06510
28500.	1.11138	1.09196	1.06210
29000.	1.10708	1.08813	1.05904
29500.	1.10279	1.08431	1.05594
30000.	1.09850	1.08049	1.05280
30500.	1.09420	1.07674	1.04964
31000.	1.08990	1.07298	1.04646
31500.	1.08560	1.06923	1.04327
32000.	1.08130	1.06547	1.04008
32500.	1.07700	1.06172	1.03689
33000.	1.07270	1.05801	1.03370
35000.	1.05548	1.04317	1.02093
37500.	1.03393	1.02484	1.00544
40000.	1.01238	1.00675	0.99035
42500.	0.99088	0.98893	0.97566
45000.	0.96948	0.97140	0.96140
47500.	0.94827	0.95420	0.94759
50000.	0.92732	0.93738	0.93424
52500.	0.90677	0.92097	0.92137
55000.	0.88672	0.90503	0.90899
57500.	0.86731	0.88963	0.89713
60000.	0.84867	0.87481	0.88579
62500.	0.83094	0.86061	0.87497
65000.	0.81423	0.84710	0.86469
67500.	0.79865	0.83431	0.85493
70000.	0.78428	0.82227	0.84571

Table B.16 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.461	1.474	1.473
100.	1.454	1.468	1.468
500.	1.445	1.460	1.463
1000.	1.435	1.451	1.456
1500.	1.423	1.441	1.449
2000.	1.410	1.430	1.441
2500.	1.397	1.418	1.432
3000.	1.383	1.406	1.422
3500.	1.369	1.394	1.413
4000.	1.355	1.382	1.404
4500.	1.342	1.370	1.394
5000.	1.328	1.358	1.385
5500.	1.318	1.346	1.375
6000.	1.308	1.335	1.366
6500.	1.300	1.324	1.357
7000.	1.291	1.314	1.349
7500.	1.284	1.304	1.340
8000.	1.276	1.294	1.332
8500.	1.269	1.284	1.324
9000.	1.262	1.278	1.316
9500.	1.255	1.273	1.308
10000.	1.248	1.268	1.301
10500.	1.241	1.263	1.293
11000.	1.235	1.257	1.286
11500.	1.229	1.252	1.280
12000.	1.223	1.247	1.276
12500.	1.218	1.242	1.271
13000.	1.212	1.237	1.267
13500.	1.206	1.232	1.263
14000.	1.200	1.227	1.258
14500.	1.194	1.222	1.254
15000.	1.188	1.216	1.250
15500.	1.181	1.211	1.245
16000.	1.174	1.205	1.241
16500.	1.168	1.199	1.236
17000.	1.162	1.193	1.232
17500.	1.156	1.187	1.227
18000.	1.151	1.180	1.222
18500.	1.145	1.173	1.217
19000.	1.140	1.167	1.212
19500.	1.135	1.162	1.207
20000.	1.130	1.157	1.202
20500.	1.126	1.153	1.197
21000.	1.123	1.149	1.192
21500.	1.119	1.145	1.187
22000.	1.116	1.141	1.182
22500.	1.113	1.138	1.178
23000.	1.112	1.135	1.174
23500.	1.110	1.132	1.170
24000.	1.109	1.129	1.166
24500.	1.108	1.127	1.163
25000.	1.106	1.125	1.160
25500.	1.104	1.122	1.157
26000.	1.103	1.120	1.154
26500.	1.101	1.118	1.151
27000.	1.100	1.117	1.149
27500.	1.098	1.115	1.147
28000.	1.096	1.113	1.145
28500.	1.095	1.111	1.143
29000.	1.093	1.110	1.142
29500.	1.092	1.108	1.140
30000.	1.090	1.106	1.139
30500.	1.088	1.104	1.137
31000.	1.086	1.102	1.136
31500.	1.085	1.101	1.134
32000.	1.083	1.099	1.133
32500.	1.081	1.097	1.131
33000.	1.079	1.095	1.130
35000.	1.073	1.089	1.125
37500.	1.064	1.080	1.119
40000.	1.056	1.072	1.113
42500.	1.049	1.064	1.107
45000.	1.043	1.058	1.102
47500.	1.041	1.052	1.100
50000.	1.039	1.048	1.107
52500.	1.037	1.044	1.116
55000.	1.038	1.043	1.126
57500.	1.041	1.042	1.136
60000.	1.043	1.042	1.146
62500.	1.043	1.054	1.157
65000.	1.041	1.069	1.168
67500.	1.045	1.084	1.179
70000.	1.064	1.098	1.190

Table B.17 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.12421	1.10266	1.07803
100.	1.09827	1.07863	1.05662
500.	1.09461	1.07571	1.05444
1000.	1.09403	1.07558	1.05460
1500.	1.09459	1.07640	1.05545
2000.	1.09546	1.07744	1.05642
2500.	1.09642	1.07852	1.05733
3000.	1.09740	1.07955	1.05816
3500.	1.09841	1.08054	1.05891
4000.	1.09948	1.08154	1.05961
4500.	1.10063	1.08256	1.06028
5000.	1.10188	1.08363	1.06095
5500.	1.10322	1.08476	1.06163
6000.	1.10466	1.08595	1.06232
6500.	1.10618	1.08719	1.06305
7000.	1.10778	1.08848	1.06381
7500.	1.10947	1.08983	1.06462
8000.	1.11124	1.09124	1.06546
8500.	1.11311	1.09272	1.06635
9000.	1.11508	1.09427	1.06729
9500.	1.11715	1.09590	1.06827
10000.	1.11933	1.09761	1.06929
10500.	1.12161	1.09938	1.07035
11000.	1.12401	1.10124	1.07144
11500.	1.12653	1.10317	1.07257
12000.	1.12920	1.10520	1.07373
12500.	1.13204	1.10733	1.07494
13000.	1.13505	1.10958	1.07621
13500.	1.13825	1.11193	1.07753
14000.	1.14165	1.11440	1.07890
14500.	1.14523	1.11697	1.08032
15000.	1.14899	1.11962	1.08176
15500.	1.15289	1.12232	1.08321
16000.	1.15682	1.12502	1.08463
16500.	1.16066	1.12765	1.08600
17000.	1.16424	1.13017	1.08727
17500.	1.16740	1.13250	1.08844
18000.	1.17003	1.13455	1.08947
18500.	1.17196	1.13625	1.09036
19000.	1.17313	1.13753	1.09107
19500.	1.17349	1.13836	1.09158
20000.	1.17309	1.13870	1.09190
20500.	1.17195	1.13853	1.09200
21000.	1.17014	1.13787	1.09185
21500.	1.16776	1.13673	1.09145
22000.	1.16493	1.13514	1.09081
22500.	1.16174	1.13313	1.08990
23000.	1.15825	1.13074	1.08874
23500.	1.15454	1.12805	1.08734
24000.	1.15065	1.12510	1.08571
24500.	1.14661	1.12194	1.08386
25000.	1.14248	1.11862	1.08180
25500.	1.13814	1.11516	1.07954
26000.	1.13381	1.11160	1.07711
26500.	1.12947	1.10796	1.07452
27000.	1.12514	1.10426	1.07180
27500.	1.12080	1.10052	1.06897
28000.	1.11650	1.09675	1.06605
28500.	1.11220	1.09291	1.06305
29000.	1.10789	1.08906	1.05999
29500.	1.10359	1.08521	1.05689
30000.	1.09929	1.08137	1.05375
30500.	1.09498	1.07760	1.05059
31000.	1.09067	1.07384	1.04740
31500.	1.08636	1.07007	1.04421
32000.	1.08205	1.06631	1.04101
32500.	1.07774	1.06254	1.03781
33000.	1.07342	1.05882	1.03461
33500.	1.06911	1.05510	1.03142
35000.	1.05616	1.04393	1.02182
37500.	1.03455	1.02556	1.00627
40000.	1.01295	1.00742	0.99113
42500.	0.99139	0.98955	0.97640
45000.	0.96994	0.97197	0.96210
47500.	0.94868	0.95474	0.94825
50000.	0.92769	0.93787	0.93487
52500.	0.90710	0.92143	0.92197
55000.	0.88702	0.90547	0.90957
57500.	0.86758	0.89004	0.89768
60000.	0.84893	0.87519	0.88632
62500.	0.83119	0.86099	0.87548
65000.	0.81448	0.84746	0.86519
67500.	0.79891	0.83466	0.85542
70000.	0.78456	0.82262	0.84620

Table B.18 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.406	1.422	1.430
100.	1.401	1.419	1.427
500.	1.396	1.414	1.424
1000.	1.389	1.408	1.420
1500.	1.382	1.402	1.416
2000.	1.373	1.394	1.410
2500.	1.365	1.387	1.404
3000.	1.356	1.379	1.398
3500.	1.347	1.371	1.391
4000.	1.337	1.363	1.385
4500.	1.328	1.355	1.378
5000.	1.319	1.346	1.371
5500.	1.310	1.338	1.365
6000.	1.304	1.329	1.358
6500.	1.297	1.321	1.351
7000.	1.291	1.312	1.344
7500.	1.284	1.303	1.337
8000.	1.278	1.294	1.330
8500.	1.271	1.285	1.323
9000.	1.264	1.279	1.315
9500.	1.257	1.274	1.308
10000.	1.251	1.269	1.301
10500.	1.244	1.264	1.294
11000.	1.238	1.259	1.287
11500.	1.232	1.254	1.281
12000.	1.226	1.249	1.276
12500.	1.220	1.244	1.272
13000.	1.214	1.239	1.268
13500.	1.208	1.234	1.263
14000.	1.202	1.229	1.259
14500.	1.196	1.224	1.255
15000.	1.190	1.218	1.251
15500.	1.184	1.213	1.246
16000.	1.177	1.207	1.242
16500.	1.171	1.201	1.237
17000.	1.165	1.195	1.233
17500.	1.159	1.189	1.228
18000.	1.153	1.182	1.223
18500.	1.148	1.175	1.218
19000.	1.142	1.169	1.213
19500.	1.137	1.163	1.208
20000.	1.133	1.159	1.202
20500.	1.128	1.154	1.197
21000.	1.125	1.150	1.192
21500.	1.121	1.146	1.188
22000.	1.118	1.143	1.183
22500.	1.115	1.139	1.179
23000.	1.114	1.136	1.175
23500.	1.113	1.133	1.171
24000.	1.112	1.131	1.167
24500.	1.110	1.128	1.164
25000.	1.109	1.126	1.160
25500.	1.107	1.124	1.157
26000.	1.106	1.121	1.154
26500.	1.104	1.120	1.152
27000.	1.103	1.118	1.149
27500.	1.101	1.116	1.147
28000.	1.099	1.114	1.146
28500.	1.097	1.112	1.144
29000.	1.096	1.110	1.142
29500.	1.094	1.109	1.141
30000.	1.092	1.107	1.139
30500.	1.090	1.105	1.138
31000.	1.089	1.103	1.136
31500.	1.087	1.102	1.135
32000.	1.086	1.100	1.133
32500.	1.084	1.098	1.132
33000.	1.082	1.096	1.130
33500.	1.080	1.095	1.129
35000.	1.075	1.090	1.125
37500.	1.067	1.081	1.119
40000.	1.059	1.073	1.113
42500.	1.051	1.065	1.107
45000.	1.044	1.059	1.102
47500.	1.041	1.054	1.099
50000.	1.039	1.049	1.107
52500.	1.037	1.045	1.116
55000.	1.039	1.043	1.126
57500.	1.042	1.042	1.136
60000.	1.043	1.041	1.146
62500.	1.043	1.054	1.157
65000.	1.042	1.069	1.168
67500.	1.045	1.083	1.179
70000.	1.064	1.098	1.190

Table B.19 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.09528	1.07797	1.05714
100.	1.06932	1.05377	1.03545
500.	1.06596	1.05116	1.03361
1000.	1.06581	1.05154	1.03434
1500.	1.06694	1.05301	1.03588
2000.	1.06846	1.05478	1.03762
2500.	1.07012	1.05664	1.03934
3000.	1.07186	1.05849	1.04101
3500.	1.07369	1.06036	1.04261
4000.	1.07565	1.06228	1.04420
4500.	1.07774	1.06428	1.04578
5000.	1.07999	1.06637	1.04737
5500.	1.08238	1.06855	1.04899
6000.	1.08489	1.07082	1.05064
6500.	1.08752	1.07317	1.05234
7000.	1.09026	1.07560	1.05408
7500.	1.09312	1.07810	1.05588
8000.	1.09611	1.08069	1.05773
8500.	1.09925	1.08338	1.05965
9000.	1.10252	1.08617	1.06163
9500.	1.10594	1.08907	1.06366
10000.	1.10950	1.09206	1.06575
10500.	1.11321	1.09516	1.06789
11000.	1.11710	1.09838	1.07009
11500.	1.12118	1.10173	1.07234
12000.	1.12550	1.10523	1.07466
12500.	1.13008	1.10889	1.07706
13000.	1.13495	1.11273	1.07954
13500.	1.14014	1.11675	1.08211
14000.	1.14561	1.12095	1.08476
14500.	1.15137	1.12531	1.08747
15000.	1.15735	1.12980	1.09021
15500.	1.16330	1.13431	1.09294
16000.	1.16901	1.13875	1.09563
16500.	1.17421	1.14302	1.09821
17000.	1.17864	1.14692	1.10067
17500.	1.18215	1.15034	1.10295
18000.	1.18458	1.15316	1.10501
18500.	1.18590	1.15530	1.10680
19000.	1.18617	1.15669	1.10829
19500.	1.18554	1.15732	1.10944
20000.	1.18416	1.15721	1.11024
20500.	1.18216	1.15644	1.11065
21000.	1.17965	1.15508	1.11067
21500.	1.17672	1.15319	1.11030
22000.	1.17344	1.15086	1.10955
22500.	1.16986	1.14817	1.10845
23000.	1.16604	1.14520	1.10702
23500.	1.16200	1.14199	1.10527
24000.	1.15780	1.13858	1.10323
24500.	1.15348	1.13502	1.10093
25000.	1.14896	1.13132	1.09840
25500.	1.14437	1.12751	1.09568
26000.	1.13977	1.12363	1.09280
26500.	1.13518	1.11969	1.08979
27000.	1.13058	1.11560	1.08668
27500.	1.12599	1.11151	1.08348
28000.	1.12141	1.10745	1.08021
28500.	1.11683	1.10338	1.07689
29000.	1.11224	1.09932	1.07352
29500.	1.10766	1.09525	1.07013
30000.	1.10308	1.09119	1.06671
30500.	1.09845	1.08716	1.06328
31000.	1.09382	1.08314	1.05985
32500.	1.07992	1.07106	1.04938
35000.	1.05650	1.05099	1.03236
37500.	1.03281	1.03097	1.01566
40000.	1.00890	1.01103	0.99929
42500.	0.98481	0.99120	0.98323
45000.	0.96064	0.97151	0.96752
47500.	0.93648	0.95203	0.95220
50000.	0.91249	0.93283	0.93729
52500.	0.88884	0.91397	0.92282
55000.	0.86573	0.89555	0.90882
57500.	0.84339	0.87767	0.89533
60000.	0.82202	0.86044	0.88237
62500.	0.80187	0.84394	0.86996
65000.	0.78313	0.82827	0.85813
67500.	0.76596	0.81351	0.84690
70000.	0.75047	0.79973	0.83628

Table B.20 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.484	1.487	1.477
100.	1.482	1.486	1.477
500.	1.475	1.480	1.474
1000.	1.467	1.474	1.470
1500.	1.457	1.466	1.465
2000.	1.446	1.457	1.459
2500.	1.435	1.448	1.453
3000.	1.424	1.438	1.446
3500.	1.412	1.428	1.438
4000.	1.400	1.417	1.431
4500.	1.388	1.407	1.423
5000.	1.376	1.396	1.415
5500.	1.363	1.385	1.407
6000.	1.350	1.374	1.399
6500.	1.338	1.363	1.390
7000.	1.325	1.352	1.382
7500.	1.312	1.341	1.373
8000.	1.299	1.329	1.364
8500.	1.286	1.318	1.356
9000.	1.273	1.307	1.347
9500.	1.260	1.295	1.338
10000.	1.248	1.284	1.329
10500.	1.237	1.272	1.321
11000.	1.225	1.261	1.312
11500.	1.217	1.250	1.303
12000.	1.209	1.238	1.294
12500.	1.200	1.227	1.285
13000.	1.194	1.216	1.276
13500.	1.189	1.206	1.268
14000.	1.185	1.198	1.259
14500.	1.180	1.190	1.250
15000.	1.176	1.183	1.241
15500.	1.172	1.178	1.232
16000.	1.168	1.175	1.224
16500.	1.165	1.171	1.215
17000.	1.161	1.168	1.206
17500.	1.159	1.165	1.197
18000.	1.156	1.162	1.189
18500.	1.154	1.159	1.182
19000.	1.152	1.156	1.176
19500.	1.150	1.154	1.170
20000.	1.148	1.152	1.165
20500.	1.146	1.149	1.160
21000.	1.144	1.147	1.155
21500.	1.142	1.145	1.152
22000.	1.140	1.143	1.151
22500.	1.138	1.142	1.149
23000.	1.135	1.140	1.148
23500.	1.133	1.138	1.147
24000.	1.130	1.136	1.146
24500.	1.128	1.134	1.145
25000.	1.125	1.132	1.143
25500.	1.123	1.130	1.142
26000.	1.120	1.128	1.141
26500.	1.118	1.125	1.140
27000.	1.115	1.123	1.139
27500.	1.113	1.121	1.138
28000.	1.110	1.119	1.137
28500.	1.107	1.117	1.135
29000.	1.105	1.115	1.134
29500.	1.102	1.113	1.133
30000.	1.099	1.111	1.132
30500.	1.097	1.109	1.131
31000.	1.094	1.107	1.129
32500.	1.087	1.101	1.126
35000.	1.074	1.091	1.120
37500.	1.062	1.082	1.114
40000.	1.051	1.073	1.109
42500.	1.041	1.065	1.105
45000.	1.041	1.058	1.101
47500.	1.045	1.052	1.097
50000.	1.049	1.047	1.094
52500.	1.053	1.043	1.092
55000.	1.055	1.040	1.090
57500.	1.056	1.038	1.088
60000.	1.055	1.038	1.087
62500.	1.054	1.038	1.087
65000.	1.050	1.040	1.087
67500.	1.045	1.042	1.092
70000.	1.039	1.046	1.102

Table B.21 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.09471	1.07777	1.05677
100.	1.06856	1.05339	1.03494
500.	1.06523	1.05085	1.03319
1000.	1.06523	1.05140	1.03411
1500.	1.06658	1.05312	1.03590
2000.	1.06835	1.05518	1.03790
2500.	1.07021	1.05727	1.03987
3000.	1.07207	1.05929	1.04171
3500.	1.07397	1.06126	1.04342
4000.	1.07593	1.06323	1.04505
4500.	1.07798	1.06523	1.04664
5000.	1.08013	1.06728	1.04822
5500.	1.08241	1.06940	1.04981
6000.	1.08486	1.07164	1.05144
6500.	1.08752	1.07401	1.05313
7000.	1.09038	1.07653	1.05491
7500.	1.09342	1.07920	1.05678
8000.	1.09663	1.08200	1.05875
8500.	1.09999	1.08491	1.06079
9000.	1.10350	1.08792	1.06291
9500.	1.10717	1.09105	1.06509
10000.	1.11103	1.09430	1.06734
10500.	1.11508	1.09770	1.06966
11000.	1.11934	1.10124	1.07205
11500.	1.12383	1.10495	1.07452
12000.	1.12857	1.10881	1.07708
12500.	1.13360	1.11285	1.07971
13000.	1.13896	1.11708	1.08243
13500.	1.14470	1.12152	1.08523
14000.	1.15081	1.12617	1.08813
14500.	1.15720	1.13100	1.09109
15000.	1.16375	1.13594	1.09409
15500.	1.17018	1.14087	1.09708
16000.	1.17618	1.14568	1.09999
16500.	1.18143	1.15017	1.10279
17000.	1.18574	1.15420	1.10544
17500.	1.18888	1.15761	1.10788
18000.	1.19077	1.16030	1.11004
18500.	1.19145	1.16217	1.11189
19000.	1.19111	1.16320	1.11340
19500.	1.18990	1.16342	1.11453
20000.	1.18799	1.16288	1.11525
20500.	1.18550	1.16167	1.11555
21000.	1.18253	1.15986	1.11541
21500.	1.17917	1.15755	1.11487
22000.	1.17548	1.15484	1.11392
22500.	1.17150	1.15181	1.11261
23000.	1.16731	1.14852	1.11094
23500.	1.16295	1.14500	1.10894
24000.	1.15830	1.14131	1.10665
24500.	1.15364	1.13749	1.10411
25000.	1.14899	1.13355	1.10135
25500.	1.14431	1.12955	1.09843
26000.	1.13964	1.12537	1.09536
26500.	1.13496	1.12120	1.09218
27000.	1.13029	1.11702	1.08891
27500.	1.12561	1.11284	1.08557
28000.	1.12091	1.10871	1.08218
28500.	1.11620	1.10458	1.07874
29000.	1.11150	1.10046	1.07527
29500.	1.10679	1.09633	1.07179
30000.	1.10209	1.09220	1.06830
32500.	1.07830	1.07164	1.05065
35000.	1.05422	1.05111	1.03346
37500.	1.02985	1.03064	1.01657
40000.	1.00524	1.01022	0.99999
42500.	0.98045	0.98991	0.98375
45000.	0.95557	0.96974	0.96786
47500.	0.93075	0.94979	0.95236
50000.	0.90614	0.93013	0.93729
52500.	0.88195	0.91085	0.92266
55000.	0.85840	0.89205	0.90852
57500.	0.83572	0.87384	0.89490
60000.	0.81417	0.85632	0.88184
62500.	0.79398	0.83961	0.86934
65000.	0.77534	0.82380	0.85744
67500.	0.75842	0.80897	0.84615
70000.	0.74331	0.79519	0.83550

Table B.22 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.486	1.471	1.436
100.	1.485	1.470	1.434
500.	1.480	1.465	1.430
1000.	1.473	1.460	1.425
1500.	1.464	1.453	1.420
2000.	1.455	1.445	1.414
2500.	1.445	1.436	1.409
3000.	1.435	1.428	1.403
3500.	1.425	1.419	1.397
4000.	1.414	1.410	1.391
4500.	1.403	1.401	1.385
5000.	1.392	1.392	1.379
5500.	1.381	1.384	1.373
6000.	1.373	1.377	1.367
6500.	1.365	1.369	1.361
7000.	1.356	1.361	1.355
7500.	1.347	1.353	1.349
8000.	1.338	1.345	1.342
8500.	1.329	1.337	1.336
9000.	1.320	1.329	1.330
9500.	1.311	1.321	1.323
10000.	1.302	1.313	1.317
10500.	1.293	1.305	1.310
11000.	1.283	1.296	1.304
11500.	1.274	1.288	1.299
12000.	1.264	1.280	1.294
12500.	1.254	1.271	1.288
13000.	1.245	1.263	1.283
13500.	1.234	1.254	1.277
14000.	1.224	1.246	1.272
14500.	1.214	1.237	1.267
15000.	1.204	1.229	1.261
15500.	1.194	1.220	1.255
16000.	1.184	1.212	1.249
16500.	1.176	1.204	1.243
17000.	1.167	1.196	1.237
17500.	1.160	1.189	1.231
18000.	1.153	1.182	1.224
18500.	1.147	1.175	1.218
19000.	1.142	1.169	1.212
19500.	1.137	1.164	1.205
20000.	1.132	1.159	1.199
20500.	1.128	1.154	1.193
21000.	1.124	1.150	1.188
21500.	1.121	1.146	1.183
22000.	1.117	1.142	1.178
22500.	1.114	1.138	1.174
23000.	1.111	1.135	1.170
23500.	1.108	1.132	1.166
24000.	1.105	1.129	1.163
24500.	1.103	1.126	1.160
25000.	1.100	1.123	1.157
25500.	1.097	1.121	1.154
26000.	1.095	1.118	1.152
26500.	1.092	1.116	1.149
27000.	1.090	1.113	1.147
27500.	1.087	1.111	1.144
28000.	1.084	1.108	1.142
28500.	1.081	1.106	1.140
29000.	1.079	1.103	1.138
29500.	1.076	1.101	1.136
30000.	1.073	1.098	1.134
32500.	1.064	1.086	1.124
35000.	1.059	1.074	1.115
37500.	1.053	1.062	1.106
40000.	1.048	1.052	1.097
42500.	1.050	1.047	1.089
45000.	1.050	1.043	1.081
47500.	1.053	1.040	1.075
50000.	1.055	1.036	1.069
52500.	1.057	1.035	1.064
55000.	1.058	1.034	1.064
57500.	1.057	1.035	1.065
60000.	1.055	1.036	1.067
62500.	1.051	1.036	1.073
65000.	1.046	1.036	1.083
67500.	1.040	1.037	1.093
70000.	1.047	1.052	1.103

Table B.23 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.07017	1.05560	1.03672
100.	1.04418	1.03127	1.01482
500.	1.04109	1.02896	1.01333
1000.	1.04141	1.02988	1.01465
1500.	1.04315	1.03203	1.01691
2000.	1.04535	1.03456	1.01940
2500.	1.04765	1.03714	1.02187
3000.	1.04998	1.03965	1.02420
3500.	1.05238	1.04214	1.02642
4000.	1.05487	1.04466	1.02857
4500.	1.05748	1.04722	1.03069
5000.	1.06022	1.04986	1.03281
5500.	1.06313	1.05260	1.03494
6000.	1.06626	1.05548	1.03712
6500.	1.06962	1.05853	1.03938
7000.	1.07322	1.06176	1.04174
7500.	1.07704	1.06515	1.04421
8000.	1.08105	1.06870	1.04678
8500.	1.08525	1.07237	1.04945
9000.	1.08964	1.07617	1.05220
9500.	1.09423	1.08011	1.05502
10000.	1.09905	1.08421	1.05793
10500.	1.10413	1.08848	1.06092
11000.	1.10949	1.09295	1.06401
11500.	1.11517	1.09761	1.06719
12000.	1.12121	1.10248	1.07048
12500.	1.12764	1.10759	1.07387
13000.	1.13454	1.11296	1.07737
13500.	1.14185	1.11862	1.08099
14000.	1.14953	1.12457	1.08472
14500.	1.15729	1.13076	1.08856
15000.	1.16488	1.13703	1.09246
15500.	1.17188	1.14321	1.09638
16000.	1.17799	1.14909	1.10024
16500.	1.18294	1.15441	1.10400
17000.	1.18667	1.15898	1.10757
17500.	1.18913	1.16260	1.11085
18000.	1.19044	1.16523	1.11376
18500.	1.19075	1.16685	1.11624
19000.	1.19022	1.16748	1.11823
19500.	1.18896	1.16725	1.11969
20000.	1.18704	1.16630	1.12059
20500.	1.18456	1.16474	1.12092
21000.	1.18160	1.16267	1.12073
21500.	1.17823	1.16018	1.12003
22000.	1.17448	1.15733	1.11887
22500.	1.17044	1.15418	1.11730
23000.	1.16614	1.15078	1.11534
23500.	1.16167	1.14715	1.11307
24000.	1.15686	1.14334	1.11052
24500.	1.15206	1.13939	1.10775
25000.	1.14725	1.13533	1.10480
25500.	1.14241	1.13103	1.10169
26000.	1.13756	1.12674	1.09846
26500.	1.13272	1.12244	1.09513
27000.	1.12787	1.11815	1.09172
27500.	1.12303	1.11385	1.08824
28000.	1.11814	1.10959	1.08471
28500.	1.11324	1.10532	1.08115
29000.	1.10835	1.10106	1.07757
30000.	1.09856	1.09253	1.07020
32500.	1.07367	1.07112	1.05206
35000.	1.04831	1.04964	1.03426
37500.	1.02251	1.02808	1.01668
40000.	0.99631	1.00647	0.99936
42500.	0.96978	0.98485	0.98231
45000.	0.94305	0.96327	0.96557
47500.	0.91629	0.94182	0.94917
50000.	0.88973	0.92060	0.93316
52500.	0.86362	0.89973	0.91757
55000.	0.83826	0.87936	0.90246
57500.	0.81399	0.85962	0.88785
60000.	0.79112	0.84068	0.87381
62500.	0.76996	0.82267	0.86037
65000.	0.75074	0.80574	0.84756
67500.	0.73363	0.79000	0.83543
70000.	0.71867	0.77554	0.82400

Table B.24 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.429	1.419	1.400
100.	1.428	1.419	1.398
500.	1.422	1.414	1.393
1000.	1.415	1.408	1.389
1500.	1.407	1.401	1.383
2000.	1.398	1.393	1.378
2500.	1.389	1.385	1.372
3000.	1.380	1.377	1.366
3500.	1.370	1.369	1.360
4000.	1.360	1.361	1.355
4500.	1.349	1.354	1.349
5000.	1.340	1.347	1.343
5500.	1.332	1.339	1.337
6000.	1.324	1.332	1.331
6500.	1.316	1.324	1.325
7000.	1.307	1.316	1.318
7500.	1.299	1.309	1.312
8000.	1.290	1.301	1.306
8500.	1.281	1.293	1.300
9000.	1.272	1.285	1.294
9500.	1.263	1.277	1.288
10000.	1.254	1.269	1.283
10500.	1.245	1.261	1.277
11000.	1.236	1.253	1.272
11500.	1.226	1.244	1.267
12000.	1.216	1.236	1.261
12500.	1.207	1.228	1.256
13000.	1.197	1.219	1.250
13500.	1.187	1.211	1.245
14000.	1.176	1.202	1.239
14500.	1.166	1.194	1.234
15000.	1.156	1.185	1.228
15500.	1.147	1.177	1.223
16000.	1.139	1.169	1.217
16500.	1.132	1.162	1.210
17000.	1.125	1.154	1.204
17500.	1.119	1.147	1.198
18000.	1.114	1.141	1.191
18500.	1.110	1.136	1.185
19000.	1.105	1.131	1.178
19500.	1.101	1.127	1.172
20000.	1.097	1.123	1.166
20500.	1.094	1.119	1.161
21000.	1.090	1.115	1.156
21500.	1.087	1.112	1.152
22000.	1.085	1.109	1.147
22500.	1.082	1.106	1.144
23000.	1.080	1.103	1.140
23500.	1.078	1.101	1.137
24000.	1.076	1.098	1.134
24500.	1.074	1.096	1.132
25000.	1.072	1.094	1.129
25500.	1.070	1.092	1.127
26000.	1.068	1.090	1.125
26500.	1.066	1.088	1.123
27000.	1.064	1.086	1.121
27500.	1.062	1.084	1.119
28000.	1.060	1.082	1.117
28500.	1.058	1.080	1.115
29000.	1.056	1.078	1.113
30000.	1.052	1.074	1.110
32500.	1.045	1.064	1.101
35000.	1.042	1.054	1.093
37500.	1.041	1.045	1.085
40000.	1.047	1.038	1.077
42500.	1.052	1.034	1.070
45000.	1.057	1.032	1.063
47500.	1.060	1.033	1.056
50000.	1.062	1.037	1.052
52500.	1.064	1.040	1.048
55000.	1.063	1.043	1.045
57500.	1.061	1.044	1.046
60000.	1.057	1.045	1.047
62500.	1.052	1.044	1.050
65000.	1.046	1.042	1.054
67500.	1.039	1.039	1.065
70000.	1.036	1.036	1.076

Table B.25 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.05327	1.03972	1.02116
100.	1.02755	1.01559	0.99945
500.	1.02472	1.01364	0.99843
1000.	1.02558	1.01521	1.00052
1500.	1.02789	1.01805	1.00353
2000.	1.03061	1.02122	1.00674
2500.	1.03340	1.02438	1.00985
3000.	1.03625	1.02749	1.01279
3500.	1.03919	1.03060	1.01562
4000.	1.04226	1.03377	1.01838
4500.	1.04548	1.03701	1.02114
5000.	1.04890	1.04036	1.02390
5500.	1.05255	1.04386	1.02669
6000.	1.05649	1.04757	1.02956
6500.	1.06072	1.05150	1.03255
7000.	1.06521	1.05563	1.03565
7500.	1.06994	1.05993	1.03887
8000.	1.07488	1.06439	1.04219
8500.	1.08006	1.06898	1.04560
9000.	1.08549	1.07375	1.04910
9500.	1.09122	1.07871	1.05269
10000.	1.09727	1.08388	1.05641
10500.	1.10368	1.08928	1.06023
11000.	1.11049	1.09492	1.06417
11500.	1.11777	1.10083	1.06823
12000.	1.12557	1.10706	1.07241
12500.	1.13395	1.11363	1.07672
13000.	1.14274	1.12055	1.08116
13500.	1.15165	1.12776	1.08571
14000.	1.16027	1.13507	1.09033
14500.	1.16812	1.14221	1.09493
15000.	1.17481	1.14897	1.09945
15500.	1.18014	1.15502	1.10380
16000.	1.18404	1.16014	1.10790
16500.	1.18658	1.16413	1.11165
17000.	1.18790	1.16695	1.11496
17500.	1.18826	1.16860	1.11779
18000.	1.18782	1.16920	1.12009
18500.	1.18670	1.16893	1.12177
19000.	1.18494	1.16795	1.12283
19500.	1.18259	1.16638	1.12327
20000.	1.17971	1.16430	1.12312
20500.	1.17640	1.16179	1.12245
21000.	1.17269	1.15890	1.12128
21500.	1.16863	1.15570	1.11967
22000.	1.16427	1.15224	1.11766
22500.	1.15967	1.14854	1.11532
23000.	1.15461	1.14463	1.11269
23500.	1.14955	1.14055	1.10983
24000.	1.14448	1.13634	1.10680
24500.	1.13942	1.13204	1.10361
25000.	1.13436	1.12756	1.10029
25500.	1.12924	1.12303	1.09687
26000.	1.12412	1.11851	1.09336
26500.	1.11901	1.11398	1.08978
27000.	1.11389	1.10946	1.08614
27500.	1.10877	1.10493	1.08247
28000.	1.10355	1.10044	1.07878
30000.	1.08267	1.08250	1.06364
32500.	1.05606	1.05998	1.04515
35000.	1.02895	1.03738	1.02693
37500.	1.00140	1.01469	1.00897
40000.	0.97348	0.99198	0.99131
42500.	0.94534	0.96932	0.97395
45000.	0.91718	0.94679	0.95696
47500.	0.88926	0.92450	0.94038
50000.	0.86189	0.90260	0.92425
52500.	0.83541	0.88125	0.90862
55000.	0.81020	0.86062	0.89355
57500.	0.78661	0.84088	0.87906
60000.	0.76498	0.82221	0.86522
62500.	0.74555	0.80475	0.85205
65000.	0.72845	0.78862	0.83960
67500.	0.71371	0.77392	0.82791
70000.	0.70123	0.76068	0.81697

Table B.26 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.399	1.404	1.398
100.	1.398	1.403	1.397
500.	1.391	1.397	1.394
1000.	1.383	1.391	1.391
1500.	1.373	1.383	1.386
2000.	1.362	1.373	1.380
2500.	1.351	1.364	1.373
3000.	1.339	1.353	1.366
3500.	1.326	1.343	1.359
4000.	1.314	1.332	1.351
4500.	1.307	1.321	1.343
5000.	1.300	1.309	1.335
5500.	1.293	1.298	1.326
6000.	1.286	1.286	1.318
6500.	1.278	1.274	1.309
7000.	1.271	1.262	1.300
7500.	1.263	1.250	1.291
8000.	1.255	1.238	1.282
8500.	1.248	1.226	1.273
9000.	1.240	1.214	1.264
9500.	1.232	1.202	1.255
10000.	1.223	1.190	1.246
10500.	1.215	1.179	1.236
11000.	1.207	1.171	1.227
11500.	1.198	1.165	1.218
12000.	1.190	1.159	1.209
12500.	1.181	1.154	1.199
13000.	1.172	1.148	1.190
13500.	1.163	1.142	1.181
14000.	1.154	1.135	1.172
14500.	1.145	1.129	1.162
15000.	1.136	1.122	1.153
15500.	1.139	1.116	1.143
16000.	1.138	1.109	1.134
16500.	1.135	1.103	1.125
17000.	1.132	1.098	1.116
17500.	1.131	1.092	1.107
18000.	1.129	1.088	1.099
18500.	1.126	1.084	1.094
19000.	1.124	1.080	1.089
19500.	1.121	1.077	1.084
20000.	1.119	1.075	1.084
20500.	1.117	1.073	1.084
21000.	1.115	1.072	1.083
21500.	1.112	1.072	1.083
22000.	1.110	1.070	1.082
22500.	1.108	1.069	1.082
23000.	1.106	1.068	1.082
23500.	1.103	1.067	1.081
24000.	1.101	1.066	1.081
24500.	1.098	1.065	1.080
25000.	1.096	1.063	1.079
25500.	1.094	1.062	1.079
26000.	1.091	1.061	1.078
26500.	1.089	1.061	1.077
27000.	1.086	1.060	1.077
27500.	1.084	1.059	1.076
28000.	1.082	1.059	1.075
30000.	1.072	1.058	1.072
32500.	1.072	1.057	1.069
35000.	1.076	1.056	1.066
37500.	1.080	1.055	1.063
40000.	1.082	1.055	1.061
42500.	1.086	1.059	1.059
45000.	1.089	1.062	1.057
47500.	1.090	1.065	1.056
50000.	1.089	1.067	1.056
52500.	1.087	1.068	1.055
55000.	1.083	1.067	1.056
57500.	1.076	1.065	1.057
60000.	1.068	1.063	1.058
62500.	1.059	1.059	1.059
65000.	1.050	1.054	1.064
67500.	1.044	1.048	1.074
70000.	1.052	1.050	1.085

Table B.27 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.07383	1.06337	1.04873
100.	1.04802	1.03909	1.02678
500.	1.04687	1.03868	1.02704
1000.	1.05030	1.04261	1.03100
1500.	1.05540	1.04801	1.03602
2000.	1.06093	1.05372	1.04120
2500.	1.06663	1.05949	1.04625
3000.	1.07259	1.06535	1.05120
3500.	1.07890	1.07139	1.05613
4000.	1.08567	1.07772	1.06112
4500.	1.09293	1.08438	1.06624
5000.	1.10068	1.09137	1.07151
5500.	1.10889	1.09867	1.07693
6000.	1.11756	1.10627	1.08249
6500.	1.12678	1.11420	1.08820
7000.	1.13664	1.12253	1.09409
7500.	1.14723	1.13130	1.10018
8000.	1.15851	1.14051	1.10649
8500.	1.17044	1.15014	1.11300
9000.	1.18276	1.16012	1.11966
9500.	1.19493	1.17026	1.12642
10000.	1.20636	1.18023	1.13316
10500.	1.21635	1.18957	1.13973
11000.	1.22453	1.19788	1.14599
11500.	1.23073	1.20485	1.15176
12000.	1.23499	1.21028	1.15689
12500.	1.23753	1.21409	1.16126
13000.	1.23865	1.21635	1.16476
13500.	1.23853	1.21724	1.16735
14000.	1.23738	1.21699	1.16902
14500.	1.23535	1.21579	1.16982
15000.	1.23261	1.21384	1.16980
15500.	1.22929	1.21129	1.16904
16000.	1.22550	1.20826	1.16763
16500.	1.22135	1.20485	1.16566
17000.	1.21693	1.20114	1.16323
17500.	1.21233	1.19719	1.16045
18000.	1.20759	1.19306	1.15738
18500.	1.20258	1.18881	1.15410
19000.	1.19757	1.18446	1.15064
19500.	1.19257	1.18005	1.14704
20000.	1.18756	1.17552	1.14335
20500.	1.18256	1.17097	1.13957
21000.	1.17757	1.16641	1.13575
21500.	1.17257	1.16186	1.13189
22000.	1.16758	1.15730	1.12800
22500.	1.16258	1.15275	1.12411
25000.	1.13728	1.13027	1.10444
27500.	1.11150	1.10774	1.08526
30000.	1.08522	1.08512	1.06636
32500.	1.05842	1.06241	1.04771
35000.	1.03111	1.03961	1.02931
37500.	1.00333	1.01672	1.01118
40000.	0.97520	0.99381	0.99334
42500.	0.94685	0.97095	0.97582
45000.	0.91849	0.94823	0.95867
47500.	0.89040	0.92577	0.94194
50000.	0.86288	0.90371	0.92567
52500.	0.83630	0.88224	0.90993
55000.	0.81103	0.86151	0.89476
57500.	0.78745	0.84172	0.88019
60000.	0.76587	0.82302	0.86628
62500.	0.74653	0.80558	0.85307
65000.	0.72956	0.78950	0.84061
67500.	0.71497	0.77487	0.82890
70000.	0.70264	0.76174	0.81799

Table B.28 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.378	1.383	1.376
100.	1.376	1.381	1.375
500.	1.368	1.374	1.371
1000.	1.357	1.365	1.366
1500.	1.345	1.355	1.360
2000.	1.331	1.344	1.352
2500.	1.317	1.332	1.344
3000.	1.305	1.319	1.335
3500.	1.297	1.307	1.326
4000.	1.289	1.293	1.317
4500.	1.280	1.280	1.307
5000.	1.271	1.266	1.297
5500.	1.262	1.253	1.287
6000.	1.253	1.238	1.277
6500.	1.243	1.224	1.267
7000.	1.233	1.210	1.257
7500.	1.223	1.196	1.246
8000.	1.213	1.181	1.235
8500.	1.202	1.166	1.225
9000.	1.192	1.156	1.214
9500.	1.181	1.148	1.203
10000.	1.170	1.141	1.192
10500.	1.160	1.133	1.181
11000.	1.151	1.125	1.170
11500.	1.142	1.118	1.159
12000.	1.137	1.112	1.149
12500.	1.135	1.106	1.139
13000.	1.132	1.100	1.130
13500.	1.128	1.096	1.121
14000.	1.127	1.092	1.114
14500.	1.125	1.088	1.106
15000.	1.123	1.086	1.100
15500.	1.121	1.085	1.094
16000.	1.119	1.084	1.091
16500.	1.117	1.083	1.089
17000.	1.114	1.082	1.088
17500.	1.112	1.081	1.088
18000.	1.110	1.079	1.087
18500.	1.108	1.078	1.086
19000.	1.106	1.076	1.086
19500.	1.104	1.075	1.085
20000.	1.102	1.073	1.084
20500.	1.100	1.071	1.084
21000.	1.098	1.070	1.083
21500.	1.095	1.068	1.082
22000.	1.093	1.067	1.081
22500.	1.091	1.065	1.081
25000.	1.081	1.058	1.077
27500.	1.070	1.055	1.073
30000.	1.061	1.054	1.069
32500.	1.060	1.053	1.065
35000.	1.064	1.053	1.062
37500.	1.067	1.052	1.059
40000.	1.070	1.051	1.057
42500.	1.072	1.049	1.055
45000.	1.074	1.052	1.054
47500.	1.075	1.054	1.053
50000.	1.075	1.056	1.052
52500.	1.073	1.056	1.052
55000.	1.069	1.056	1.052
57500.	1.063	1.055	1.053
60000.	1.056	1.052	1.055
62500.	1.048	1.048	1.056
65000.	1.039	1.044	1.064
67500.	1.041	1.039	1.074
70000.	1.051	1.050	1.085

Table B.29 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.08960	1.07180	1.04997
100.	1.06350	1.04749	1.02821
500.	1.05991	1.04471	1.02626
1000.	1.05951	1.04491	1.02688
1500.	1.06040	1.04621	1.02832
2000.	1.06171	1.04785	1.02996
2500.	1.06312	1.04955	1.03158
3000.	1.06451	1.05117	1.03309
3500.	1.06592	1.05272	1.03449
4000.	1.06737	1.05426	1.03580
4500.	1.06888	1.05581	1.03706
5000.	1.07047	1.05739	1.03831
5500.	1.07214	1.05902	1.03955
6000.	1.07393	1.06071	1.04082
6500.	1.07587	1.06249	1.04213
7000.	1.07798	1.06439	1.04350
7500.	1.08027	1.06643	1.04495
8000.	1.08274	1.06860	1.04648
8500.	1.08535	1.07090	1.04811
9000.	1.08810	1.07330	1.04981
9500.	1.09097	1.07580	1.05158
10000.	1.09398	1.07840	1.05340
10500.	1.09712	1.08110	1.05527
11000.	1.10041	1.08392	1.05721
11500.	1.10387	1.08685	1.05920
12000.	1.10750	1.08990	1.06125
12500.	1.11133	1.09308	1.06337
13000.	1.11537	1.09640	1.06556
13500.	1.11965	1.09987	1.06782
14000.	1.12421	1.10350	1.07015
14500.	1.12910	1.10732	1.07257
15000.	1.13435	1.11134	1.07507
15500.	1.13997	1.11557	1.07765
16000.	1.14589	1.11996	1.08029
16500.	1.15192	1.12444	1.08297
17000.	1.15780	1.12892	1.08562
17500.	1.16327	1.13327	1.08822
18000.	1.16809	1.13735	1.09071
18500.	1.17196	1.14102	1.09306
19000.	1.17474	1.14413	1.09523
19500.	1.17634	1.14657	1.09715
20000.	1.17682	1.14828	1.09880
20500.	1.17633	1.14920	1.10016
21000.	1.17506	1.14937	1.10120
21500.	1.17313	1.14884	1.10188
22000.	1.17066	1.14769	1.10219
22500.	1.16774	1.14597	1.10212
23000.	1.16444	1.14376	1.10165
23500.	1.16081	1.14116	1.10081
24000.	1.15691	1.13823	1.09964
24500.	1.15276	1.13505	1.09813
25000.	1.14843	1.13164	1.09631
25500.	1.14375	1.12804	1.09420
26000.	1.13907	1.12430	1.09183
26500.	1.13440	1.12043	1.08924
27000.	1.12972	1.11648	1.08646
27500.	1.12504	1.11237	1.08353
28000.	1.12035	1.10822	1.08048
28500.	1.11566	1.10407	1.07733
29000.	1.11097	1.09993	1.07409
29500.	1.10628	1.09578	1.07078
30000.	1.10159	1.09163	1.06743
30500.	1.09684	1.08753	1.06404
31000.	1.09209	1.08343	1.06062
31500.	1.08735	1.07933	1.05719
32500.	1.07785	1.07113	1.05017
35000.	1.05382	1.05065	1.03295
37500.	1.02951	1.03023	1.01610
40000.	1.00496	1.00986	0.99956
42500.	0.98023	0.98960	0.98336
45000.	0.95542	0.96949	0.96751
47500.	0.93066	0.94959	0.95205
50000.	0.90610	0.92997	0.93701
52500.	0.88194	0.91073	0.92242
55000.	0.85842	0.89196	0.90830
57500.	0.83575	0.87377	0.89471
60000.	0.81420	0.85627	0.88165
62500.	0.79399	0.83956	0.86917
65000.	0.77531	0.82374	0.85727
67500.	0.75835	0.80889	0.84599
70000.	0.74318	0.79509	0.83534

Table B.30 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.491	1.475	1.440
100.	1.490	1.475	1.438
500.	1.484	1.470	1.434
1000.	1.478	1.465	1.429
1500.	1.470	1.458	1.424
2000.	1.461	1.451	1.419
2500.	1.452	1.443	1.413
3000.	1.442	1.435	1.408
3500.	1.432	1.426	1.402
4000.	1.422	1.418	1.397
4500.	1.412	1.409	1.391
5000.	1.401	1.400	1.385
5500.	1.390	1.392	1.380
6000.	1.382	1.384	1.374
6500.	1.374	1.377	1.368
7000.	1.365	1.370	1.362
7500.	1.357	1.362	1.356
8000.	1.349	1.354	1.350
8500.	1.340	1.347	1.344
9000.	1.332	1.339	1.338
9500.	1.323	1.331	1.331
10000.	1.314	1.324	1.325
10500.	1.306	1.316	1.319
11000.	1.297	1.308	1.313
11500.	1.288	1.300	1.307
12000.	1.279	1.292	1.302
12500.	1.270	1.284	1.296
13000.	1.260	1.276	1.291
13500.	1.251	1.268	1.286
14000.	1.242	1.260	1.281
14500.	1.232	1.252	1.276
15000.	1.222	1.244	1.270
15500.	1.213	1.235	1.265
16000.	1.203	1.227	1.260
16500.	1.193	1.219	1.255
17000.	1.183	1.211	1.249
17500.	1.174	1.203	1.243
18000.	1.165	1.195	1.238
18500.	1.157	1.187	1.232
19000.	1.150	1.180	1.225
19500.	1.144	1.173	1.219
20000.	1.138	1.167	1.213
20500.	1.133	1.161	1.206
21000.	1.128	1.155	1.200
21500.	1.123	1.150	1.194
22000.	1.119	1.145	1.188
22500.	1.115	1.141	1.183
23000.	1.111	1.137	1.178
23500.	1.107	1.133	1.173
24000.	1.104	1.129	1.168
24500.	1.101	1.126	1.164
25000.	1.098	1.123	1.160
25500.	1.095	1.120	1.157
26000.	1.092	1.117	1.154
26500.	1.090	1.114	1.151
27000.	1.087	1.111	1.148
27500.	1.084	1.109	1.145
28000.	1.081	1.106	1.142
28500.	1.079	1.104	1.140
29000.	1.076	1.101	1.138
29500.	1.074	1.099	1.135
30000.	1.071	1.096	1.133
30500.	1.070	1.094	1.131
31000.	1.069	1.091	1.129
31500.	1.068	1.089	1.127
32500.	1.066	1.084	1.123
35000.	1.060	1.072	1.114
37500.	1.054	1.060	1.105
40000.	1.052	1.052	1.096
42500.	1.053	1.048	1.088
45000.	1.054	1.044	1.081
47500.	1.057	1.041	1.074
50000.	1.060	1.037	1.068
52500.	1.062	1.036	1.065
55000.	1.062	1.037	1.065
57500.	1.061	1.039	1.065
60000.	1.059	1.040	1.067
62500.	1.055	1.040	1.072
65000.	1.050	1.039	1.082
67500.	1.044	1.037	1.093
70000.	1.047	1.052	1.103

Table B.31 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.06503	1.04956	1.02975
100.	1.03909	1.02529	1.00792
500.	1.03572	1.02273	1.00620
1000.	1.03560	1.02325	1.00720
1500.	1.03684	1.02495	1.00906
2000.	1.03854	1.02702	1.01116
2500.	1.04034	1.02916	1.01325
3000.	1.04214	1.03122	1.01522
3500.	1.04400	1.03324	1.01708
4000.	1.04592	1.03527	1.01886
4500.	1.04792	1.03733	1.02061
5000.	1.05002	1.03943	1.02235
5500.	1.05224	1.04160	1.02408
6000.	1.05461	1.04385	1.02584
6500.	1.05715	1.04621	1.02765
7000.	1.05990	1.04873	1.02954
7500.	1.06286	1.05140	1.03151
8000.	1.06602	1.05423	1.03360
8500.	1.06935	1.05719	1.03577
9000.	1.07285	1.06028	1.03804
9500.	1.07649	1.06348	1.04038
10000.	1.08030	1.06680	1.04278
10500.	1.08427	1.07025	1.04524
11000.	1.08844	1.07383	1.04778
11500.	1.09282	1.07755	1.05038
12000.	1.09744	1.08143	1.05307
12500.	1.10232	1.08548	1.05583
13000.	1.10751	1.08970	1.05868
13500.	1.11304	1.09412	1.06162
14000.	1.11897	1.09877	1.06466
14500.	1.12535	1.10368	1.06780
15000.	1.13215	1.10887	1.07106
15500.	1.13922	1.11435	1.07442
16000.	1.14635	1.12003	1.07789
16500.	1.15322	1.12577	1.08142
17000.	1.15953	1.13141	1.08495
17500.	1.16501	1.13678	1.08844
18000.	1.16940	1.14163	1.09183
18500.	1.17263	1.14576	1.09506
19000.	1.17469	1.14904	1.09805
19500.	1.17567	1.15141	1.10070
20000.	1.17574	1.15282	1.10298
20500.	1.17505	1.15333	1.10484
21000.	1.17372	1.15302	1.10622
21500.	1.17179	1.15204	1.10711
22000.	1.16933	1.15051	1.10747
22500.	1.16641	1.14851	1.10732
23000.	1.16310	1.14609	1.10672
23500.	1.15943	1.14334	1.10568
24000.	1.15545	1.14029	1.10425
24500.	1.15120	1.13699	1.10245
25000.	1.14674	1.13346	1.10034
25500.	1.14189	1.12974	1.09794
26000.	1.13703	1.12587	1.09531
26500.	1.13218	1.12186	1.09250
27000.	1.12732	1.11777	1.08952
27500.	1.12247	1.11350	1.08642
28000.	1.11759	1.10919	1.08320
28500.	1.11271	1.10488	1.07989
29000.	1.10783	1.10056	1.07650
29500.	1.10295	1.09625	1.07306
30000.	1.09807	1.09194	1.06956
30500.	1.09310	1.08767	1.06604
31000.	1.08813	1.08340	1.06249
32500.	1.07322	1.07059	1.05156
35000.	1.04793	1.04917	1.03374
37500.	1.02220	1.02767	1.01621
40000.	0.99606	1.00612	0.99894
42500.	0.96960	0.98455	0.98194
45000.	0.94293	0.96303	0.96524
47500.	0.91623	0.94164	0.94888
50000.	0.88972	0.92047	0.93291
52500.	0.86364	0.89965	0.91735
55000.	0.83831	0.87930	0.90226
57500.	0.81403	0.85959	0.88769
60000.	0.79115	0.84065	0.87366
62500.	0.76995	0.82264	0.86023
65000.	0.75068	0.80569	0.84742
67500.	0.73350	0.78992	0.83529
70000.	0.71847	0.77542	0.82385

Table B.32 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.433	1.423	1.404
100.	1.432	1.423	1.401
500.	1.427	1.418	1.397
1000.	1.420	1.413	1.393
1500.	1.413	1.406	1.388
2000.	1.404	1.399	1.382
2500.	1.396	1.392	1.377
3000.	1.387	1.384	1.371
3500.	1.377	1.376	1.366
4000.	1.368	1.368	1.360
4500.	1.358	1.361	1.355
5000.	1.348	1.354	1.349
5500.	1.340	1.347	1.343
6000.	1.333	1.340	1.338
6500.	1.325	1.333	1.332
7000.	1.317	1.325	1.326
7500.	1.309	1.318	1.320
8000.	1.301	1.310	1.314
8500.	1.293	1.303	1.308
9000.	1.284	1.295	1.302
9500.	1.276	1.288	1.296
10000.	1.267	1.280	1.291
10500.	1.259	1.273	1.286
11000.	1.250	1.265	1.280
11500.	1.241	1.257	1.275
12000.	1.232	1.249	1.270
12500.	1.223	1.242	1.265
13000.	1.214	1.234	1.259
13500.	1.205	1.226	1.254
14000.	1.196	1.218	1.249
14500.	1.186	1.210	1.244
15000.	1.176	1.202	1.239
15500.	1.166	1.193	1.233
16000.	1.157	1.185	1.228
16500.	1.147	1.178	1.223
17000.	1.139	1.171	1.217
17500.	1.131	1.164	1.211
18000.	1.124	1.156	1.205
18500.	1.117	1.149	1.199
19000.	1.112	1.142	1.193
19500.	1.107	1.135	1.186
20000.	1.102	1.129	1.180
20500.	1.098	1.124	1.174
21000.	1.094	1.120	1.168
21500.	1.090	1.116	1.162
22000.	1.086	1.112	1.157
22500.	1.083	1.108	1.152
23000.	1.080	1.105	1.147
23500.	1.077	1.101	1.143
24000.	1.074	1.098	1.139
24500.	1.072	1.096	1.135
25000.	1.070	1.093	1.132
25500.	1.068	1.090	1.129
26000.	1.066	1.088	1.126
26500.	1.063	1.086	1.124
27000.	1.061	1.084	1.121
27500.	1.059	1.082	1.119
28000.	1.057	1.080	1.117
28500.	1.055	1.078	1.115
29000.	1.053	1.076	1.113
29500.	1.051	1.074	1.111
30000.	1.049	1.072	1.109
30500.	1.048	1.070	1.107
31000.	1.048	1.068	1.105
32500.	1.046	1.062	1.100
35000.	1.044	1.053	1.092
37500.	1.045	1.044	1.084
40000.	1.051	1.038	1.076
42500.	1.056	1.035	1.069
45000.	1.061	1.033	1.062
47500.	1.065	1.036	1.056
50000.	1.067	1.040	1.052
52500.	1.068	1.044	1.048
55000.	1.068	1.046	1.045
57500.	1.065	1.048	1.047
60000.	1.062	1.048	1.048
62500.	1.056	1.047	1.051
65000.	1.050	1.045	1.054
67500.	1.043	1.042	1.065
70000.	1.036	1.038	1.076

Table B.33 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.05139	1.03692	1.01740
100.	1.02563	1.01278	0.99569
500.	1.02244	1.01047	0.99434
1000.	1.02271	1.01149	0.99593
1500.	1.02438	1.01371	0.99838
2000.	1.02648	1.01628	1.00105
2500.	1.02865	1.01888	1.00366
3000.	1.03085	1.02140	1.00612
3500.	1.03312	1.02390	1.00845
4000.	1.03547	1.02643	1.01071
4500.	1.03794	1.02901	1.01295
5000.	1.04053	1.03165	1.01519
5500.	1.04328	1.03437	1.01743
6000.	1.04623	1.03723	1.01971
6500.	1.04941	1.04025	1.02205
7000.	1.05284	1.04346	1.02450
7500.	1.05652	1.04687	1.02707
8000.	1.06041	1.05043	1.02975
8500.	1.06449	1.05413	1.03252
9000.	1.06874	1.05795	1.03537
9500.	1.07319	1.06190	1.03830
10000.	1.07784	1.06600	1.04130
10500.	1.08273	1.07026	1.04437
11000.	1.08788	1.07469	1.04754
11500.	1.09332	1.07932	1.05079
12000.	1.09912	1.08415	1.05414
12500.	1.10530	1.08920	1.05759
13000.	1.11195	1.09450	1.06114
13500.	1.11910	1.10011	1.06481
14000.	1.12675	1.10605	1.06860
14500.	1.13471	1.11234	1.07252
15000.	1.14277	1.11889	1.07654
15500.	1.15049	1.12550	1.08064
16000.	1.15743	1.13198	1.08472
16500.	1.16332	1.13812	1.08875
17000.	1.16800	1.14366	1.09266
17500.	1.17140	1.14834	1.09637
18000.	1.17359	1.15199	1.09980
18500.	1.17468	1.15458	1.10286
19000.	1.17489	1.15610	1.10551
19500.	1.17437	1.15664	1.10771
20000.	1.17323	1.15633	1.10939
20500.	1.17150	1.15536	1.11051
21000.	1.16922	1.15384	1.11104
21500.	1.16642	1.15185	1.11102
22000.	1.16320	1.14944	1.11050
22500.	1.15961	1.14668	1.10951
23000.	1.15567	1.14361	1.10810
23500.	1.15142	1.14028	1.10629
24000.	1.14690	1.13671	1.10415
24500.	1.14217	1.13293	1.10172
25000.	1.13716	1.12897	1.09904
25500.	1.13201	1.12485	1.09617
26000.	1.12686	1.12061	1.09314
26500.	1.12170	1.11612	1.08997
27000.	1.11655	1.11163	1.08669
27500.	1.11140	1.10714	1.08331
28000.	1.10622	1.10266	1.07985
28500.	1.10104	1.09819	1.07632
29000.	1.09586	1.09371	1.07274
29500.	1.09068	1.08924	1.06912
30000.	1.08550	1.08476	1.06547
32500.	1.05911	1.06239	1.04686
35000.	1.03220	1.03993	1.02871
37500.	1.00483	1.01738	1.01081
40000.	0.97707	0.99478	0.99320
42500.	0.94906	0.97220	0.97589
45000.	0.92098	0.94973	0.95892
47500.	0.89308	0.92748	0.94235
50000.	0.86565	0.90557	0.92620
52500.	0.83904	0.88417	0.91055
55000.	0.81360	0.86344	0.89543
57500.	0.78972	0.84356	0.88089
60000.	0.76773	0.82471	0.86696
62500.	0.74788	0.80702	0.85369
65000.	0.73035	0.79063	0.84113
67500.	0.71517	0.77565	0.82930
70000.	0.70227	0.76212	0.81823

Table B.34 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.397	1.401	1.394
100.	1.396	1.400	1.394
500.	1.389	1.395	1.391
1000.	1.382	1.389	1.389
1500.	1.373	1.382	1.384
2000.	1.363	1.373	1.379
2500.	1.352	1.364	1.373
3000.	1.341	1.355	1.366
3500.	1.329	1.345	1.359
4000.	1.318	1.334	1.352
4500.	1.306	1.324	1.345
5000.	1.300	1.313	1.337
5500.	1.293	1.302	1.329
6000.	1.287	1.291	1.321
6500.	1.280	1.280	1.313
7000.	1.273	1.269	1.304
7500.	1.266	1.258	1.296
8000.	1.259	1.246	1.288
8500.	1.252	1.235	1.279
9000.	1.244	1.223	1.270
9500.	1.237	1.212	1.262
10000.	1.229	1.200	1.253
10500.	1.222	1.189	1.244
11000.	1.214	1.178	1.235
11500.	1.206	1.170	1.226
12000.	1.198	1.164	1.218
12500.	1.190	1.159	1.209
13000.	1.182	1.154	1.200
13500.	1.174	1.148	1.192
14000.	1.166	1.143	1.183
14500.	1.157	1.137	1.174
15000.	1.149	1.131	1.166
15500.	1.140	1.125	1.157
16000.	1.132	1.119	1.148
16500.	1.133	1.113	1.139
17000.	1.134	1.107	1.130
17500.	1.132	1.101	1.122
18000.	1.128	1.095	1.117
18500.	1.128	1.090	1.111
19000.	1.127	1.084	1.106
19500.	1.124	1.080	1.101
20000.	1.122	1.076	1.096
20500.	1.119	1.074	1.091
21000.	1.116	1.072	1.087
21500.	1.114	1.071	1.082
22000.	1.112	1.070	1.079
22500.	1.109	1.069	1.079
23000.	1.107	1.068	1.078
23500.	1.105	1.067	1.078
24000.	1.102	1.066	1.077
24500.	1.100	1.065	1.077
25000.	1.097	1.063	1.077
25500.	1.095	1.062	1.076
26000.	1.092	1.061	1.076
26500.	1.090	1.060	1.075
27000.	1.087	1.058	1.074
27500.	1.085	1.057	1.074
28000.	1.083	1.057	1.073
28500.	1.080	1.056	1.072
29000.	1.078	1.056	1.072
29500.	1.075	1.055	1.071
30000.	1.073	1.055	1.070
32500.	1.072	1.054	1.067
35000.	1.076	1.053	1.064
37500.	1.079	1.052	1.061
40000.	1.082	1.054	1.059
42500.	1.086	1.058	1.057
45000.	1.089	1.062	1.055
47500.	1.090	1.065	1.054
50000.	1.090	1.067	1.054
52500.	1.088	1.068	1.054
55000.	1.084	1.068	1.054
57500.	1.078	1.066	1.055
60000.	1.071	1.064	1.057
62500.	1.062	1.060	1.058
65000.	1.053	1.056	1.061
67500.	1.043	1.050	1.072
70000.	1.051	1.047	1.083

Table B.35 [ ] Hot Uncontrolled k_∞

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.07609	1.06566	1.05106
100.	1.05022	1.04133	1.02907
500.	1.04902	1.04085	1.02925
1000.	1.05236	1.04468	1.03310
1500.	1.05739	1.04998	1.03802
2000.	1.06284	1.05561	1.04310
2500.	1.06848	1.06130	1.04807
3000.	1.07437	1.06708	1.05293
3500.	1.08060	1.07304	1.05777
4000.	1.08728	1.07927	1.06267
4500.	1.09445	1.08583	1.06769
5000.	1.10211	1.09273	1.07286
5500.	1.11022	1.09992	1.07818
6000.	1.11878	1.10742	1.08364
6500.	1.12789	1.11523	1.08924
7000.	1.13763	1.12345	1.09503
7500.	1.14806	1.13209	1.10101
8000.	1.15921	1.14117	1.10721
8500.	1.17100	1.15067	1.11360
9000.	1.18321	1.16053	1.12016
9500.	1.19533	1.17059	1.12683
10000.	1.20676	1.18053	1.13351
10500.	1.21683	1.18990	1.14005
11000.	1.22514	1.19830	1.14631
11500.	1.23149	1.20539	1.15211
12000.	1.23593	1.21097	1.15730
12500.	1.23866	1.21495	1.16176
13000.	1.23993	1.21738	1.16536
13500.	1.23996	1.21841	1.16805
14000.	1.23891	1.21828	1.16984
14500.	1.23698	1.21718	1.17074
15000.	1.23432	1.21531	1.17083
15500.	1.23106	1.21283	1.17015
16000.	1.22732	1.20986	1.16882
16500.	1.22322	1.20649	1.16692
17000.	1.21884	1.20282	1.16455
17500.	1.21427	1.19890	1.16181
18000.	1.20956	1.19480	1.15879
18500.	1.20458	1.19057	1.15553
19000.	1.19960	1.18624	1.15210
19500.	1.19461	1.18186	1.14853
20000.	1.18963	1.17734	1.14485
20500.	1.18465	1.17280	1.14110
21000.	1.17968	1.16826	1.13729
21500.	1.17470	1.16373	1.13344
22000.	1.16973	1.15919	1.12957
22500.	1.16475	1.15465	1.12568
25000.	1.13957	1.13224	1.10606
27500.	1.11390	1.10978	1.08691
30000.	1.08773	1.08724	1.06804
32500.	1.06104	1.06460	1.04940
35000.	1.03383	1.04185	1.03102
37500.	1.00614	1.01902	1.01290
40000.	0.97807	0.99615	0.99506
42500.	0.94977	0.97330	0.97754
45000.	0.92142	0.95059	0.96038
47500.	0.89330	0.92811	0.94362
50000.	0.86571	0.90602	0.92732
52500.	0.83901	0.88448	0.91153
55000.	0.81357	0.86366	0.89630
57500.	0.78978	0.84375	0.88167
60000.	0.76795	0.82491	0.86769
62500.	0.74834	0.80731	0.85440
65000.	0.73109	0.79106	0.84185
67500.	0.71623	0.77625	0.83006
70000.	0.70365	0.76294	0.81904

Table B.36 [ ] Hot Uncontrolled LPF

Exposure MWd/MTU	0.00 Void History	0.40 Void History	0.80 Void History
0.	1.373	1.376	1.369
100.	1.371	1.375	1.368
500.	1.363	1.368	1.364
1000.	1.352	1.359	1.360
1500.	1.340	1.349	1.353
2000.	1.327	1.338	1.346
2500.	1.313	1.326	1.338
3000.	1.300	1.314	1.329
3500.	1.292	1.302	1.321
4000.	1.284	1.289	1.312
4500.	1.275	1.276	1.302
5000.	1.267	1.262	1.293
5500.	1.258	1.248	1.283
6000.	1.248	1.235	1.273
6500.	1.239	1.221	1.263
7000.	1.229	1.206	1.252
7500.	1.219	1.192	1.242
8000.	1.209	1.178	1.232
8500.	1.199	1.163	1.221
9000.	1.188	1.151	1.211
9500.	1.178	1.144	1.200
10000.	1.167	1.137	1.189
10500.	1.157	1.129	1.178
11000.	1.147	1.122	1.167
11500.	1.138	1.115	1.157
12000.	1.135	1.108	1.146
12500.	1.132	1.102	1.137
13000.	1.129	1.097	1.127
13500.	1.126	1.092	1.119
14000.	1.124	1.088	1.111
14500.	1.122	1.085	1.104
15000.	1.120	1.084	1.097
15500.	1.118	1.083	1.092
16000.	1.116	1.082	1.088
16500.	1.114	1.081	1.087
17000.	1.112	1.080	1.086
17500.	1.110	1.078	1.086
18000.	1.108	1.077	1.085
18500.	1.106	1.076	1.084
19000.	1.104	1.074	1.084
19500.	1.101	1.072	1.083
20000.	1.099	1.071	1.082
20500.	1.097	1.069	1.082
21000.	1.095	1.068	1.081
21500.	1.093	1.066	1.080
22000.	1.091	1.065	1.079
22500.	1.089	1.063	1.079
25000.	1.078	1.055	1.075
27500.	1.068	1.053	1.071
30000.	1.058	1.051	1.067
32500.	1.057	1.050	1.063
35000.	1.061	1.050	1.060
37500.	1.064	1.049	1.057
40000.	1.066	1.048	1.055
42500.	1.068	1.047	1.053
45000.	1.071	1.049	1.052
47500.	1.072	1.051	1.051
50000.	1.072	1.053	1.050
52500.	1.070	1.054	1.050
55000.	1.067	1.054	1.051
57500.	1.061	1.053	1.052
60000.	1.055	1.051	1.053
62500.	1.047	1.047	1.055
65000.	1.038	1.043	1.062
67500.	1.040	1.038	1.073
70000.	1.049	1.048	1.083

Appendix C Enriched Lattice Isotopic Data Tables

The results in this appendix are based on hot operating and equilibrium xenon conditions.

Table C.1 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.2 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.3 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.4 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.5 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.6 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.7 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.8 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.9 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.10 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.11 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.12 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.13 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.14 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[

]

Table C.15 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.16 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.17 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.18 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.19 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.20 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.21 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.22 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.23 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.24 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.25 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.26 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.27 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.28 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.29 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.30 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.31 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.32 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.33 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.34 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.35 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.36 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.37 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.38 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

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Table C.39 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.40 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.41 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.42 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.43 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.44 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.45 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.46 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[

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Table C.47 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.48 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.49 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.50 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.51 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Table C.52 [ ] Exposure-Dependent 0% Void Isotopics (kg/MTU Initial)

[ ]

Table C.53 [ ] Exposure-Dependent 40% Void Isotopics (kg/MTU Initial)

[ ]

Table C.54 [ ] Exposure-Dependent 80% Void Isotopics (kg/MTU Initial)

[ ]

Appendix D Lattice Enrichment Distribution Maps

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Figure D.1 [ ] Enrichment Distribution

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Figure D.2 [ ] Enrichment Distribution

[ ]

Figure D.3 [ ] Enrichment Distribution

[ ]

Figure D.4 [ ] Enrichment Distribution

Figure D.5 [ ] Enrichment Distribution

Figure D.6 [ ] Enrichment Distribution

[ ]

Figure D.7 [ ] Enrichment Distribution

Figure D.8 [ ] Enrichment Distribution

[

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Figure D.9 [ ] Enrichment Distribution

[ ]

Figure D.10 [ ] Enrichment Distribution

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Figure D.11 [ ] Enrichment Distribution

[

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Figure D.12 [ ] Enrichment Distribution

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Figure D.13 [ ] Enrichment Distribution

[ ]

Figure D.14 [ ] Enrichment Distribution

[

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Figure D.15 [ ] Enrichment Distribution

[ ]

Figure D.16 [ ] Enrichment Distribution

[ ]

Figure D.17 [ ] Enrichment Distribution

[ ]

Figure D.18 [ ] Enrichment Distribution

[

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Figure D.19 [ ] Enrichment Distribution

[ ]

Figure D.20 [ ] Enrichment Distribution

[

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Figure D.21 [ ] Enrichment Distribution

[

]

Figure D.22 [ ] Enrichment Distribution

[ ]

Figure D.23 [ ] Enrichment Distribution

[

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Figure D.24 [ ] Enrichment Distribution

[

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Figure D.25 [ ] Enrichment Distribution

[

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Figure D.26 [ ] Enrichment Distribution

[

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Figure D.27 [ ] Enrichment Distribution

Figure D.28 [ ] Enrichment Distribution

[

]

Figure D.29 [ ] Enrichment Distribution

[ ]

Figure D.30 [ ] Enrichment Distribution

[ ]

Figure D.31 [ ] Enrichment Distribution

Figure D.32 [ ] Enrichment Distribution

[ ]

Figure D.33 [ ] Enrichment Distribution

Affidavits for ANP-3808P, ANP-3791P, ANP-3759P, and ANP-3758P

AFFIDAVIT

1. My name is Alan B. Meginnis. I am Manager, Product Licensing, for Framatome Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by Framatome to determine whether certain Framatome information is proprietary. I am familiar with the policies established by Framatome to ensure the proper application of these criteria.

3. I am familiar with the Framatome information contained in the report ANP-3808P, Revision 0, "Brunswick Unit 1 Cycle 23 Reload Safety Analysis," dated October 2019 and referred to herein as "Document." Information contained in this Document has been classified by Framatome as proprietary in accordance with the policies established by Framatome for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by Framatome and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

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(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for Framatome.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for Framatome in product optimization or marketability.

(e) The information is vital to a competitive advantage held by Framatome, would be helpful to competitors to Framatome, and would likely cause substantial harm to the competitive position of Framatome.

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8. Framatome policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Alan Meginnis

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

SUBSCRIBED before me this 18 day of October, 2019.

Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/14/2020

SUSAN K McCOY
MY COMM. EXP. 1-14-2020
NOTARY PUBLIC
COMM. NO. 70009
STATE OF WASHINGTON

AFFIDAVIT

1. My name is Alan B. Meginnis. I am Manager, Product Licensing, for Framatome Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by Framatome to determine whether certain Framatome information is proprietary. I am familiar with the policies established by Framatome to ensure the proper application of these criteria.

3. I am familiar with the Framatome information contained in the report ANP-3791P, Revision 0, "ATRIUM 11 Fuel Rod Thermal-Mechanical Evaluation for Brunswick Unit 1 Cycle 23," dated October 2019 and referred to herein as "Document." Information contained in this Document has been classified by Framatome as proprietary in accordance with the policies established by Framatome for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by Framatome and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

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(a) The information reveals details of Framatome's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for Framatome.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for Framatome in product optimization or marketability.

(e) The information is vital to a competitive advantage held by Framatome, would be helpful to competitors to Framatome, and would likely cause substantial harm to the competitive position of Framatome.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b), 6(d) and 6(e) above.

7. In accordance with Framatome's policies governing the protection and control of information, proprietary information contained in this Document have been made available, on a limited basis, to others outside Framatome only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. Framatome policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Alan Meginnis

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

SUBSCRIBED before me this 17th day of October, 2019.

Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/14/2020

SUSAN K McCOY
MY COMM. EXP. 1-14-2020
NOTARY PUBLIC
COMM. NO. 70009
STATE OF WASHINGTON

AFFIDAVIT

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2. I am familiar with the criteria applied by Framatome to determine whether certain Framatome information is proprietary. I am familiar with the policies established by Framatome to ensure the proper application of these criteria.

3. I am familiar with the Framatome information contained in the report ANP-3759P, Revision 2, "Brunswick Unit 1 Cycle 23 Fuel Cycle Design Report," dated October 2019 and referred to herein as "Document." Information contained in this Document has been classified by Framatome as proprietary in accordance with the policies established by Framatome for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by Framatome and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by Framatome to determine whether information should be classified as proprietary:

(a) The information reveals details of Framatome's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for Framatome.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for Framatome in product optimization or marketability.

(e) The information is vital to a competitive advantage held by Framatome, would be helpful to competitors to Framatome, and would likely cause substantial harm to the competitive position of Framatome.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b), 6(d) and 6(e) above.

7. In accordance with Framatome's policies governing the protection and control of information, proprietary information contained in this Document have been made available, on a limited basis, to others outside Framatome only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. Framatome policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Alan Meginnis

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

SUBSCRIBED before me this 4th day of October, 2019.

Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/14/2020

SUSAN K McCOY
MY COMM. EXP. 1-14-2020
NOTARY PUBLIC
COMM. NO. 70009
STATE OF WASHINGTON

A F F I D A V I T

1. My name is Alan B. Meginnis. I am Manager, Product Licensing, for Framatome Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by Framatome to determine whether certain Framatome information is proprietary. I am familiar with the policies established by Framatome to ensure the proper application of these criteria.

3. I am familiar with the Framatome information contained in the report ANP-3758P, Revision 1, "Brunswick Unit 1 Cycle 23 ATRIUM 11 Fuel Nuclear Fuel Design Report," dated September 2019 and referred to herein as "Document." Information contained in this Document has been classified by Framatome as proprietary in accordance with the policies established by Framatome for the control and protection of proprietary and confidential information.

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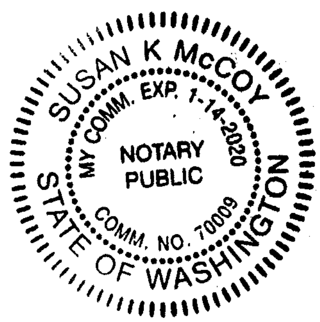
9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Alan Meginnis

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

SUBSCRIBED before me this 16th day of September, 2019.



Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/14/2020