Entergy

Entergy Operations, Inc.
P.O. Box 756
Port Gibson, Mississippi 39150

Eric A. Larson
Site Vice President
Grand Gulf Nuclear Station
Tel: 601-437-7500

GNRO-2020/00020

May 5, 2020

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

SUBJECT: Core Operating Limits Report (COLR) Cycle 23, and Pressure and Temperature Limits Report (PTLR) Update for Grand Gulf Nuclear Station, Unit 1 (GGNS)

Grand Gulf Nuclear Station, Unit 1
Docket No. 50-416
Renewed License No. NPF-29

Dear Sir or Madam:

In accordance with 10 CFR 50.36 GGNS is required to provide to the Nuclear Regulatory Commission (NRC) any updates to the COLR and PTLR. Specifically, GGNS is required to inform the NRC under Technical Specification Sections 5.6.5.d and 5.6.6.c respectfully. The Updated GGNS Cycle 23 COLR and PTLR are attached to this letter.

This letter contains no new Regulatory Commitments. Should you have any questions concerning the content of this letter, please contact Jim Shaw, Manager Regulatory Assurance at 601-437-2103.

Sincerely,

Eric A. Larson
EAL/fas

Attachments: 1, Core Operating Limits Report (COLR) Cycle 23
2, Pressure and Temperature Limits Report (PTLR)

cc: NRC Senior Resident Inspector
Grand Gulf Nuclear Station
Port Gibson, MS 39150

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

U. S. Nuclear Regulatory Commission
ATTN: Ms. Jennifer Bridges
1600 East Lamar Boulevard
Arlington, TX 76011-4511

Attachment 1
Core Operating Limits Report (COLR) Cycle 23

Grand Gulf Nuclear Station

Core Operating Limits Report

Cycle 23

Revision 0

CORE OPERATING LIMITS REPORT

REASON FOR REVISION

The Cycle 23 core operating limits are updated to provide cycle-specific MCPR and LHGRFAC multiplier values for the GNF2 and GNF3 fuel type. Figure 1-1 and 1-2 provides the APLHGR limits for the GNF2 and GNF3 fuel types, respectively. Figures 2-1 through 2-9 are updated with new MCPR limits and Figures 3-1 through 3-7 are updated with new LHGRFAC limits. No other core operating limits are changed. These limits are based on a core power of 4408 MWt.

TABLE OF CONTENTS

CORE OPERATING LIMITS REPORT

1.0 PURPOSE

The COLR is controlled as a License Basis Document and revised accordingly for each fuel cycle or remaining portion of a fuel cycle. Any revisions to the COLR must be submitted to the NRC for information as required by Tech Spec 5.6.5 and tracked by Licensing Commitment 29132. This COLR reports the Cycle 23 core operating limits and stability setpoint confirmation and regions.

2.0 SCOPE

As defined in Technical Specification 1.1, the COLR is the GGNS document that provides the core operating limits for the current fuel cycle. This document is prepared in accordance with Technical Specification 5.6.5 for each reload cycle using NRC-approved analytical methods.

The Cycle 23 core operating and stability limits included in this report are:

- the Average Planar Linear Heat Generation Rate (APLHGR),
- the Minimum Critical Power Ratio (MCPR) (including EOC-RPT inoperable),
- the Linear Heat Generation Rate (LHGR) limit, and
- the DSS-CD stability setpoint confirmation and regions.

3.0 REFERENCES

This section contains the cycle-specific references used in the safety analysis of Grand Gulf Cycle 23.

Methodology references are documented in Technical Specification 5.6.5b

3.1 Current Cycle References

3.1.1 ECH-NE-20-00009 Revision 0, Supplemental Reload Licensing Report for Grand Gulf-1 Reload 22 Cycle 23, dated February 2020.

3.1.2 ECH-NE-10-00021 Revision 5, GNF2 Fuel Design Cycle-Independent Analyses for Entergy Grand Gulf Nuclear Station, dated February 2020.

3.1.3 ECH-NE-20-00010 Revision 0, Fuel Bundle Information Report for Grand Gulf-1 Reload 22 Cycle 23, dated November 2019.

3.1.4 NEDC-32910P, Revision 1, Grand Gulf Nuclear Station SAFER/GESTR-LOCA Accident Analysis With Relaxed ECCS Parameters, dated October 1999.

3.1.5 GGNS-NE-12-00022 Revision 0, Grand Gulf Nuclear Station MELLLA+ Task T0407, ECCS-LOCA Performance, dated September 2012.

3.1.6 GGNS-SA-09-00002 Revision 1, Grand Gulf Nuclear Station GNF2 ECCS-LOCA Evaluation, dated December 2009.

3.1.7 NEDC-33173P-A, Revision5, Applicability of GE Methods to Expanded Operating Domains (with Supplements 5P-A Rev. 1, and 6P-A Rev. 1), dated October 2019

3.1.8 NEDC-33006P-A, Revision 3, GE BWR Maximum Extended Load Line Limit Analysis Plus, dated June 2009

3.1.9 ECH-NE-20-00012, Revision 1, GGNS Cycle 23 GESTAR Assessment, dated March 2020.

3.1.10 ECH-NE-20-00006 Revision 0, GNF3 Fuel Design Cycle-Independent Analyses for Grand Gulf Nuclear Station, dated February 2020.

3.1.11 GGNS-SA-19-00002 Revision 0 Grand Gulf Nuclear Station GNF3 ECCS-LOCA Evaluation Revision 1, dated October 2019

3.1.12 GEH-GGNS-AEP-632, GGNS MELLLA+ Final DSS-CD Settings Report, dated October 23, 2013.

3.1.13 NEDE-24011-P-A-29, General Electric Standard Application for Reactor Fuel (GESTAR-II), dated October 2019, (KGO-ENO-GEN-19-087).

3.1.14 Not Used.

3.1.15 NEDO-33612-A, Revision 0, Safety Analysis Report for GGNS Maximum Extended Load Line Limit Analysis Plus, September 2013.

3.1.16 NEDC-33292P, Revision 3, GEXL17 Correlation for GNF2 Fuel, June 2009 (RA-ENO-GEN-10-034).

3.1.17 NEDC-33880P, Revision 1, GEXL21 Correlation for GNF3 Fuel, November 2017 (KGO-ENO-GEN-20-031).

3.1.18 NEDC-33840P-A, Revision 1, The PRIME Model for Transient Analysis of Fuel Rod Thermal - Mechanical Performance, August 2017.

3.1.19 GGNS-NE-10-00076, Revision 0 (GEH 0000-012101122-R0), GGNS EPU Option°B Scram Times, dated September 2010.

3.1.20 NEDC-33270P, Revision 9, GNF2 Advantage Generic Compliance with NEDE-24011-P-A (GESTAR II), Dec 2017. (KGO-ENO-JB1-18-068).

3.1.21 NEDC-33879P, Revision 2, GNF3 Generic Compliance with NEDE-24011-P-A (GESTAR II), March 2018. (CIN2018-00052).

CORE OPERATING LIMITS REPORT

4.0 DEFINITIONS

4.1 Average Planar Linear Heat Generation Rate (APLHGR) - the APLHGR shall be applicable to a specific planar height and is equal to the sum of the linear heat generation rates for all the fuel rods in the specified bundle at the specified height divided by the number of fuel rods in the fuel bundle at the specified height.

4.2 Average Planar Exposure - the Average Planar Exposure shall be applicable to a specific planar height and is equal to the sum of the exposure of all the fuel rods in the specified bundle at the specified height divided by the number of fuel rods in the fuel bundle at the specified height.

4.3 Critical Power Ratio (CPR) - the ratio of that power in the assembly, which is calculated by application of the fuel vendor's appropriate boiling correlation, to cause some point in the assembly to experience boiling transition, divided by the actual assembly operating power.

4.4 Core Operating Limits Report (COLR) - The Grand Gulf Nuclear Station specific document that provides core operating limits for the current reload cycle in accordance with Technical Specification 5.6.5.

4.5 Linear Heat Generation Rate (LHGR) - the LHGR shall be the heat generation per unit length of fuel rod. It is the integral of the heat flux over the heat transfer area associated with the unit length.

4.6 Minimum Critical Power Ratio (MCPR) - the MCPR shall be the smallest CPR which exists in the core.

4.7 MCPR Safety Limit - cycle specific SLMCPR, known as $MCPR_{99.9\%}$, is the minimum value of the CPR at which the fuel could be operated to ensure that 99.9% percent of the fuel in the core is not susceptible to the boiling transition.

4.8 Oscillation Power Range Monitor (OPRM) - Provides automatic detection and suppression of reactor core thermal-hydraulic instabilities through monitoring neutron flux changes.

4.9 Backup Stability Protection (BSP) Scram Region - The area of the core power and flow operating domain where the reactor is susceptible to reactor instabilities under conditions exceeding the licensing basis of the current reactor system. An immediate manual scram is required upon entry.

4.10 Backup Stability Protection (BSP) Controlled Entry Region - The area of the core power and flow operating domain where the reactor is susceptible to reactor instabilities. Compliance with at least one alternate stability control is required upon entry.

4.11 Automated Backup Stability Protection (ABSP) Scram Region - An automated reactor scram region that bounds the BSP Scram Region and is initiated by the APRM flow-biased scram setpoint upon entry.

4.12 End of Rated (EOR) - The Cycle exposure corresponding to all rods out, 100% power, 100% flow, and normal feedwater temperature [3.1.1].

4.13 Middle of Cycle (MOC) - The Cycle 23 MOC Core Average Exposure (CAE) is MOC = EOR-2,862 MWd/ST [3.1.1].

4.14 End of Cycle (EOC) - The Cycle 23 EOC CAE is 30,594 MWd/ST [3.1.1].

4.15 Maximum Extended Load Line Limit Analysis Plus (MELLLA+) - The GGNS MELLLA+ operating domain is depicted in Figure 4.

4.16 Maximum Number of OPRM Cells Along an Instability Symmetry Axis (M_{AX}) - An OPRM configuration constant representing maximum number of OPRM cells along an instability symmetry axis. It is used to calculate the number of unresponsive OPRM cells. Per [3.1.12] the GGNS specific value is five (M_{AX} = 5).

4.17 Application Conditions - The combination of equipment out of service conditions for which LHGRFAC and MCPR limits are determined [3.1.1]. The Application Conditions are specified in Table 6.

4.18 $MCPR_{95/95}$ Safety Limit - Cycle-independent Technical Specification (TS) 2.1.1 ~~SLMCPR,~~ ensures there is a 95 percent probability at a 95 percent confidence level that no fuel rods will be susceptible to transition boiling.

5.0 GENERAL REQUIREMENTS

5.1 Average Planar Linear Heat Generation Rates

Consistent with Technical Specification 3.2.1, all APLHGRs shall not exceed the fuel type and exposure-dependent limits reported in Figures 1-1 and 1-2 [3.1.1].

5.2 Minimum Critical Power Ratio

For Cycle 23, the cycle-specific MCPR Safety Limit ($MCPR_{99.9\%}$), is 1.12 for Two Loop Operation (TLO), and 1.12 for Single Loop Operation (SLO) [3.1.1].

Consistent with Technical Specification 3.2.2, the MCPR shall be equal to or greater than the limits reported in Figure(s) 2 as functions of power, flow, exposure, and scram speed. [3.1.1, 3.1.2, 3.1.10, 3.1.19]. For operation at powers ≥35.4%, the power-dependent MCPR shall be determined based on scram time surveillance data as follows. [3.1.19]

1) If the average scram time (τ_{AVE}) satisfies the following:

$$\tau_{AVE} \leq \tau_B ,$$

then the power dependent MCPR shall be equal to or greater than the Option B limits reported in Figure(s) 2 as a function of exposure.

2) If the average scram time

$$\tau_{AVE} > \tau_B \text{ and } \tau \leq 0.2 ,$$

then the power-dependent MCPR shall be equal to or greater than the Tau = 0.2 limits reported in Figure(s) 2 as a function of exposure,

3) If the average scram time

$$\tau_{AVE} > \tau_B \text{ and } \tau > 0.2 ,$$

then the power-dependent MCPR shall be equal to or greater than the Option A limits reported in Figure(s) 2 as a function of exposure.

In the above equations:

τ_{AVE} = average scram time to the 20% insertion position as calculated by equation 1 of Reference 3.1.19,

τ_B = adjusted analysis mean scram time for 20% insertion as calculated by equation 3 of Reference 3.1.19

and

$$\tau = \frac{\tau_{AVE} - \tau_B}{\tau_A - \tau_B} ,$$

where

τ_A = the technical specification limit on core average scram time to the 20 percent insertion position (0.503 seconds).

The limits determined above support operation with Turbine Bypass Valves Out of Service as described in Technical Specification 3.7.7. Additional MCPR operating limits are provided to support operation with EOC-RPT inoperable as described in Technical Specification 3.3.4.1.

5.3 Linear Heat Generation Rate

Consistent with Technical Specification 3.2.3, the LHGRs for any GNF2 or GNF3 fuel rod at any axial location shall not exceed the nodal exposure-dependent limits reported in Reference 3.1.3 (by reference reported in [3.1.20] for GNF2 and [3.1.21] for GNF3) multiplied by the smaller of either the power-dependent or flow-dependent LHGR factors reported in Figures 3-1 through 3-6 and 3-7, respectively [3.1.1]. The limits determined above support operation with Turbine Bypass Valves Out of Service as described in Technical Specification 3.7.7.

5.4 Stability

The OPRM Upscale Confirmation Density Algorithm (CDA) Amplitude Discriminator setpoint is reported in Table 1.

The Backup Stability Protection (BSP) regions boundaries are reported in Figures 4 and 5 [3.1.1]. BSP measures support operation with the OPRM upscale trip function inoperable as described in Technical Specification 3.3.1.1 Condition J. The endpoints for the BSP region boundaries are provided for normal (NFWT) and reduced (RFWT) feedwater temperature operations in Tables 2 and 3, respectively. Figures 4 and 5 depict the BSP region boundaries for NFWT and RFWT operations. Note that Figures 4 and 5 also depict the MELLLA+ and MELLLA domains, consistent with feedwater temperature operating limitations.

The ABSP APRM Simulated Thermal Power (STP) setpoints associated with the ABSP Scram Region are provided in Table 4. The ABSP setpoints are applicable to TLO and SLO, and to both normal and reduced feedwater temperature operations.

The BSP Boundary and Manual BSP region boundaries for normal feedwater temperature operations are valid for reductions in normal feedwater temperature as much as (and including) -10.0 °F.

5.5 Applicability

The following core operating limits are applicable for operation in the Maximum Extended Operating Domain (MEOD), with Feedwater Heaters Out of Service (FWHOOS), Turbine Bypass Out of Service (TBVOOS), EOC-RPT inoperable, and Pressure Regulator Out of Service (PROOS). For operation with one of the previous conditions mentioned, the alternate MCPR limits described in Section 5.2 above must be implemented. Table 6 provides an applicability condition list of events related to the Figures. For SLO, the following additional requirements must be satisfied.

1. THE APLHGRs shall not exceed the exposure-dependent limits determined in accordance with Section 5.1 reduced by a 0.83 SLO multiplier for GNF2 fuel bundles, and reduced by a 0.90 SLO multiplier for GNF3 fuel bundles. [3.1.1].

2. THE LHGRs shall not exceed the smaller of the nodal exposure-dependent limits determined in accordance with Section 5.3 above or the nodal

exposure-dependent limits reported in Reference 3.1.3. During SLO operation the SLO values will be used from Figures 3-7 [3.1.1].

3. The MCPR shall be equal to or greater than the limits determined in accordance with Section 5.2 above increased by 0.00 to account for the difference between the two-loop and single-loop MCPR safety limits for the allowable range of single-loop operation [3.1.1].

5.6 Limitations and Conditions

As required by Limitation and Condition 9.10/9.11 of licensing topical report NEDC-33173P-A [3.1.7], the limiting Thermal and Mechanical Overpower results are reported in Table 5. The results are summarized as a percent margin to both of these limits. The results are confirmed to meet the required 10% margin to the design limits [3.1.1].

As required by Limitation and Condition 12.10.b of licensing topical report NEDC-33006P-A [3.1.8], the off-rated limits assumed in the ECCS-LOCA analyses are confirmed to be consistent with the off-rated LHGR multipliers provided Figures 3-1 through 3-7. These off-rated LHGR multipliers provide adequate protection for MELLLA+ operation.

As required by Limitation and Condition 12.5.c of licensing topical report NEDC-33006P-A [3.1.8], the plant specific power/flow map specifying the GGNS licensed MELLLA+ operating domain is included as Figure 4.

As required by Limitation and Condition 12.5.b of licensing topical report NEDC-33006P-A [3.1.8], operation with Feedwater Heaters Out of Service (FWHOOS) is prohibited while in the MELLLA+ operating domain [3.1.1]. In addition, as required by Limitation and Condition 12.5.a of licensing topical report NEDC-33006P-A [3.1.8], and described in GGNS TS 3.4.1 LCO, SLO is prohibited in the MELLLA+ operating domain [3.1.1].Therefore, operations with RFWT and/or SLO must adhere to the operating domain shown in Figure 5.

Table 1
OPRM Upscale CDA Amplitude Discriminator Setpoint

Amplitude Discriminator Trip
1.10

Table 2
BSP Endpoints for Normal Feedwater Temperature

Endpoint	Power(%)	Flow(%)	Definition
A1	72.3	44.2	Scram Region Boundary, HFCL
B1	34.2	25.2	Scram Region Boundary, NCL
A2	67.3	50.0	Controlled Entry Region Boundary, HFCL
B2	26.4	24.4	Controlled Entry Region Boundary, NCL

Table 3
BSP Endpoints for Reduced Feedwater Temperature

Endpoint	Power(%)	Flow(%)	Definition
A1'	65.9	48.3	Scram Region Boundary, HFCL
B1'	28.5	24.6	Scram Region Boundary, NCL
A2'	68.8	51.8	Controlled Entry Region Boundary, HFCL
B2'	26.4	24.4	Controlled Entry Region Boundary, NCL

Table 4
ABSP Setpoints for the Scram Region

Parameter	Symbol	Value
Slope of ABSP APRM flow-biased trip linear segment	m_{TRIP}	0.77
ABSP APRM flow-biased trip setpoint power intercept. Constant Power Line for Trip from zero Drive Flow to Flow Breakpoint.	$P_{BSP-TRIP}$	31.0% RTP[1]
ABSP APRM flow-biased trip setpoint drive flow intercept. Constant Flow Line for Trip.	$W_{BSP-TRIP}$	39.0% RDF[2]
Flow Breakpoint value	$W_{BSP-BREAK}$	7.5% RDF[2]

1. RTP - Rated Thermal Power 2. RDF - Recirculation Drive Flow

Table 5
Margin to Thermal Overpower and Mechanical Overpower Limits

Criteria	GNF3	GNF2
Thermal Overpower Margin	54.74%	51.02%
Mechanical Overpower Margin	55.03%	55.03%

Table 6
Application Conditions

Application Condition	FWH OOS	EOC-RPT	PROOS	TBVOOS
1*				X
2*	X			X
3		X		X
4	X	X		X
5			X	X
6*	X		X	X
7		X	X	X
8*	X	X	X	X

* These are the limiting conditions evaluated in [3.1.1] and the only ones monitored.

CORE OPERATING LIMITS REPORT

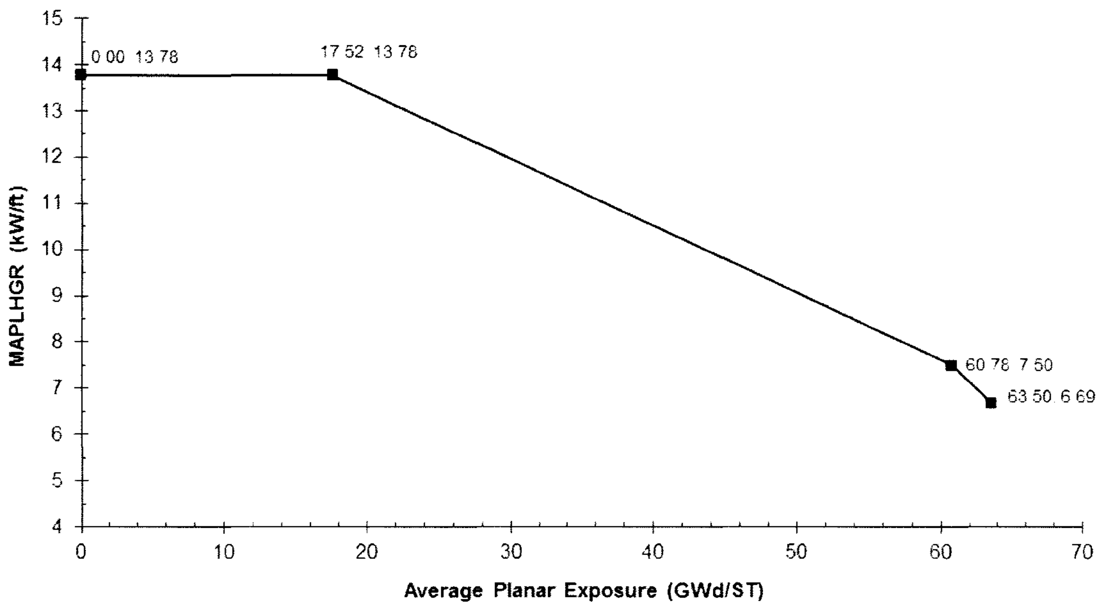

Figure 1-1
GNF2 Maximum Average Planar Linear Heat Generation Rate
Note: Actual Limits described in Sections 5.1 and 5.5

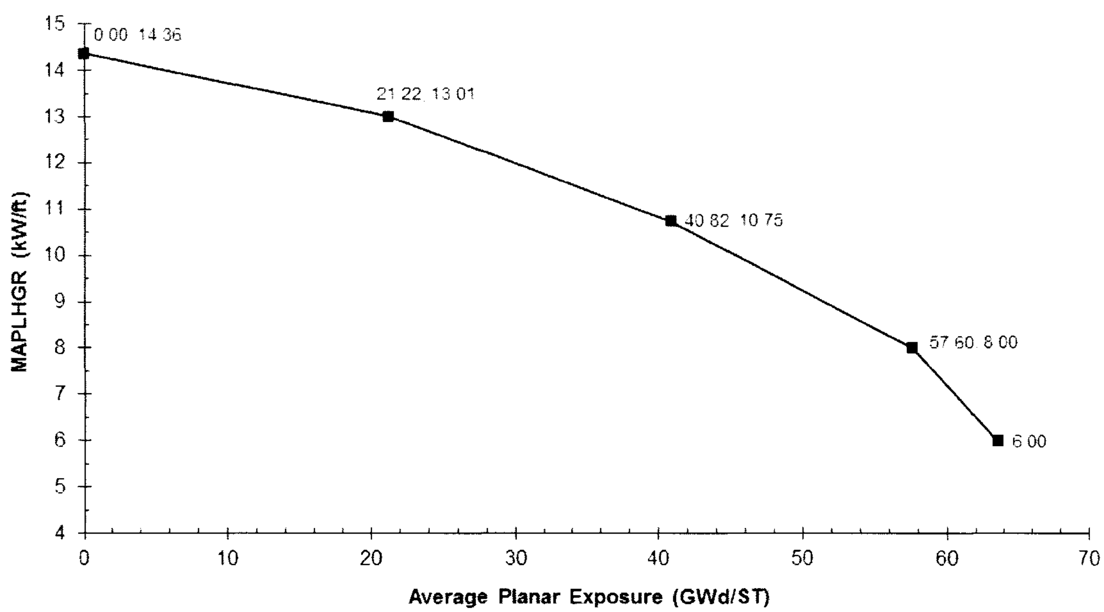

Figure 1-2
GNF3 Maximum Average Planar Linear Heat Generation Rate
Note: Actual Limits described in Sections 5.1 and 5.5

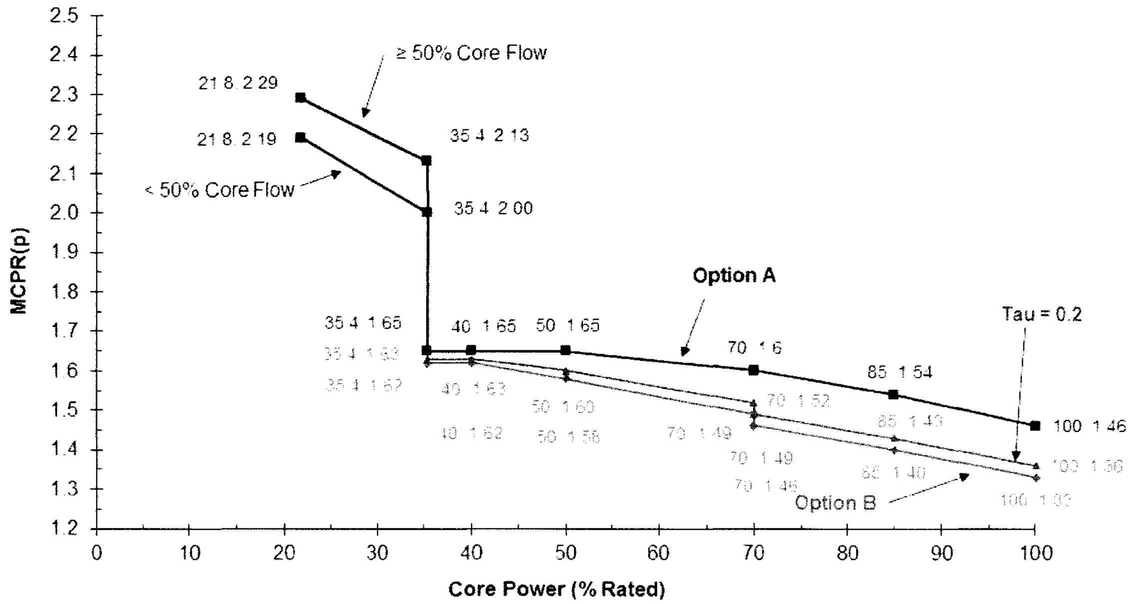

Figure 2-1A
Cycle 23 GNF2 Power-Dependent MCPR Limits, EIS
BOC to MOC

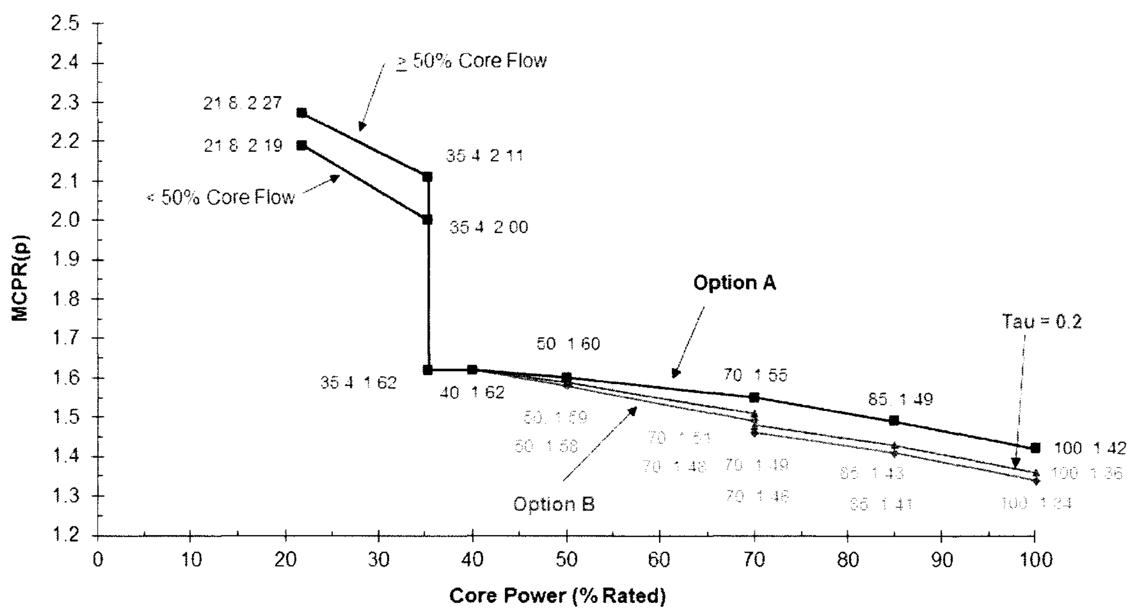

Figure 2-1B
Cycle 23 GNF3 Power-Dependent MCPR Limits, EIS
BOC to MOC

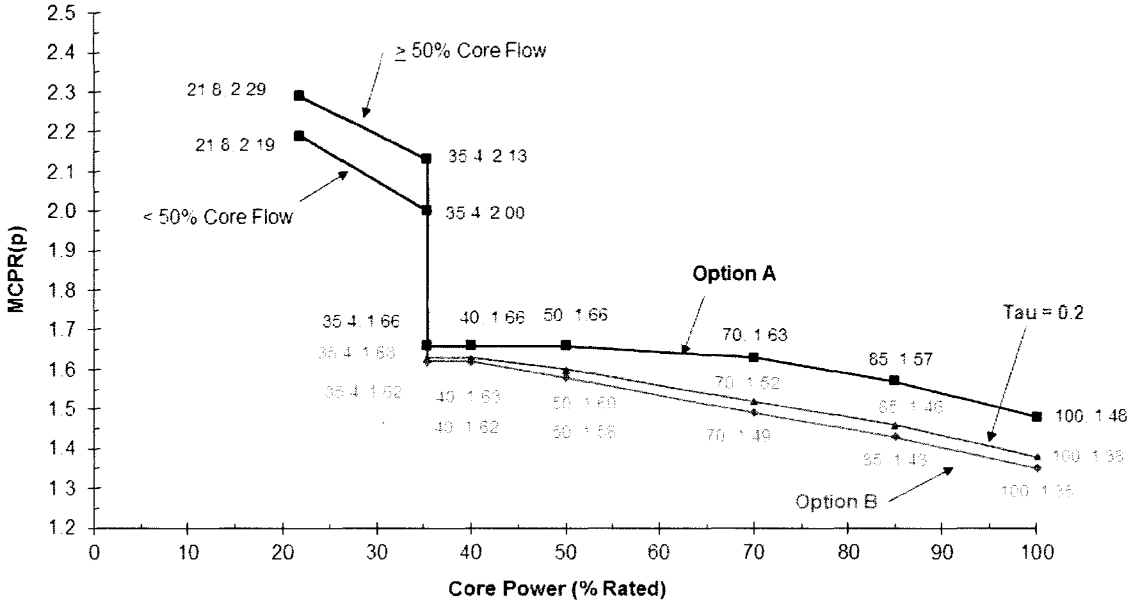

Figure 2-2A
Cycle 23 GNF2 Power-Dependent MCPR Limits with FWH OOS
BOC to MOC

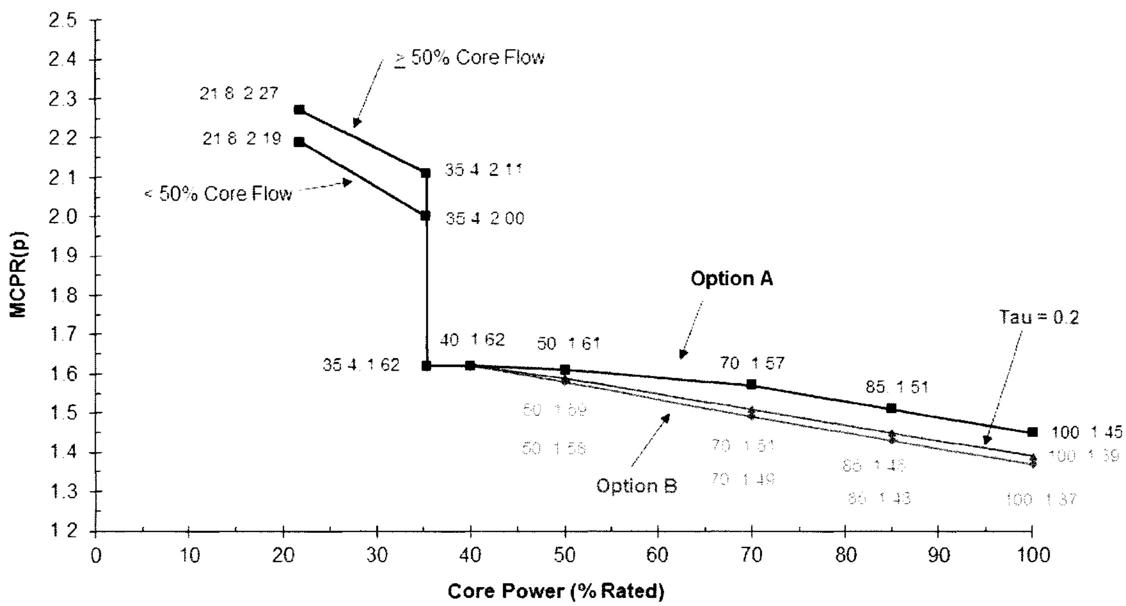

Figure 2-2B
Cycle 23 GNF3 Power-Dependent MCPR Limits with FWH OOS
BOC to MOC

CORE OPERATING LIMITS REPORT

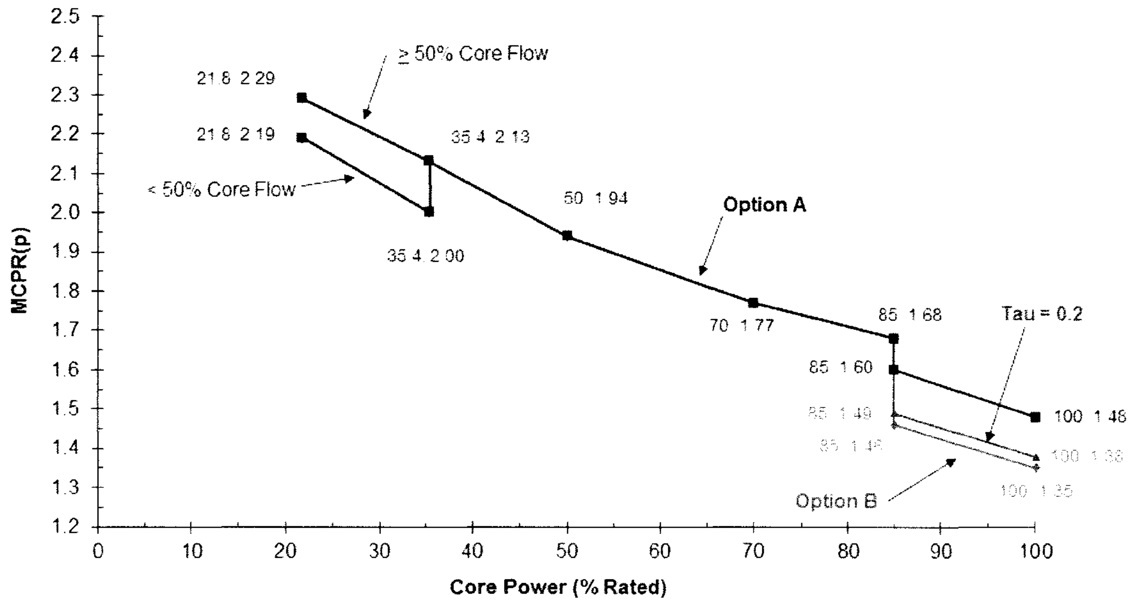

Figure 2-3A
Cycle 23 GNF2 Power-Dependent MCPR Limits with PR+FWH OOS
BOC to MOC

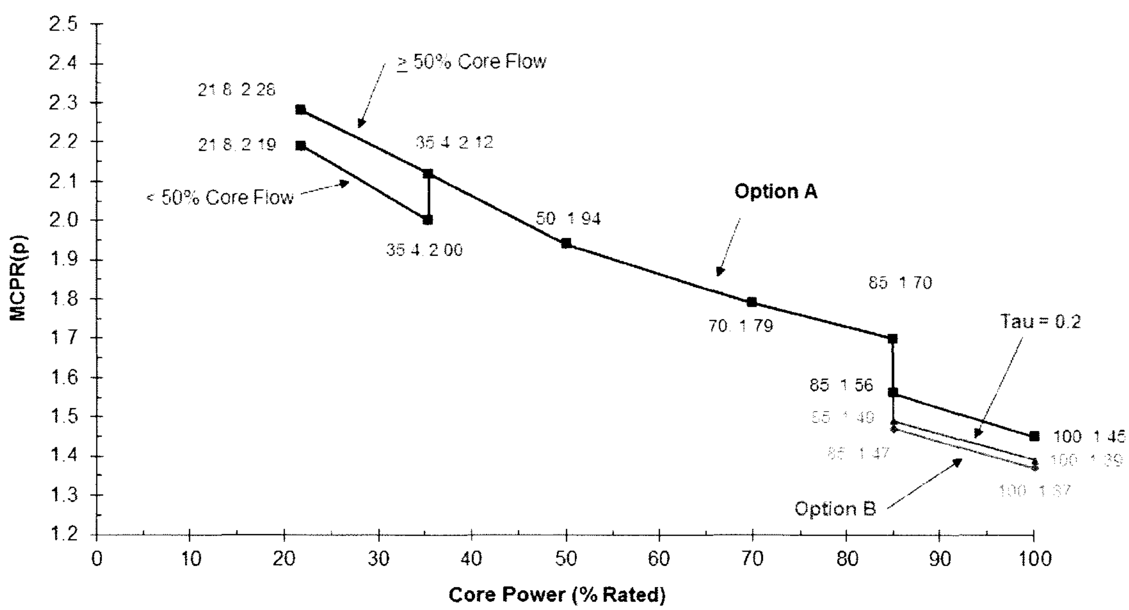

Figure 2-3B
Cycle 23 GNF3 Power-Dependent MCPR Limits with PR+FWH OOS
BOC to MOC

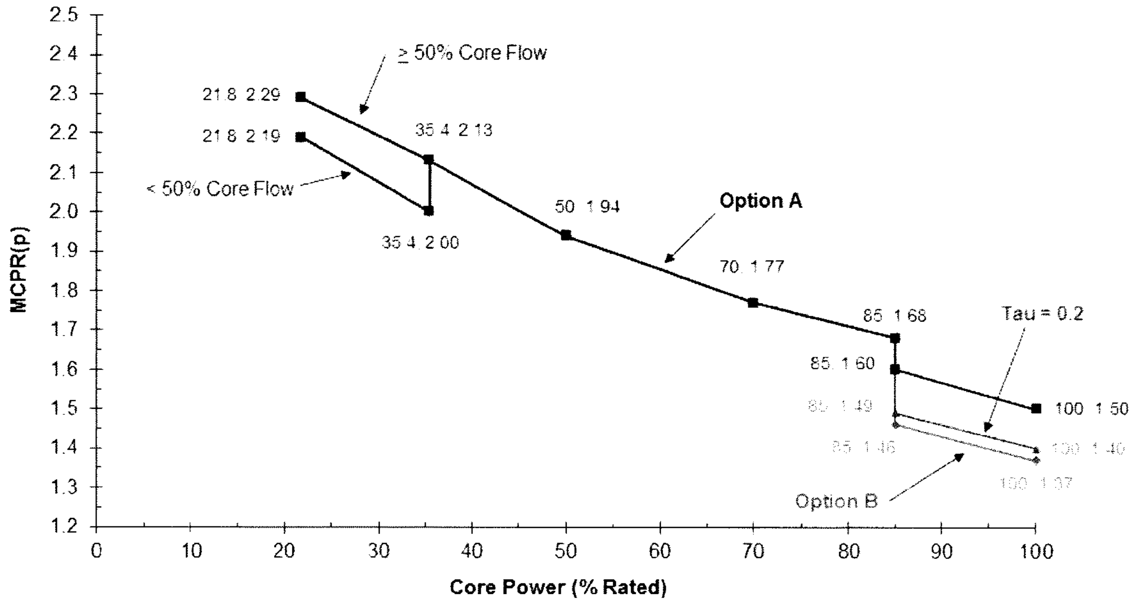

Figure 2-4A
Cycle 23 GNF2 Power-Dependent MCPR Limits with PR+EOC-RPT+FWH OOS
BOC to MOC

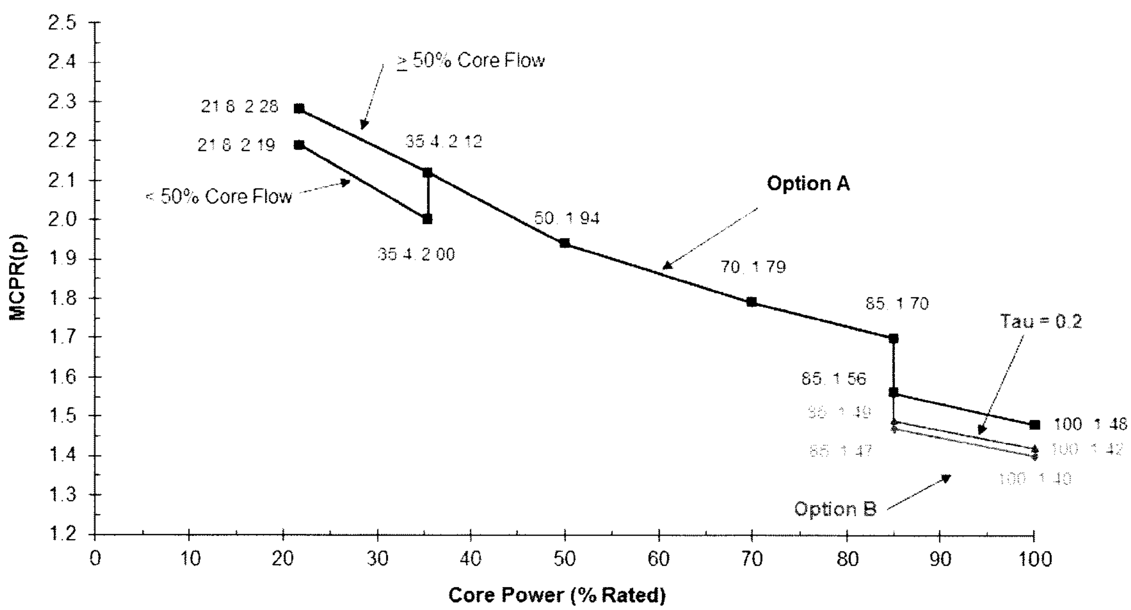

Figure 2-4B
Cycle 23 GNF3 Power-Dependent MCPR Limits with PR+EOC-RPT+FWH OOS
BOC to MOC

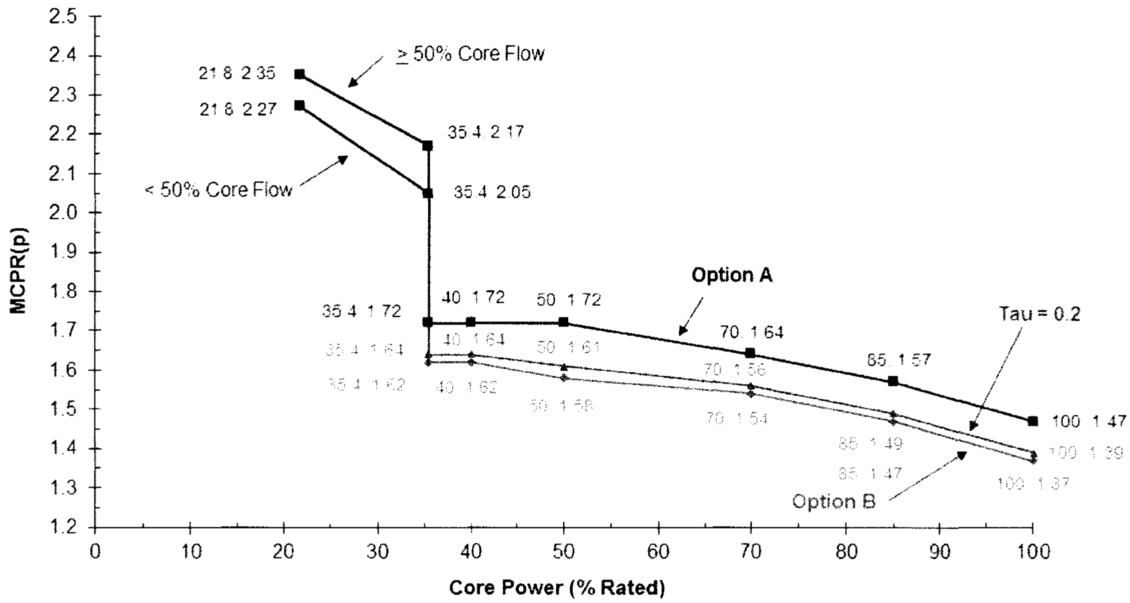

Figure 2-5A
Cycle 23 GNF2 Power-Dependent MCPR Limits, EIS
MOC to EOC

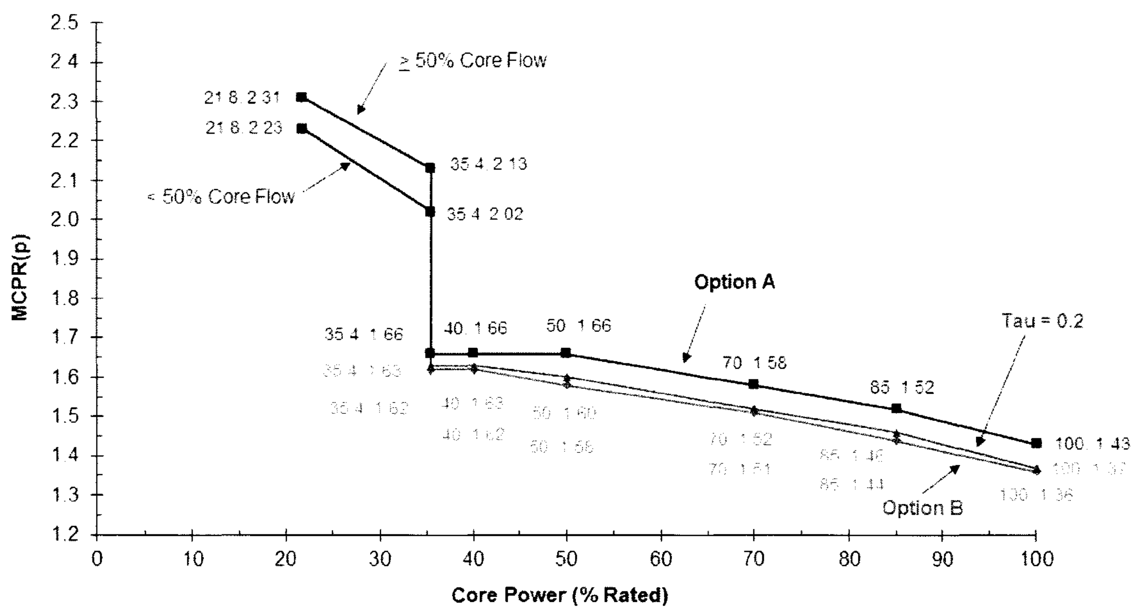

Figure 2-5B
Cycle 23 GNF3 Power-Dependent MCPR Limits, EIS
MOC to EOC

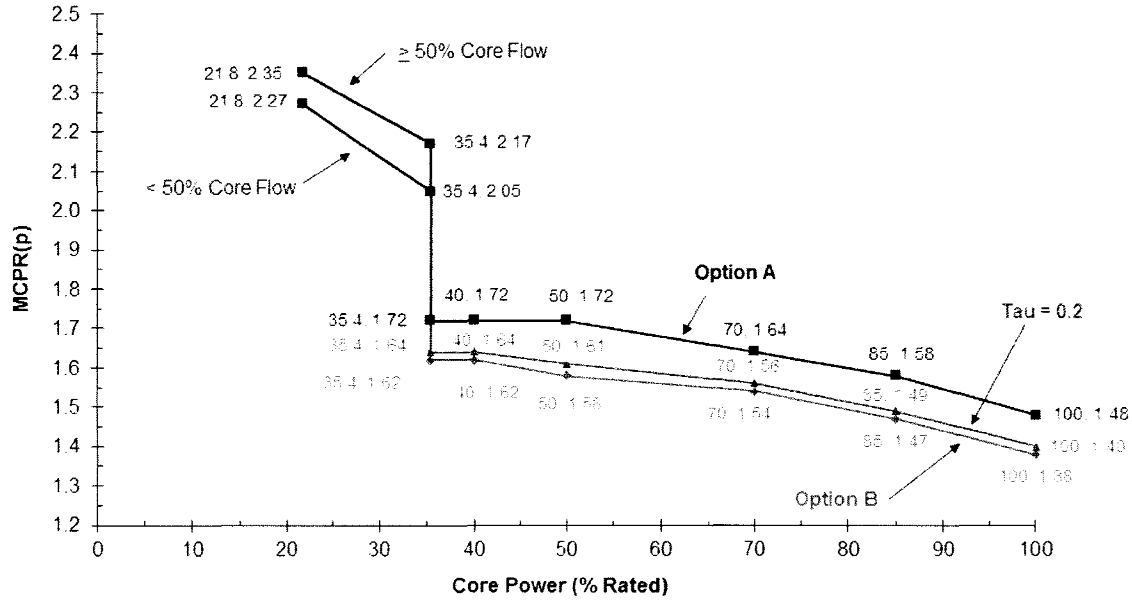

Figure 2-6A
Cycle 23 GNF2 Power-Dependent MCPR Limits with FWH OOS
MOC to EOC

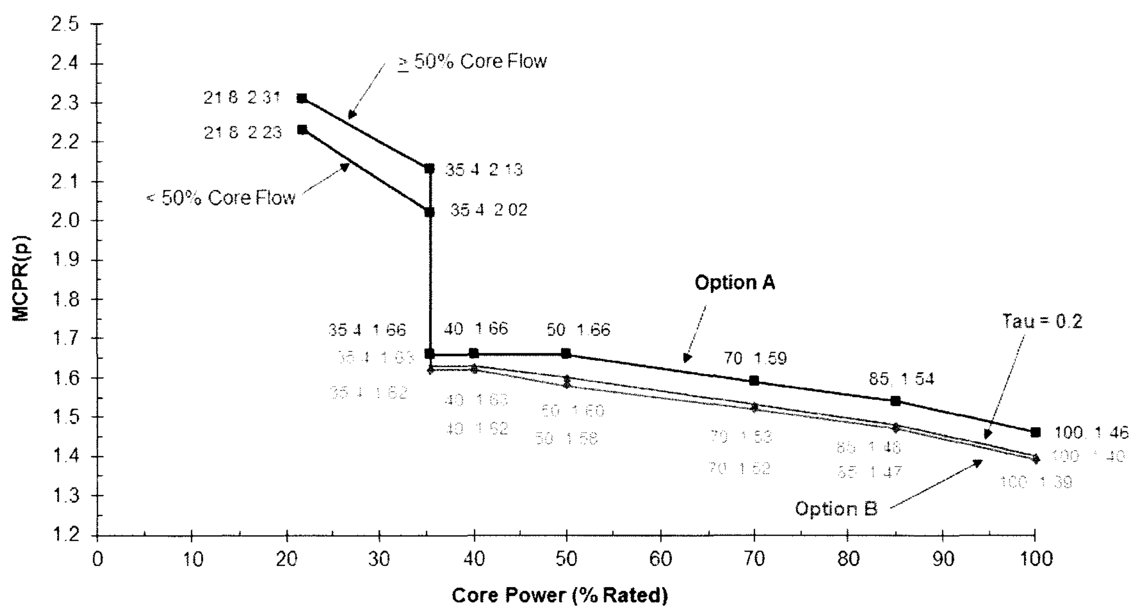

Figure 2-6B
Cycle 23 GNF3 Power-Dependent MCPR Limits with FWH OOS
MOC to EOC

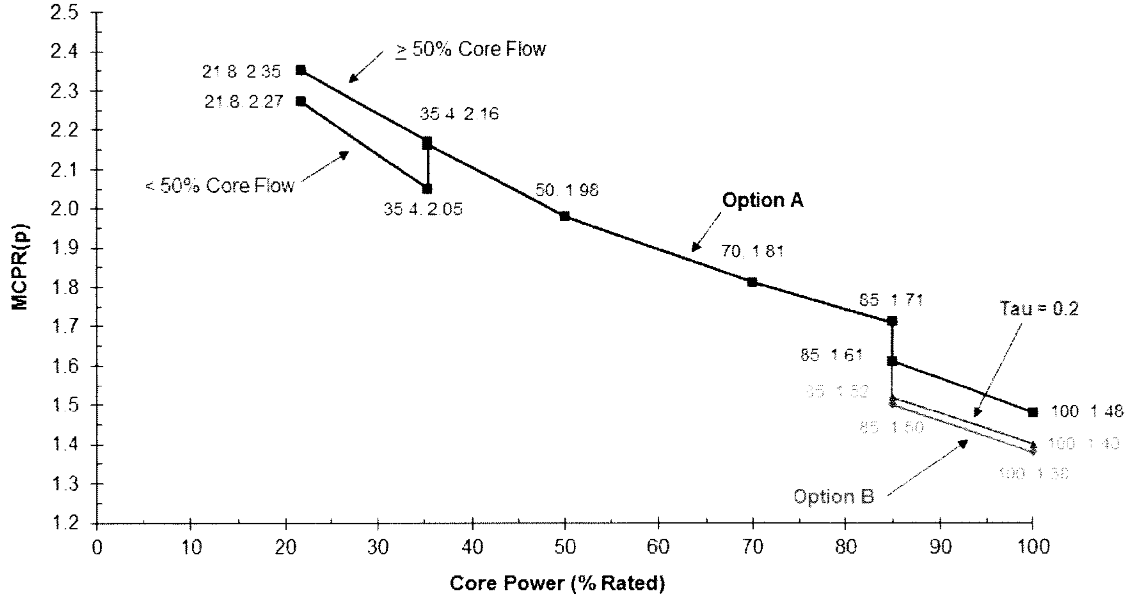

Figure 2-7A
Cycle 23 GNF2 Power-Dependent MCPR Limits with PR+FWH OOS
MOC to EOC

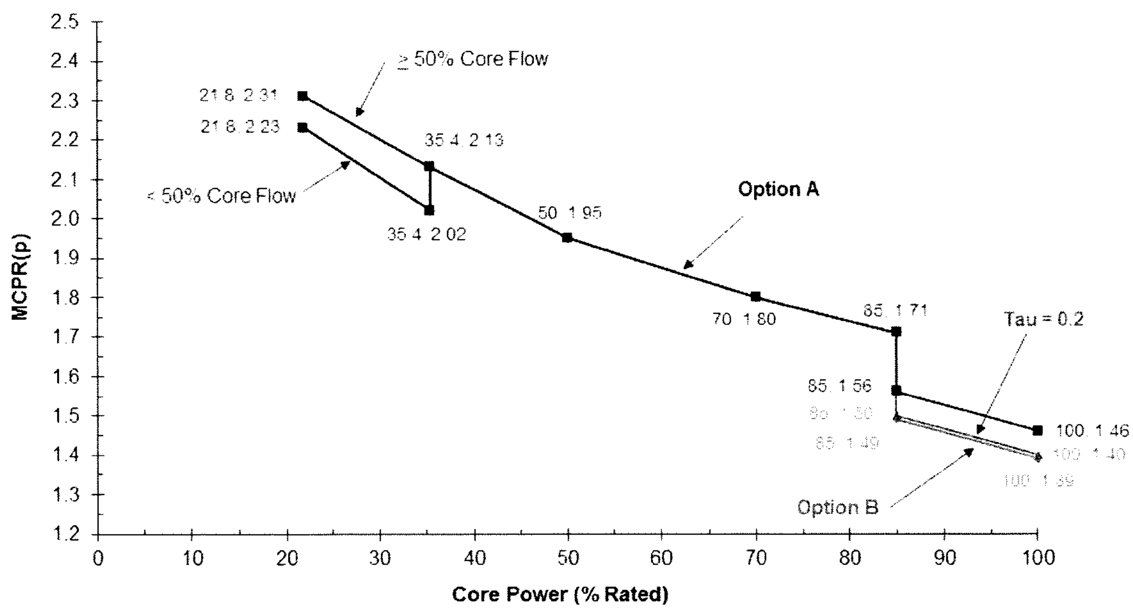

Figure 2-7B
Cycle 23 GNF3 Power-Dependent MCPR Limits with PR+FWH OOS
MOC to EOC

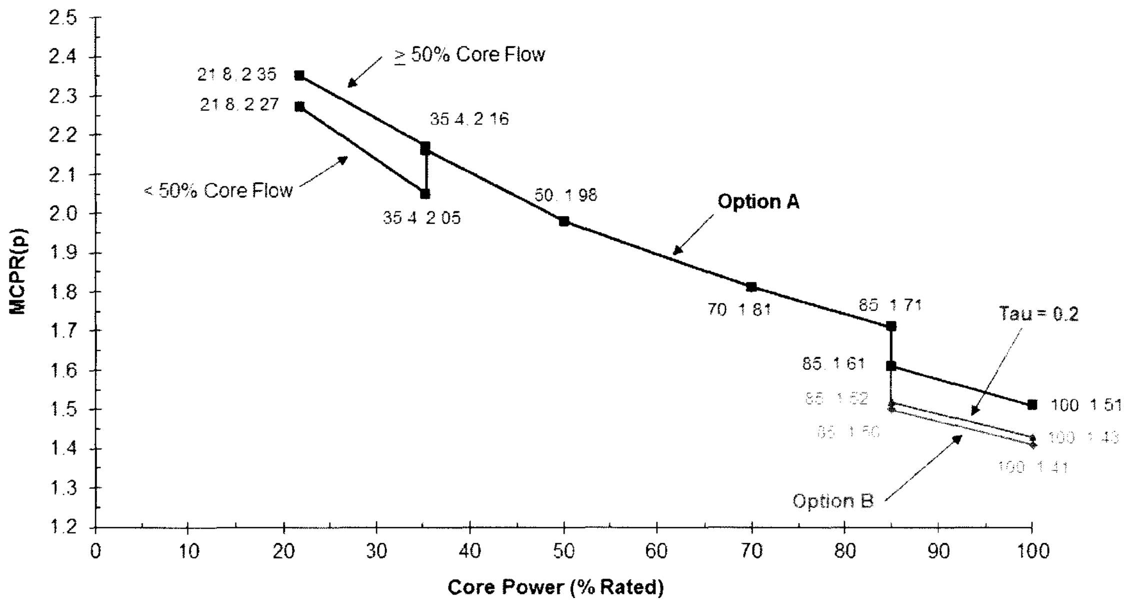

Figure 2-8A
Cycle 23 GNF2 Power-Dependent MCPR Limits with PR+EOC-RPT+FWH OOS
MOC to EOC

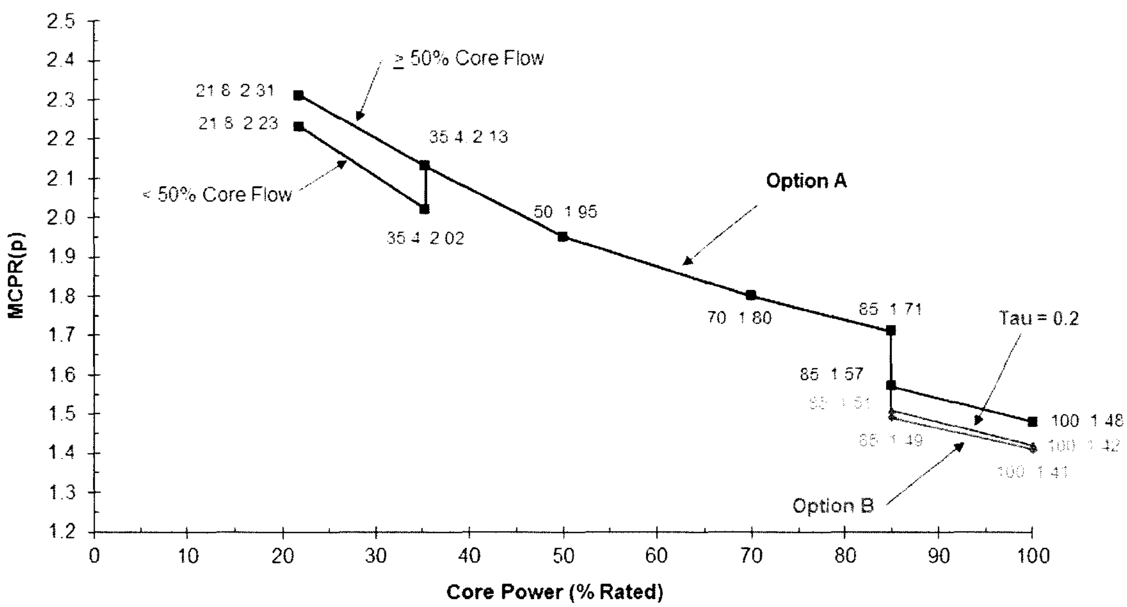

Figure 2-8B
Cycle 23 GNF3 Power-Dependent MCPR Limits with PR+EOC-RPT+FWH OOS
MOC to EOC

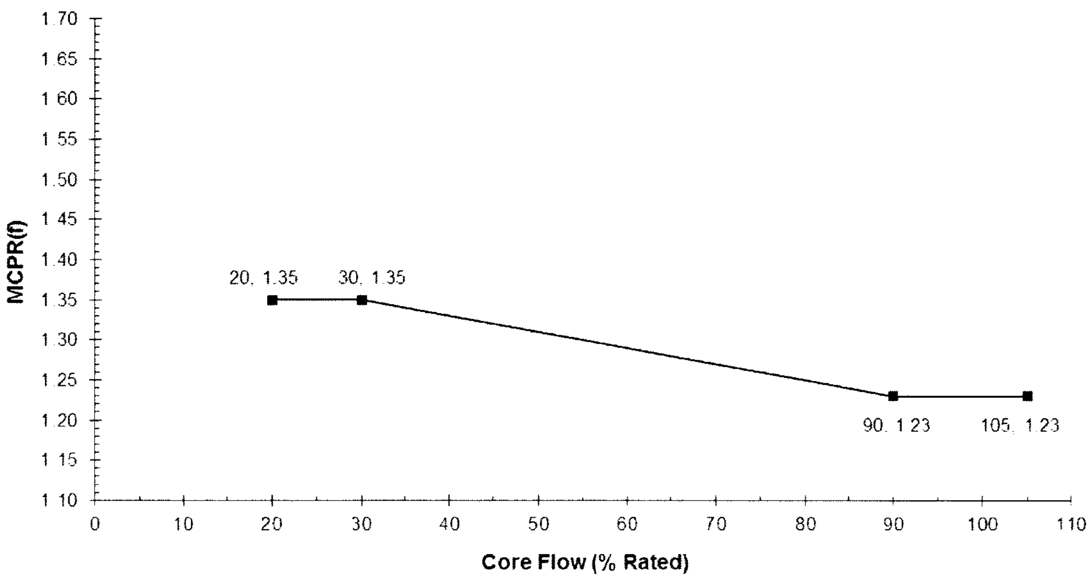

Figure 2-9A
Cycle 23 GNF2 Flow-Dependent MCPR Limits, All Application conditions

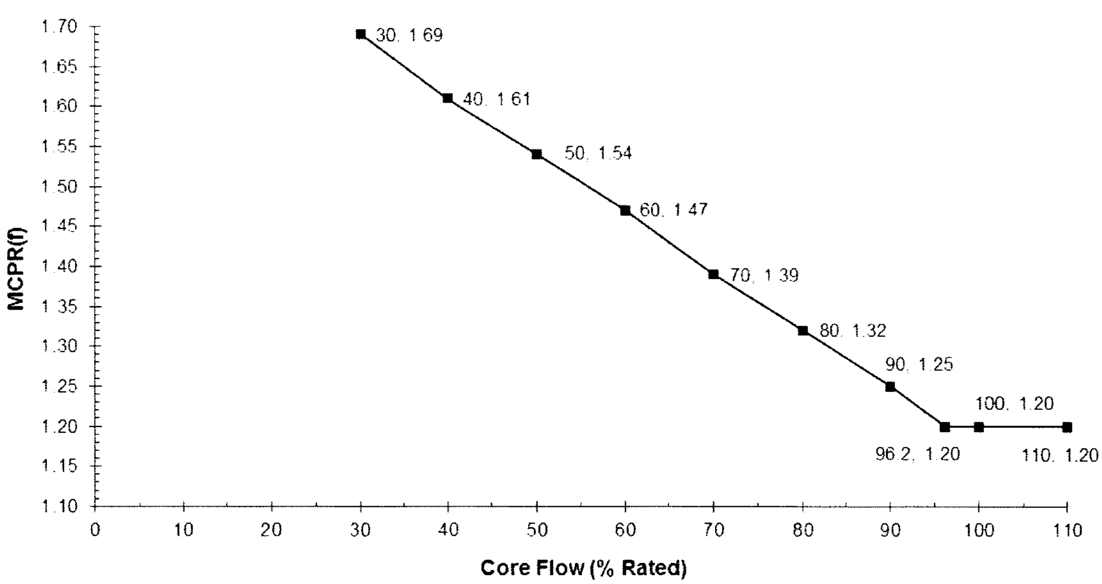

Figure 2-9B
Cycle 23 GNF3 Flow-Dependent MCPR Limits, All Application Conditions

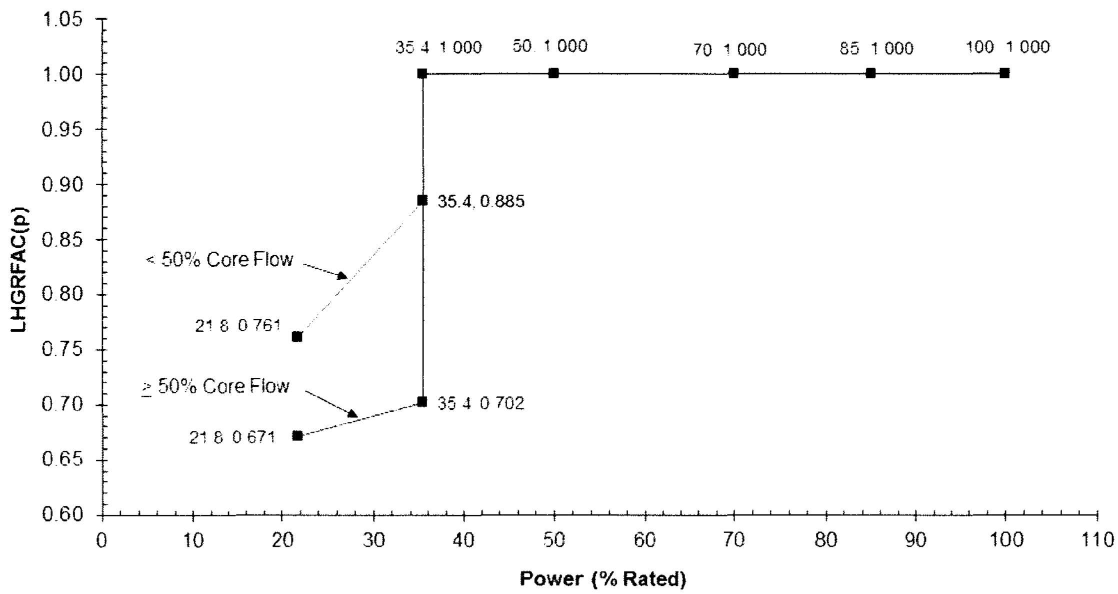

Figure 3-1A
Cycle 23 GNF2 Power-Dependent LHGR Factor BOC-MOC, EIS
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

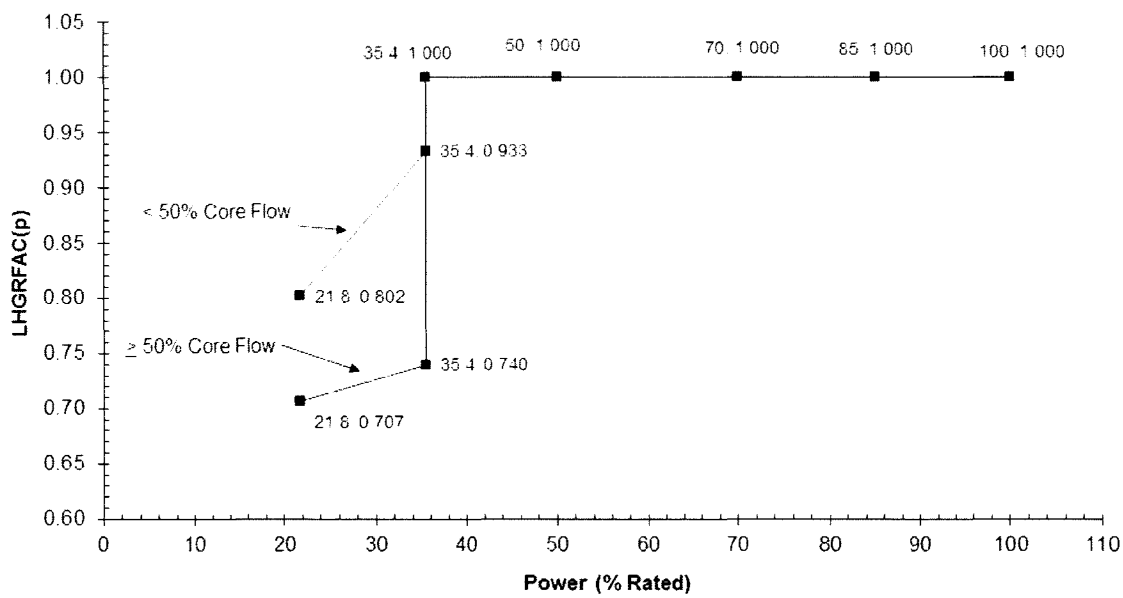

Figure 3-1B
Cycle 23 GNF3 Power-Dependent LHGR Factor BOC-MOC, EIS
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

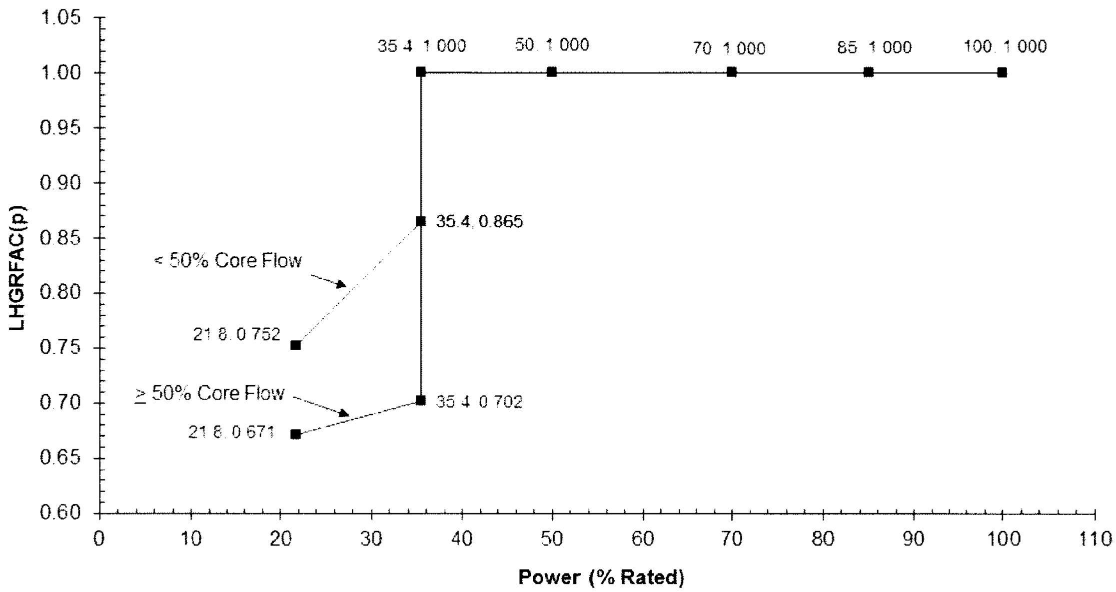

Figure 3-2A
Cycle 23 GNF2 Power-Dependent LHGR Factor BOC-MOC with FWHOOS
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

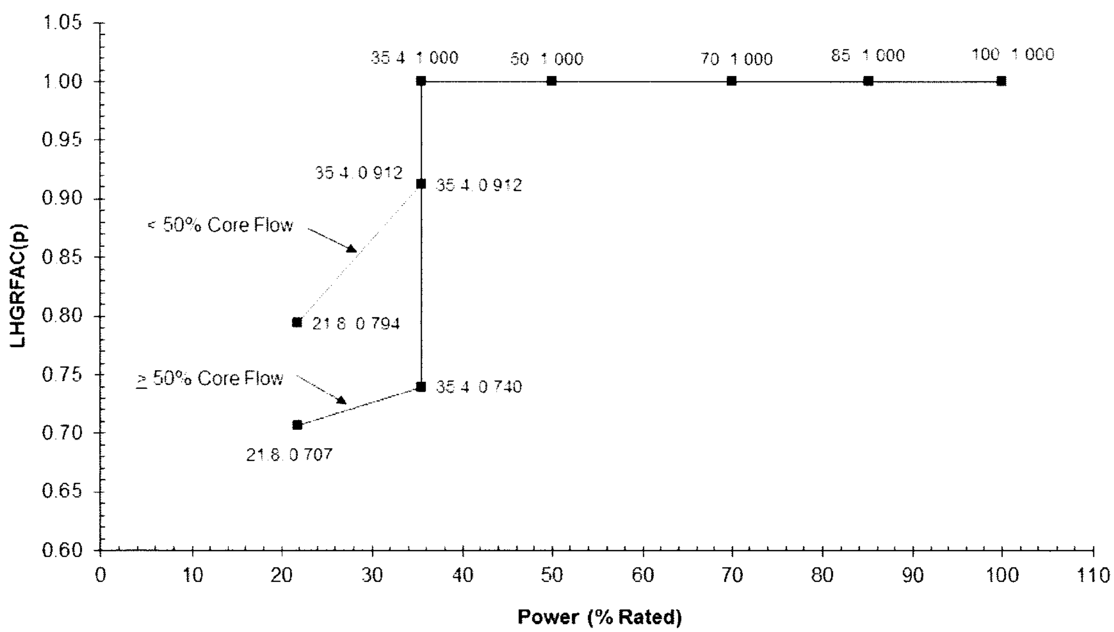

Figure 3-2B
Cycle 23 GNF3 Power-Dependent LHGR Factor BOC-MOC with FWHOOS
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

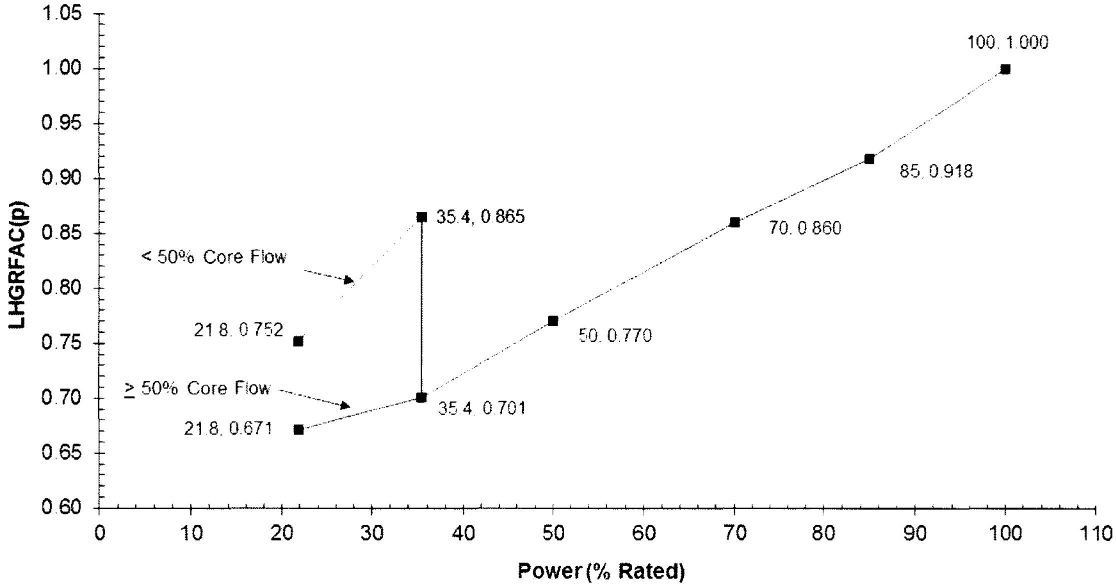

Figure 3-3A
Cycle 23 GNF2 Power-Dependent LHGR Factor BOC-MOC with PROOS, FWHOOS and EOC-RPT
(Application Conditions 6 and 8); Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

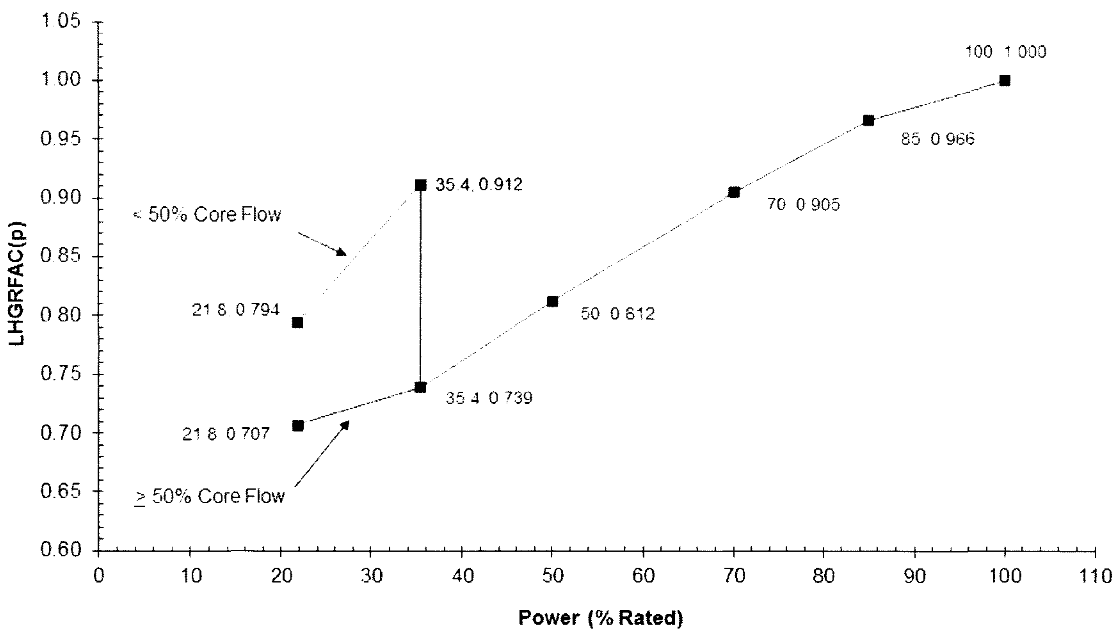

Figure 3-3B
Cycle 23 GNF3 Power-Dependent LHGR Factor BOC-MOC with PROOS, FWHOOS and EOC-RPT
(Application Conditions 6 and 8); Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

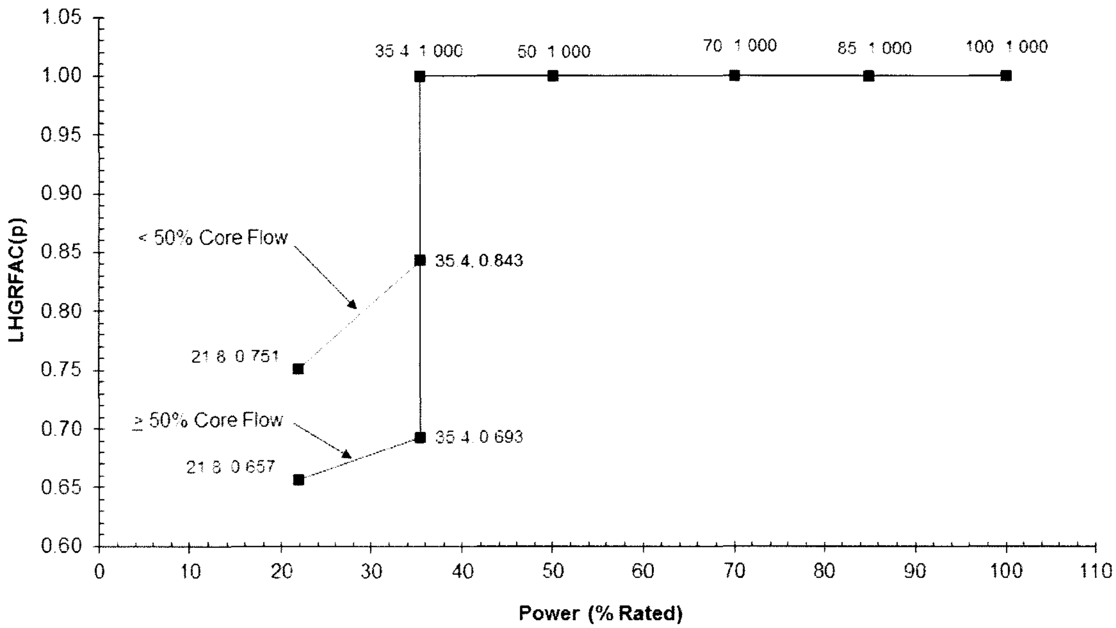

Figure 3-4A
Cycle 23 GNF2 Power-Dependent LHGR Factor MOC-EOC, EIS
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

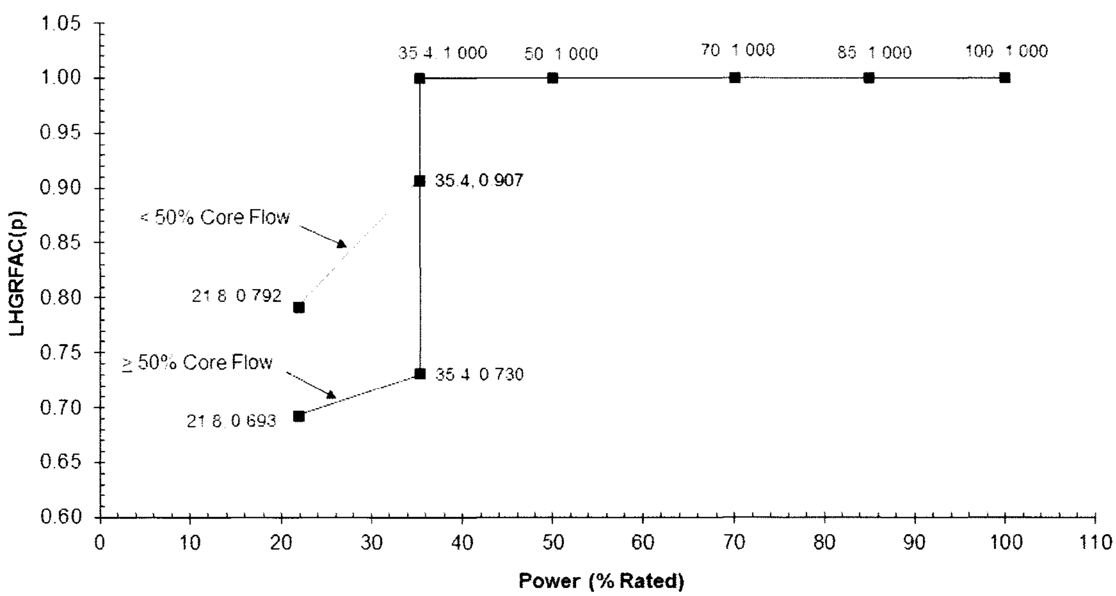

Figure 3-4B
Cycle 23 GNF3 Power-Dependent LHGR Factor MOC-EOC, EIS
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

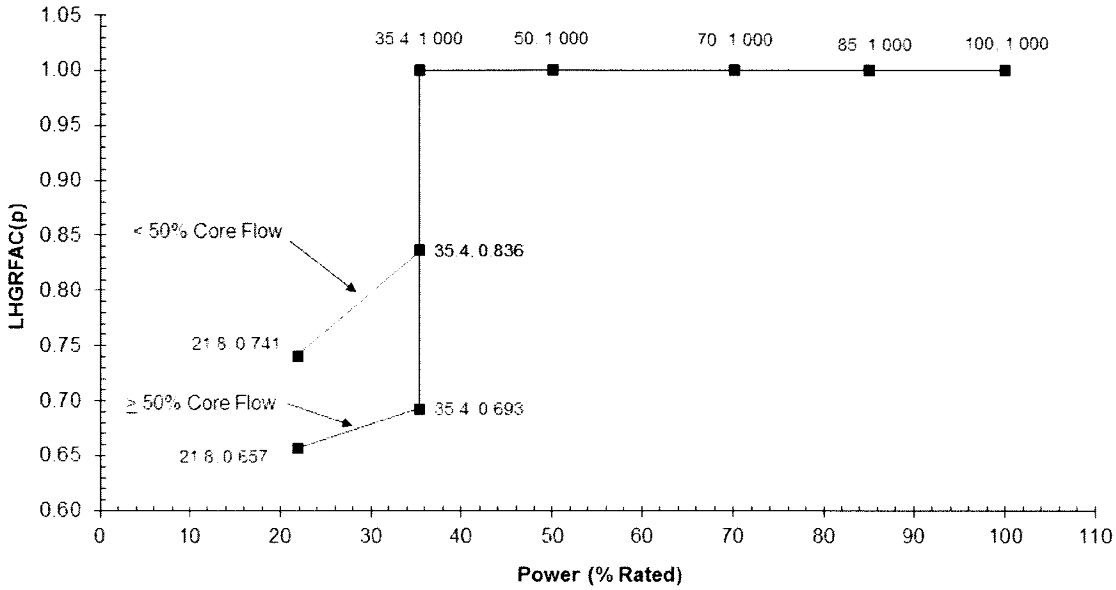

Figure 3-5A
Cycle 23 GNF2 Power-Dependent LHGR Factor MOC-EOC with FWHOOS
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

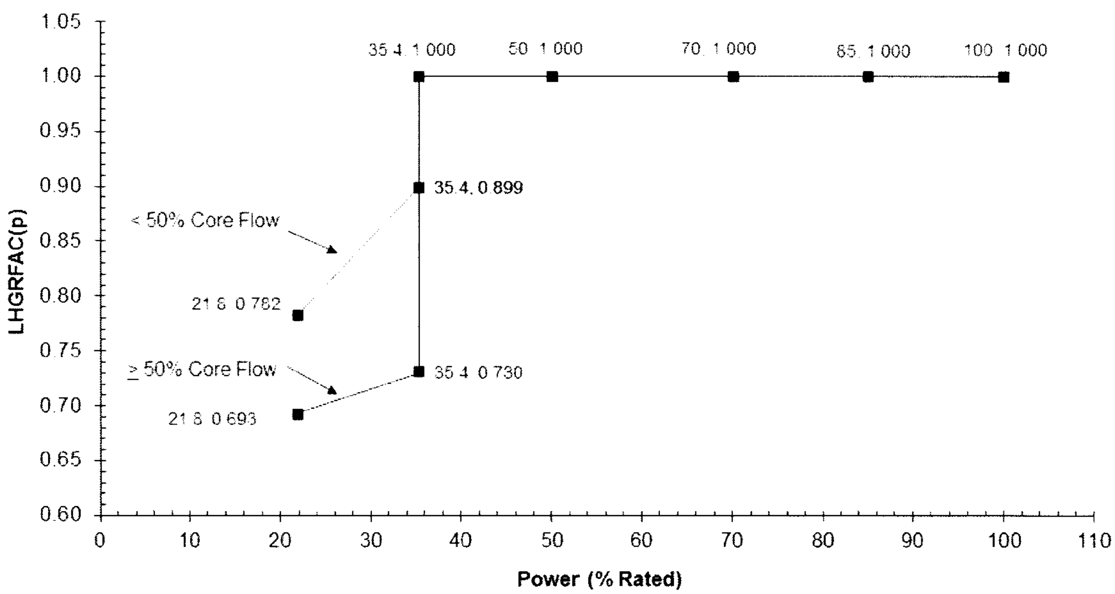

Figure 3-5B
Cycle 23 GNF3 Power-Dependent LHGR Factor MOC-EOC with FWHOOS
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

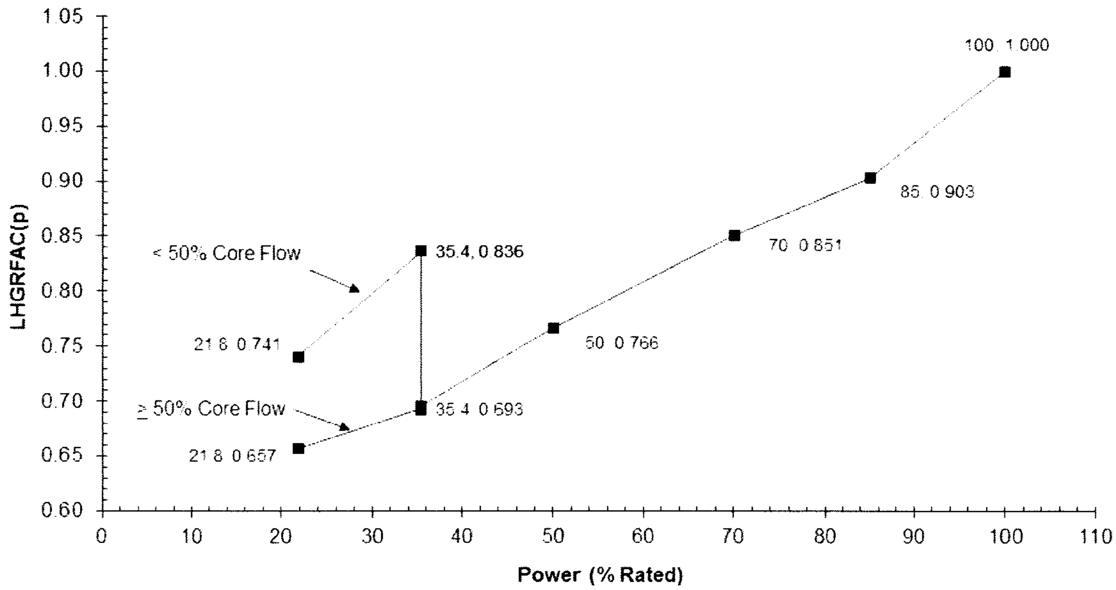

Figure 3-6A
Cycle 23 GNF2 Power-Dependent LHGR Factor MOC-EOC with PROOS, FWHOOS and EOC-RPT (Application Conditions 6 and 8); Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

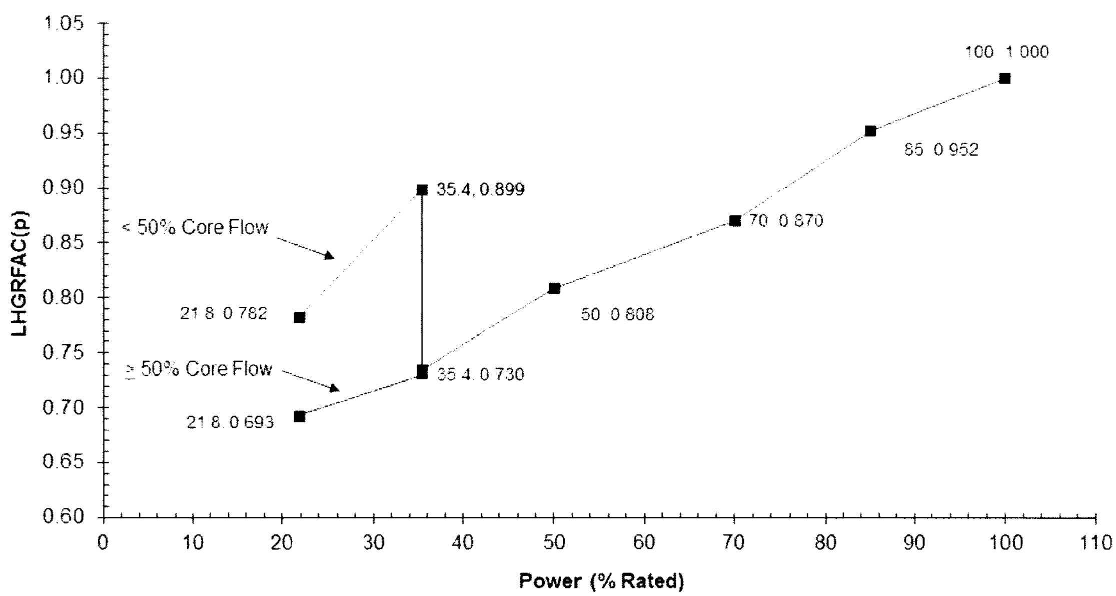

Figure 3-6B
Cycle 23 GNF3 Power-Dependent LHGR Factor MOC-EOC with PROOS, FWHOOS and EOC-RPT (Application Conditions 6 and 8); Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

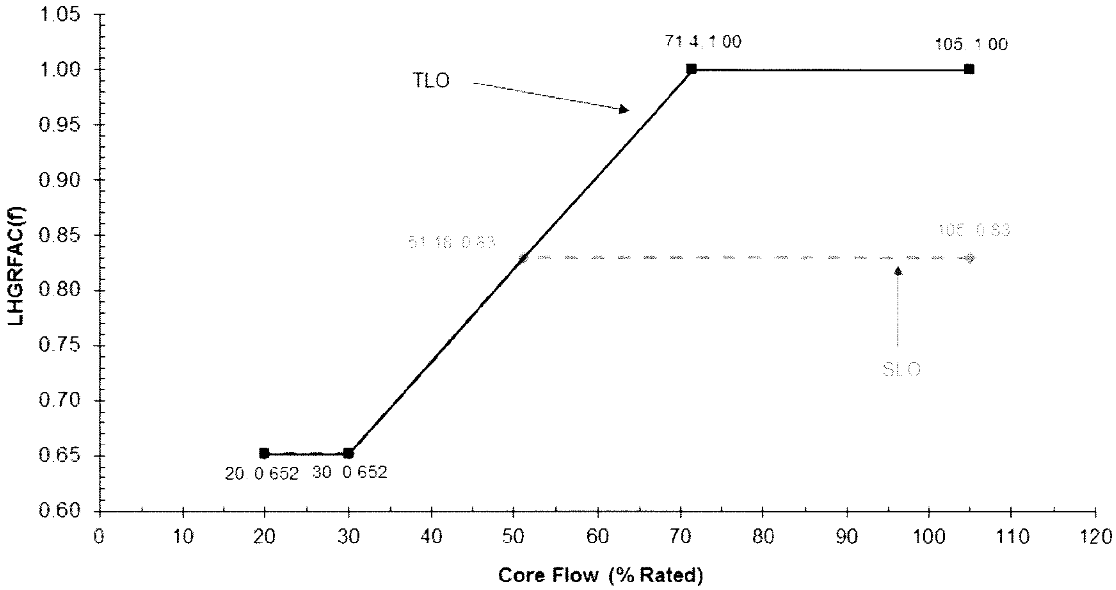

Figure 3-7A
Cycle 23 GNF2 Flow-Dependent LHGR Factor
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

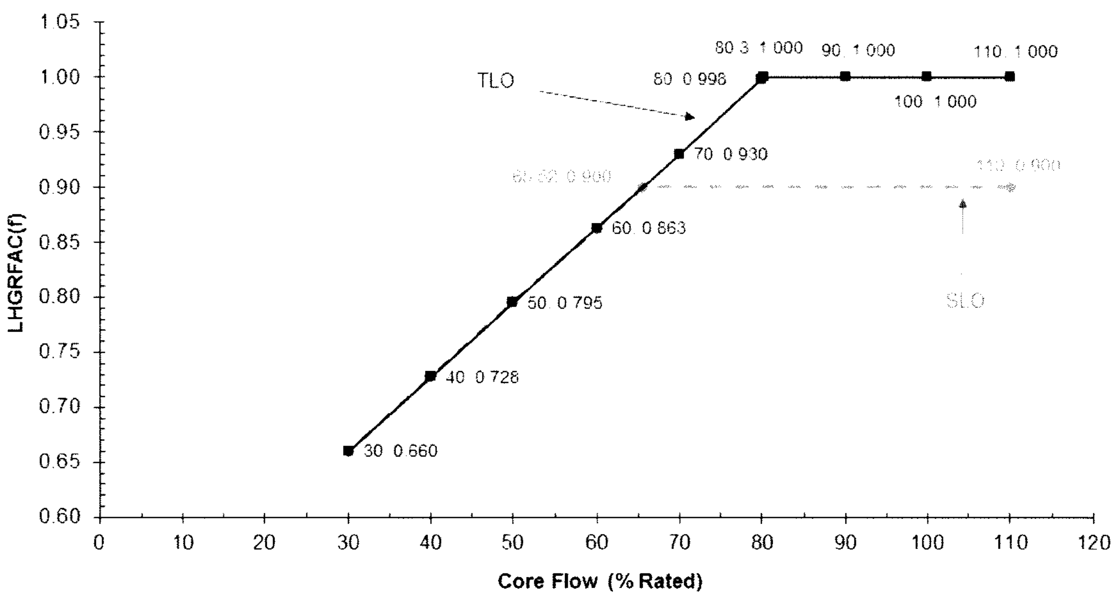

Figure 3-7B
Cycle 23 GNF3 Flow-Dependent LHGR Factor
Note: These factors to be applied to the exposure-dependent limits as descibed in Section 5.3

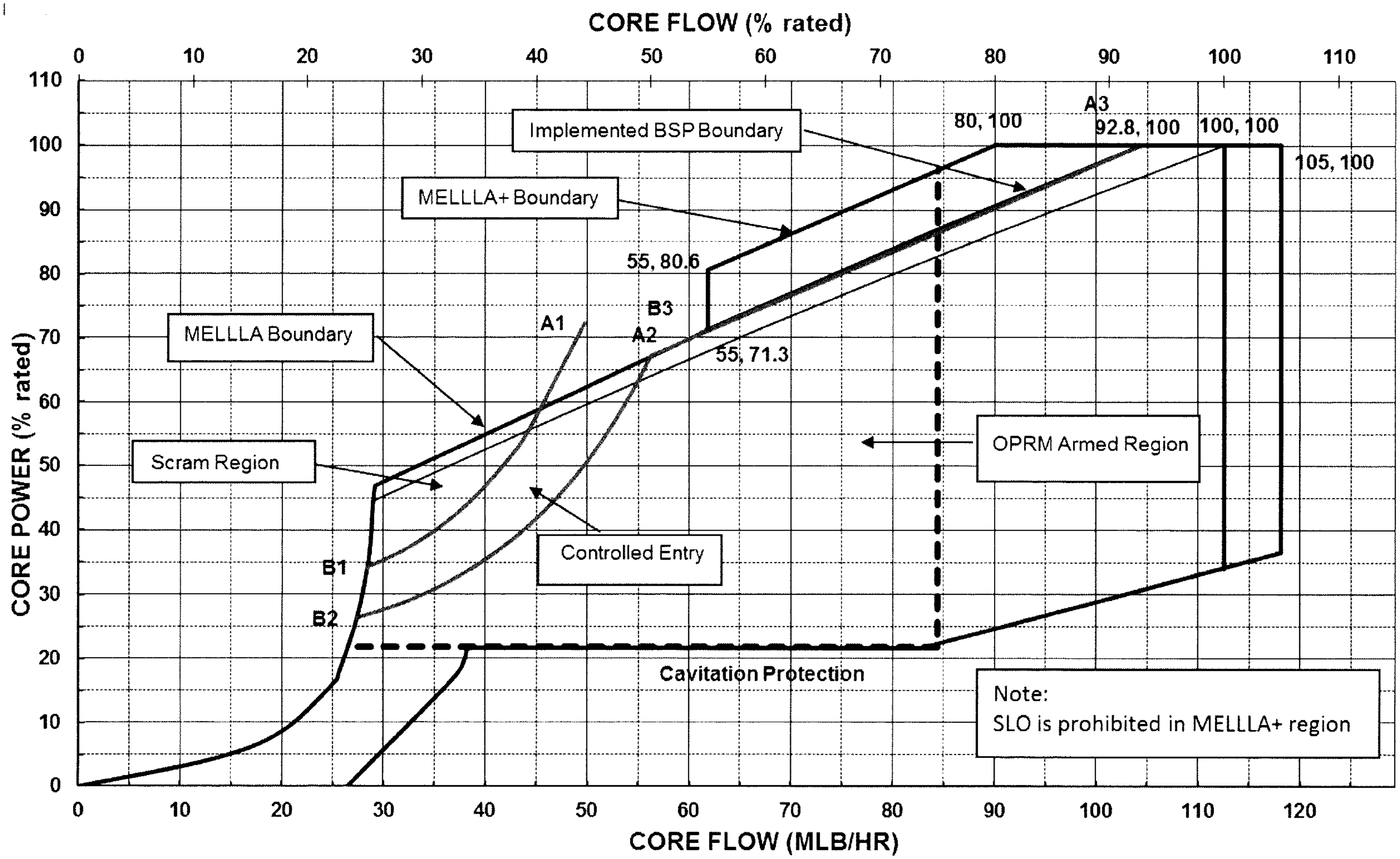

Figure 4 Backup Stability Protection Region Boundaries for Normal Feedwater Temperature (NFWT)

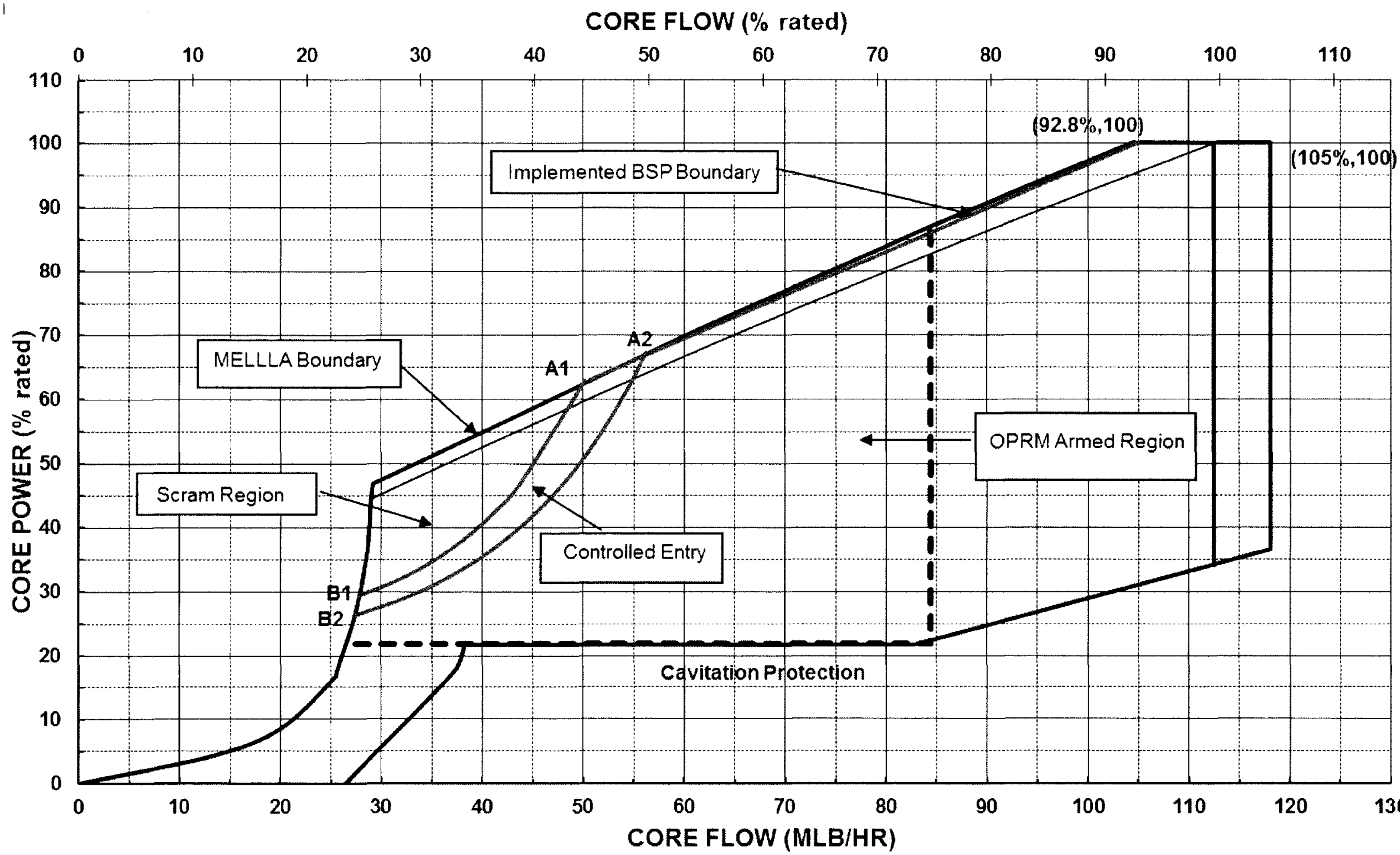

Figure 5 Backup Stability Protection Region Boundaries for Reduced Feedwater Temperature (RFWT)

Attachment 2
Pressure and Temperature Limits Report (PTLR)

Grand Gulf Nuclear Station
Pressure and Temperature Limits Report (PTLR)
Up to 35 Effective Full-Power Years (EFPY) and 54 EFPY
Revision 3

<u>Table of Contents</u>

1.0 Purpose

The purpose of the Grand Gulf Nuclear Station (GGNS) Pressure and Temperature Limits Report (PTLR) is to present operating limits relating to:

1. Reactor Coolant System (RCS) Pressure versus Temperature limits during Heatup, Cooldown, and Hydrostatic/Class 1 Leak Testing;

2. RCS Heatup and Cooldown rates;

3. Reactor Pressure Vessel (RPV) to recirculation loop ΔT requirements during Recirculation Pump startups;

4. RPV bottom head coolant temperature to RPV coolant temperature ΔT requirements during Recirculation Pump startups;

5. RPV head flange bolt-up temperature limits.

This report has been prepared in accordance with the requirements of Technical Specification (TS) 5.6.6, "Reactor Coolant System (RCS) PRESSURE AND TEMPERATURE LIMTS REPORT (PTLR).

2.0 Applicability

This report is applicable to the GGNS RPV for up to 35 Effective Full-Power Years (EFPY) and 54 EFPY.
The following TS is affected by the information contained in this report:
TS 3.4.11 RCS Pressure and Temperature (P/T) Limits

3.0 Methodology

The limits in this report were derived from the NRC-approved methods listed in TS 5.6.6 using the specific revision listed below:

1. The neutron fluence was calculated per Engineering Report MPM-814779, Rev. 5, Neutron Transport Analysis For Grand Gulf Nuclear Station, May 2015. (Ref. 7.1)

2. The pressure and temperature limits were calculated per GE Hitachi Nuclear Energy Methodology for Development of Reactor Pressure Vessel Pressure-Temperature Curves, NEDC-33178P-A, Rev. 1, June 2009 (Reference 7.2)

This revision of the PTLR incorporates the following changes:

- Application of GEH Topical Report NEDC-33178P-A for P-T Curves
- Fluence application for operation at 4,408 MWt
- New surveillance data from the Integrated Surveillance Program (ISP)
- 35 EFPY with new fluence methodology
- 54 EFPY for Licensing Renewal with new fluence methodology
- Negative Pressure in the reactor vessel

As discussed in Appendix A, GGNS participates in the BWRVIP Integrated Surveillance Program (ISP) and is not a host plant. No surveillance capsules are currently scheduled to be withdrawn and tested from the GGNS RPV. The GGNS surveillance capsules have an ISP status designation of deferred (standby) per Reference 7.4. The adjusted reference temperature (ART) values for 35 EFPY included in Appendix B and 54 EFPY included in Appendix C are developed using the latest ISP published surveillance data available that is representative of the applicable materials in the GGNS RPV beltline (Ref. 7.3). The surveillance data used in the ART calculations is not obtained from actual GGNS RPV test specimens.
Should actual surveillance capsules be withdrawn and tested from the GGNS RPV (e.g., status change to be an ISP host plant under the BWRVIP ISP), compliance with 10CFR50, Appendix H requirements on reporting test results and evaluations on the effects to plant operations parameters (e.g., P-T limits, hydrostatic and leak test conditions will be in accordance with Section 3 of Reference 7.3.
Changes to the curves, limits or parameters within this PTLR, based upon new irradiation fluence data of the RPV, surveillance capsule data of the RPV, or other plant design assumptions in the Updated Final Safety Analysis Report (UFSAR), can be made pursuant to 10CFR50.59, provided the above methodologies are utilized. The revised PTLR shall be submitted to the NRC upon issuance.

4.0 Operating Limits

The pressure-temperature (P-T) curves (See Figures 1-2) included in this report represent top head pressure versus minimum vessel metal temperature and incorporate the appropriate non-beltine limits and irradiation embrittlement effects in the beltline region. The operating limits for pressure and temperature are required for three categories of operation:

1) Curve A: Pressure Test (Hydrostatic Pressure Test and Leak Test)

   Curve A may be used during pressure tests at times when the coolant temperature heatup or cooldown rate in ≤20°F/hr during a hydrotest and when the core is not critical.

2) Curve B: Non-Nuclear Heatup / Cooldown

Curve B must be used whenever Curve A or Curve C do not apply. In other words, this curve must be followed during times when the coolant heatup or cooldown rate is greater than 20°F/hr during a pressure test and when the core is not critical. Additionally, when performing low-power physics testing, Curve B must be followed. The heatup and cooldown rate is limited to ≤100°F/hr when using Curve B.

3) Curve C: Core critical Operation

This curve must be used when the core is critical with the exception as noted in 2) during low-power physics testing activities. The heatup and cooldown rate is limited to ≤100°F/hr when using Curve C.

Complete P-T curves were developed for 35 EFPY and 54 EFPY. The P-T curves are provided in Section Figures 1-2 and a tabulation of the curves is included in Tables 1-2. Other temperature limits applicable to the RPV are:

- RPV bottom head coolant temperature to RPV coolant temperature ΔT limit during Recirculation Pump startup: ≤ 100°F.
- Recirculation loop coolant temperature in the loop to be started to RPV coolant temperature ΔT limit during Recirculation Pump startup: ≤ 50°F.
- RPV flange and head flange temperature limit: ≥ 70°F.

5.0 Discussion

The computer codes described in References 7.1, 7.2 and 7.6 were used in the development of the P-T curves for GGNS.

The method for determining the initial Reference Temperature of the Nil-Ductility Transition (RT_{NDT}) for all vessel materials is that defined in Section 4.1.2 of Reference 7.2. Initial RT_{NDT} values for all vessel materials considered are presented in tables in Appendix B, "GGNS Reactor Pressure Vessel P-T Curve Supporting Plant-Specific Information."

For GGNS, there are four thickness discontinuities: 1) Bottom Head to Support Skirt; 2) Bottom Head to Shell #1; 3) Shell #1 to Shell Ring #2, and 4) Shell Ring #3 and Shell Ring #4. There is also a thickness discontinuity between the top head dollar plate and torus; this discontinuity is bounded by the top head evaluation. The P-T curves defined in Section 5.0 of Reference 7.5 are based upon an RT_{NDT} of 10°F for Bottom Head Curve A for the plates and -20°F for the welds for the hydrostatic pressure test conditions. The results of the discontinuity analysis demonstrate that the linearized stresses in the Bottom head and cylindrical shell regions are bounded by the Bottom Head (CRD) Curve B, the Upper Vessel Curve B, and the beltline Curve B. The maximum RT_{NDT} for the bottom head, Shell #3 to Shell #4 is 10°F for the plates and -

20°F for the welds. At 54 EFPY, the maximum RT_{NDT} (ART) for the Shell #1 to Shell #2! region is 51.1°F for the plates and 16.1°F for the welds. At 35 EFPY, the maximum! RT_{NDT} (ART) for the Shell #1 to Shell #2 region is 41.8°F for the plates and 4.9°F for the! welds. The 54 EFPY beltline curves are based on an ART of 51.1°F. Curves based on! these temperatures bound the requirements due to the thickness discontinuities.

The ART of the limiting beltline material is used to adjust the beltline P-T curves to! account for irradiation effects. Regulatory Guide 1.99, Revision 2 (RG 1.99) provides! the methods for determining the ART. The RG 1.99 methods for determining the! limiting material and adjusting the P-T curves using ART are discussed in this section.

The vessel beltline copper and nickel values, except for the N12 nozzle were obtained! from the evaluation presented in the Integrated Surveillance Program (Reference 7.3).! The N12 nozzle was evaluated using the limiting material properties (Chemistry and! initial RT_{NDT}) of the adjoining Shell Ring #2. The copper (Cu) and nickel (Ni) values! were used to determine chemistry factors (CF) in accordance with RG 1.99 and! Reference 7.3 for welds and plates. ART values for 35 EFPY are included in Appendix! B.! ART values for 54 EFPY are included in Appendix C.

The N6 RHR/LPCI nozzle occurs in Shell #3 and falls within the beltline region as a! result of the update fluence provided in [7.1]. Sufficient information is contained in the! N6 CMTRs to enable evaluation for the ART. The GGNS EPU P-T curves have been! prepared considering the requirements for the N6 nozzle.

The P-T curves for the non-beltline region were developed for a Boiling Water Reactor! Product Line 6 (BWR/6) with nominal inside diameter of 251 inches. The analysis is! considered appropriate for GGNS, since it is a BWR/6 with a nominal inside diameter of! 251 inches. The generic value was adapted to the conditions as GGNS using plant-specific RT_{NDT} values for the reactor pressure vessel.

The peak RPV ID fluence used in the P-T curve evaluation for 35 effective full power! years (EFPY) is 2.14E+18 n/cm^2, which was calculated using methods that comply with! the guidelines of RG 1.190 (Reference 7.1). The peak!(Overall Maximum)!RPV ID! fluence used in the P-T curve evaluation for 54 effective full power years (EFPY) is! 3.40E+18 n/cm^2!(Reference 7.11).

This 54 EFPY fluence applies to the lower-intermediate plates and associated! longitudinal welds. The fluence is adjusted for the lower plates and associated! longitudinal welds and the girth weld based upon a factor of!0.1244; hence, the peak ID! fluence for these components, at this location,!is!4.23E+17!n/cm^2. Similarly, the fluence! is adjusted for the N12 nozzle based upon a factor of!0.1115; hence the peak ID surface

fluence used for this component is!3.79E+17!n/cm^2. The fluence is adjusted for the N6! nozzle based upon a factor of!0.0606; hence the peak ID surface fluence used for this! component, at this location, is!2.06E+17 n/cm^2.

It is to be noted that Fluence dpa attenuation was calculated for all the materials that need!to be included in the PTL Curve analysis. The fluence values calculated in Reference![7.11] are less than those reported in Reference [7-1] at exposures of 35 and 54 EFPY.!Therefore, the PTL Curves currently in this PTLR (Figures 1 and 2), and the ART values!(Appendix B, Table 4-2a and Appendix C, Table 4-2b) supporting these Curves, are!bounding, remain valid, and are still applicable. Thus, they do not need to be changed!and have not been revised.

From Reference [7.11], the calculated dpa for the maximum Peak fluence value is located!in Shell 2 (Plate) of the RPV. The attenuated fluence values using the data from! Reference 7.11 and RG 1.99 have been calculated for the needed exposures (e.g., 35! EFPY and 54 EFPY) for use in development of the PTL Curves. The fluence was!calculated using both the alternative dpa attenuation analysis and the exponential!attenuation factor in Equation 3 of Reg. Guide 1.99. Both yield comparable results. The! calculated dpa attenuation data is slightly more conservative at the RPV ID wetted surface!and the 1/4T locations in the RPV, and the exp(-0.24x) equation is more conservative at!the 3/4T position. However, the exponential attenuation factor in Equation 3 of Reg. Guide! 1.99 may not be conservative at elevations above and below the active fuel.

The P-T curves for the heatup and cooldown operating conditions as a given EFPY! apply for both ¼T and ¾T locations. When combining pressure and thermal stresses, it! is usually necessary to evaluate stresses at the ¼T location (inside surface flaw) and!the ¾T location (outside surface flaw). This is because the thermal gradient tensile!stress of interest is in the inner wall during cooldown and the outer wall during heatup.!However, as a conservative simplification, the thermal gradient stress at the ¼T location !is assumed to be tensile for both heatup and cooldown. This results in the approach of! applying the maximum tensile stress at the ¼T location. This approach is conservative! because irradiation effects cause the allowable toughness, K_{IR}, at ¼T to be less than! that at ¾T for a given metal temperature. This approach causes no operational! difficulties, since the BWR is at steam saturation conditions during normal operation,!are! well above the heatup/cooldown temperature curve limits.

For the core not critical curve (Curve B) and the core critical curve (Curve C), the P-T! curves specify a coolant heatup and cooldown temperature rate of≤ 100°F/hr for which! the curves are applicable. However, the core not critical and the core critical curves! were also developed to bound transients defined on the RPV thermal cycle diagram and! the nozzle thermal cycle diagrams. The P/T limits and corresponding heatup/cooldown

rates of either Curve A or B may be applied while achieving or recovering from hydrostatic pressure and leak test conditions. Curve A may be used for the hydrostatic pressure and leak test if a coolant heatup and cooldown rate of ≤ 20°F/hr is maintained. Otherwise, the limits of Curve B apply when performing the hydrostatic pressure and leak test.

Section 5.3.3 of the GGNS UFSAR[7.7] discusses evaluations performed for a Design Basis Accident in GE report NEDO 10029[7.8]. The UFSAR states that this analysis considered very conservative assumptions in the fracture mechanics area, resulting in an upper bound limit on brittle fracture failure mode studies. It was concluded that catastrophic failure of the pressure vessel due to such an accident will not occur from the fracture mechanics perspective. The results of the 60 years (54 EFPY) analysis provided in this appendix, based on a more representative fluence, further support these conclusions.

In order to ensure that the limiting vessel discontinuity has been considered in the development of the P-T curves, the methods in Sections 4.3.2.1 and 4.3.2.2 of Ref. 7.2 for the non-beltline and beltline regions, respectively applied.

6.0 Negative Pressure in Reactor Vessel

Grand Gulf operation has included operating the vessel at vacuum (less than atmospheric pressure). CR-GGN-2016-3150 determined that the actions from CR-GGN-2013-7021 and CR-GGN-2015-0867 were not effective in preventing reactor steam dome pressure from going negative. The issue occurs during start up or shut down or any abnormal condition where the MSIV's are open and the condenser has vacuum and the vessel is depressurized.

Calculation MC-Q1B13-16001 [7.9] has been issued addressing negative pressure in the reactor vessel. To simplify the analysis it is assumed that a vacuum in the vessel is equivalent to an external pressure of 14.7 psia with zero psia in the vessel. For determining the maximum permitted external pressure, the 2010 ASME B&PV Code [7.10], rules are applied to procedure NB-3133.2.
The evaluation determines the shell is limiting at 523 psig external pressure. For this assessment the flange stiffness has been ignored for both shell and head external pressure calculations and the shell was assumed the full length of the vessel. It is concluded that the vessel is in no danger of collapse from an external pressure or vacuum from the condenser. Substantial margin exists between the reactor and condenser.

7.0 References

7.1 Neutron Transport Analysis for Grand Gulf Nuclear Station, Report Number MPM-814779, Revision 5, May 2015,

7.2 Final Safety Evaluation for Boiling Water Reactors Owners Group Licensing Topical Report NEDC-33178P, General Electric Methodology for Development of Reactor Pressure Vessel Pressure-Temperature Curves, Revision 1, June 2009. (NRC SER included in the ML092370487),

7.3 BWR Vessel and Internals Project Integrated Surveillance Program (ISP) Data Source Book and Plant Evaluations, BWRVIP-135, Revision 3, EPRI, Palo Alto, CA, (EPRI Proprietary),

7.4 BWR Vessel and Internals Project, Updated BWR Integrated Surveillance Program (ISP) Implementation Plan, BWRVIP-86-A, EPRI, Palo Alto, CA: 2002. 1003346. (EPRI Proprietary),

7.5 Grand Gulf Nuclear Station EPU – Pressure-Temperature Limits Report, GGNS-NE-10-00073, Rev. 1, July 2015,

7.6 Benchmarking of MPM Methods for Nuclear Plant Neutron Transport Calculations, Report Number MPM-614993, Revision 5, May 2015,

7.7 GGNS UFSAR, Section 5.3.3, "Reactor Vessel Integrity",

7.8 "An Analytical Study on Brittle Fracture of GE-BWR Vessels Subject to the Design Basis Accident", GE-APED, San Jose, CA, (NEDO-10029), June 1969,

7.9 Reactor Vessel Negative Pressure During Startup, Shutdown and Off-Normal Conditions, MC-Q1B13-16001, Rev. 0,

7.10 2010 ASME Boiler and Pressure Vessel Code, Section III Division 1 – Subsection NB Class 1 Components,

7.11 Neutron Transport Analysis for Grand Gulf Nuclear Station, Report Number! MPM-814779, Revision 5B, February 2020.

Figure 1: Composite P-T Curves [Curves A, B, C] up to 35 EFPY [Without Uncertainty for Instrumentation Errors]

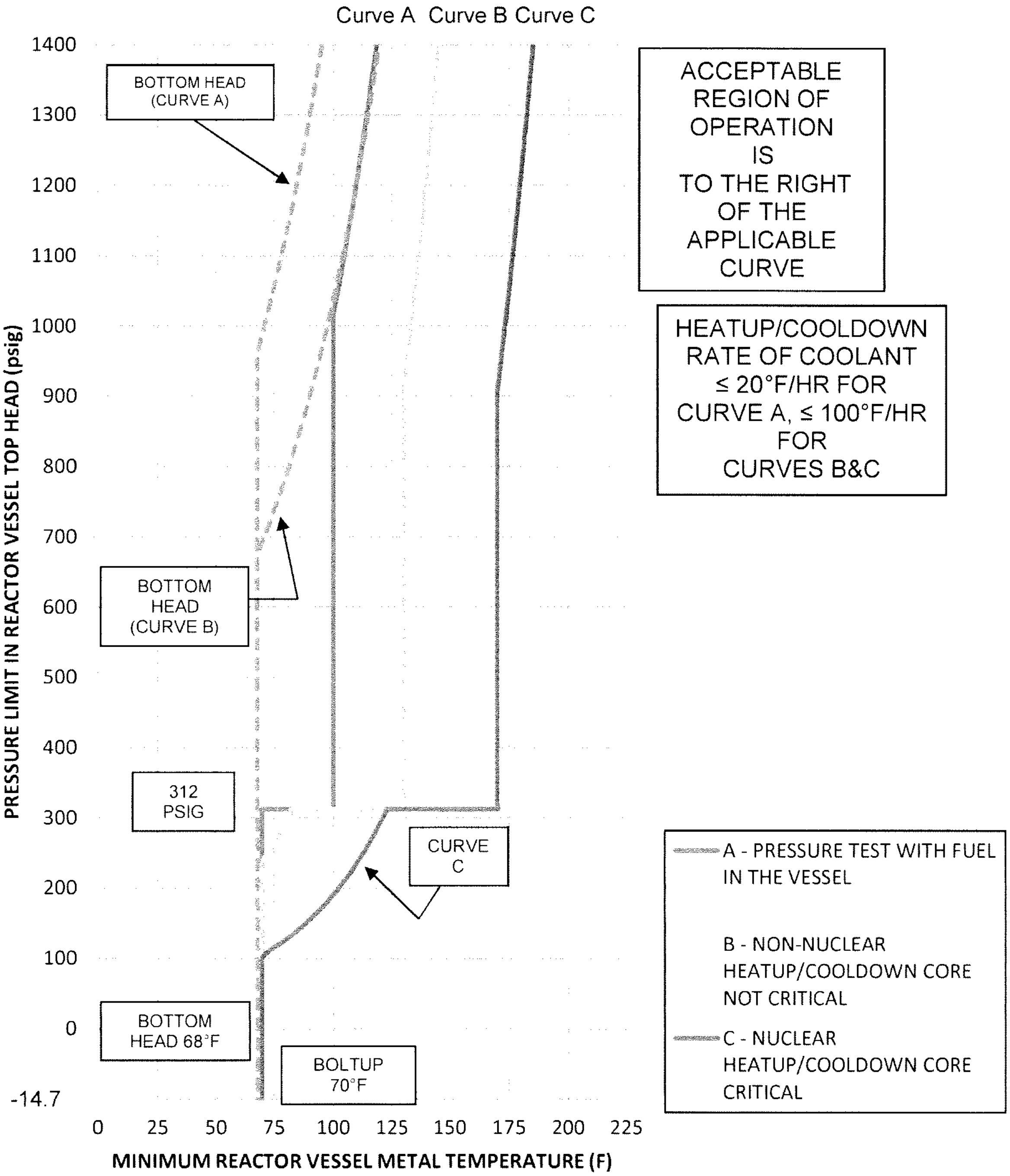

Figure 2: Composite P-T Curves [Curves A, B, C] up to 54 EFPY [Without Uncertainty for Instrumentation Errors]

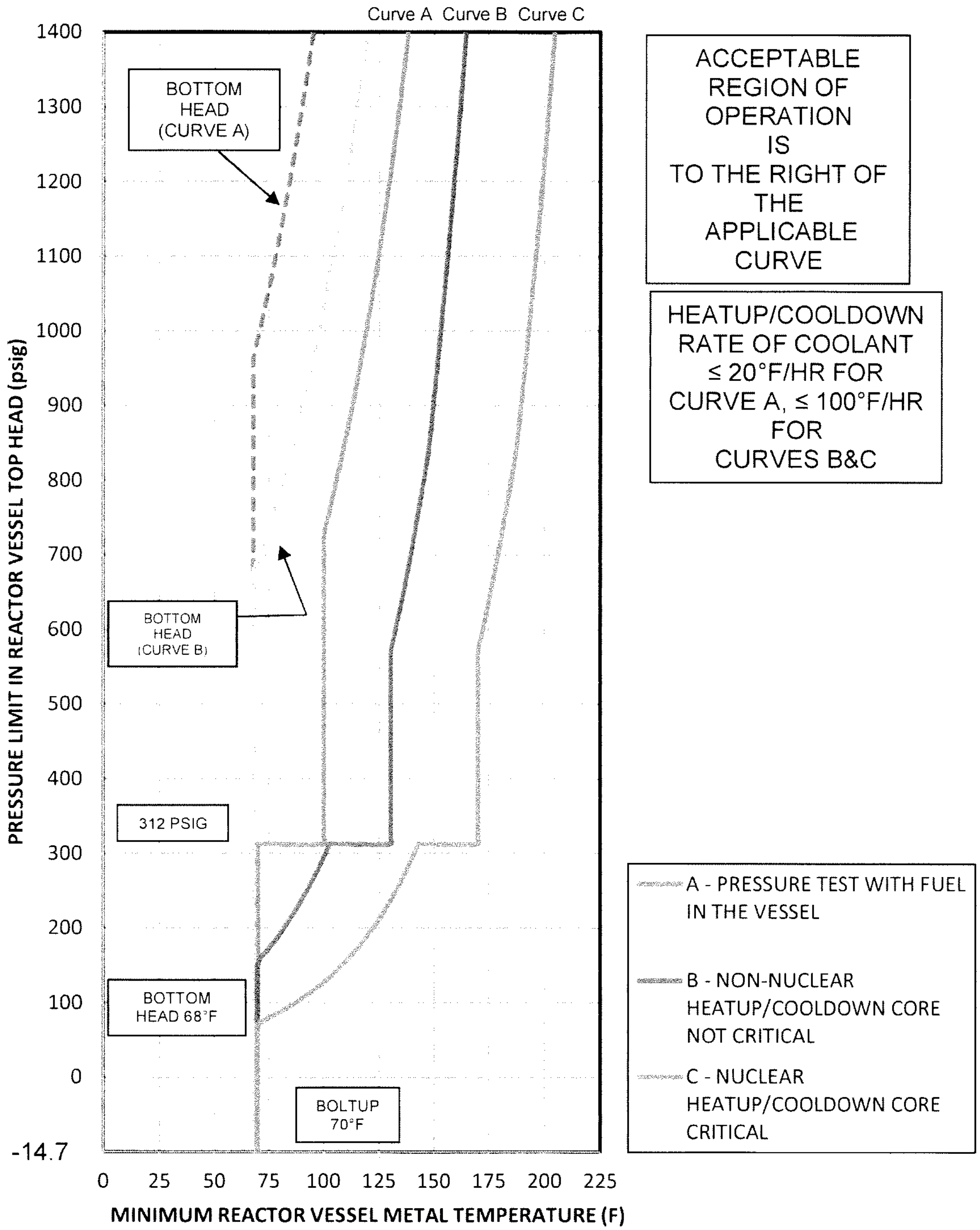

Table 1 – Tabulation of Curves -35 EFPY

Required Metal Temperature with Required Coolant Heatup / Cooldown Rate at 100°F/hr for Curves B & C and 20°F/hr for Curve A for Figure 1

Pressure Psig	Bottom Head Curve A (°F)	Upper Vessel & Beltline 35 EFPY Curve A (°F)	Bottom Head Curve B (°F)	Upper Vessel & Beltline 35 EFPY Curve B (°F)	35 EFPY Beltline Curve C (°F)
-14.7	68	70	68	70	70
0	68	70	68	70	70
10	68	70	68	70	70
20	68	70	68	70	70
30	68	70	68	70	70
40	68	70	68	70	70
50	68	70	68	70	70
60	68	70	68	70	70
70	68	70	68	70	70
80	68	70	68	70	70
90	68	70	68	70	70
100	68	70	68	70	70
110	68	70	68	70	72.6
120	68	70	68	70	77.2
130	68	70	68	70	81.4
140	68	70	68	70	85.1
150	68	70	68	70	88.4
160	68	70	68	70	91.5
170	68	70	68	70	94.5
180	68	70	68	70	97.3
190	68	70	68	70	99.8
200	68	70	68	70	102.2
210	68	70	68	70	104.5
220	68	70	68	70	106.7
230	68	70	68	70	108.8
240	68	70	68	70.7	110.7
250	68	70	68	72.6	112.6
260	68	70	68	74.4	114.4
270	68	70	68	76.1	116.1
280	68	70	68	77.8	117.8
290	68	70	68	79.4	119.4
300	68	70	68	81	121
310	68	70	68	82.5	122.5
312.5	68	70	68	82.8	122.8

Pressure Psig	Bottom Head Curve A (°F)	Upper Vessel & Beltline 35 EFPY Curve A (°F)	Bottom Head Curve B (°F)	Upper Vessel & Beltline 35 EFPY Curve B (°F)	35 EFPY Beltline Curve C (°F)
312.51	68	100	68	130	170
320	68	100	68	130	170
330	68	100	68	130	170
340	68	100	68	130	170
350	68	100	68	130	170
360	68	100	68	130	170
370	68	100	68	130	170
380	68	100	68	130	170
390	68	100	68	130	170
400	68	100	68	130	170
410	68	100	68	130	170
420	68	100	68	130	170
430	68	100	68	130	170
440	68	100	68	130	170
450	68	100	68	130	170
460	68	100	68	130	170
470	68	100	68	130	170
480	68	100	68	130	170
490	68	100	68	130	170
500	68	100	68	130	170
510	68	100	68	130	170
520	68	100	68	130	170
530	68	100	68	130	170
540	68	100	68	130	170
550	68	100	68	130	170
560	68	100	68	130	170
570	68	100	68	130	170
580	68	100	68	130	170
590	68	100	68	130	170
600	68	100	68	130	170
610	68	100	68	130	170
620	68	100	68	130	170
630	68	100	68	130	170
640	68	100	68	130	170
650	68	100	68	130	170
660	68	100	68	130	170
670	68	100	68	130	170
680	68	100	68.7	130	170
690	68	100	69.9	130	170
700	68	100	71	130	170

Pressure Psig	Bottom Head Curve A (°F)	Upper Vessel & Beltline 35 EFPY Curve A (°F)	Bottom Head Curve B (°F)	Upper Vessel & Beltline 35 EFPY Curve B (°F)	35 EFPY Beltline Curve C (°F)
710	68	100	72.2	130	170
720	68	100	73.3	130	170
730	68	100	74.4	130	170
740	68	100	75.5	130	170
750	68	100	76.6	130	170
760	68	100	77.6	130	170
770	68	100	78.6	130	170
780	68	100	79.6	130	170
790	68	100	80.6	130	170
800	68	100	81.5	130	170
810	68	100	82.5	130	170
820	68	100	83.4	130	170
830	68	100	84.3	130	170
840	68	100	85.2	130	170
850	68	100	86	130	170
860	68	100	86.9	130	170
870	68	100	87.7	130	170
880	68	100	88.6	130	170
890	68	100	89.4	130	170
900	68	100	90.2	130	170
910	68	100	91	130.1	170.1
920	68	100	91.7	130.5	170.5
930	68	100	92.5	130.8	170.8
940	68	100	93.3	131.2	171.2
950	68	100	94	131.5	171.5
960	68	100	94.7	131.8	171.8
970	68.6	100	95.5	132.2	172.2
980	69.4	100	96.2	132.5	172.5
990	70.2	100	96.9	132.8	172.8
1000	71	100	97.6	133.2	173.2
1010	71.7	100	98.2	133.5	173.5
1020	72.5	100.3	98.9	133.8	173.8
1030	73.3	100.9	99.6	134.1	174.1
1035	73.6	101.2	99.9	134.3	174.3
1040	74	101.5	100.2	134.5	174.5
1050	74.7	102	100.9	134.8	174.8
1055	75.1	102.3	101.2	134.9	174.9
1060	75.4	102.6	101.5	135.1	175.1
1070	76.2	103.1	102.1	135.4	175.4
1080	76.9	103.6	102.8	135.7	175.7

Pressure Psig	Bottom Head Curve A (°F)	Upper Vessel & Beltline 35 EFPY Curve A (°F)	Bottom Head Curve B (°F)	Upper Vessel & Beltline 35 EFPY Curve B (°F)	35 EFPY Beltline Curve C (°F)
1090	77.6	104.2	103.4	136	176
1100	78.2	104.7	104	136.4	176.4
1105	78.6	104.9	104.3	136.5	176.5
1110	78.9	105.2	104.6	136.7	176.7
1120	79.6	105.7	105.2	137	177
1130	80.2	106.2	105.8	137.3	177.3
1140	80.9	106.7	106.3	137.6	177.6
1150	81.5	107.2	106.9	137.9	177.9
1160	82.1	107.7	107.5	138.2	178.2
1170	82.8	108.2	108	138.5	178.5
1180	83.4	108.7	108.6	138.8	178.8
1190	84	109.2	109.1	139	179
1200	84.6	109.6	109.7	139.3	179.3
1210	85.2	110.1	110.2	139.6	179.6
1220	85.8	110.6	110.8	139.9	179.9
1230	86.3	111	111.3	140.2	180.2
1240	86.9	111.5	111.8	140.5	180.5
1250	87.5	111.9	112.3	140.8	180.8
1260	88	112.4	112.8	141	181
1270	88.6	112.8	113.3	141.3	181.3
1280	89.1	113.3	113.8	141.6	181.6
1290	89.7	113.7	114.3	141.9	181.9
1300	90.2	114.1	114.8	142.2	182.2
1310	90.7	114.6	115.3	142.4	182.4
1320	91.3	115	115.8	142.7	182.7
1330	91.8	115.4	116.2	143	183
1340	92.3	115.8	116.7	143.2	183.2
1350	92.8	116.2	117.2	143.5	183.5
1360	93.3	116.7	117.6	143.8	183.8
1370	93.8	117.1	118.1	144	184
1380	94.3	117.5	118.5	144.3	184.3
1390	94.8	117.9	119	144.6	184.6
1400	95.3	118.3	119.4	144.8	184.8

Table 2 – Tabulation of Curves -54 EFPY
Required Metal Temperature with Required Coolant Heatup / Cooldown Rate at 100°F/hr for Curves B & C and 20°F/hr for Curve A for Figure 2

Pressure Psig	Bottom Head Curve A (°F)	Upper Vessel & Beltline 54 EFPY Curve A (°F)	Bottom Head Curve B (°F)	Upper Vessel & Beltline 54 EFPY Curve B (°F)	54 EFPY Beltline Curve C (°F)
-14.7	68	70	68	70	70
0	68	70	68	70	70
10	68	70	68	70	70
20	68	70	68	70	70
30	68	70	68	70	70
40	68	70	68	70	70
50	68	70	68	70	70
60	68	70	68	70	70
70	68	70	68	70	70
80	68	70	68	70	75.4
90	68	70	68	70	81.8
100	68	70	68	70	87.4
110	68	70	68	70	92.4
120	68	70	68	70	97
130	68	70	68	70	101.2
140	68	70	68	70	104.9
150	68	70	68	70	108.2
160	68	70	68	71.3	111.3
170	68	70	68	74.3	114.3
180	68	70	68	77.1	117.1
190	68	70	68	79.6	119.6
200	68	70	68	82	122
210	68	70	68	84.3	124.3
220	68	70	68	86.5	126.5
230	68	70	68	88.6	128.6
240	68	70	68	90.5	130.5
250	68	70	68	92.4	132.4
260	68	70	68	94.2	134.2
270	68	70	68	95.9	135.9
280	68	70	68	97.6	137.6
290	68	70	68	99.2	139.2
300	68	70	68	100.8	140.8
310	68	70	68	102.3	142.3
312.5	68	70	68	102.6	142.6
312.51	68	100	68	130	170
320	68	100	68	130	170

Pressure Psig	Bottom Head Curve A (°F)	Upper Vessel & Beltline 54 EFPY Curve A (°F)	Bottom Head Curve B (°F)	Upper Vessel & Beltline 54 EFPY Curve B (°F)	54 EFPY Beltline Curve C (°F)
330	68	100	68	130	170
340	68	100	68	130	170
350	68	100	68	130	170
360	68	100	68	130	170
370	68	100	68	130	170
380	68	100	68	130	170
390	68	100	68	130	170
400	68	100	68	130	170
410	68	100	68	130	170
420	68	100	68	130	170
430	68	100	68	130	170
440	68	100	68	130	170
450	68	100	68	130	170
460	68	100	68	130	170
470	68	100	68	130	170
480	68	100	68	130	170
490	68	100	68	130	170
500	68	100	68	130	170
510	68	100	68	130	170
520	68	100	68	130	170
530	68	100	68	130	170
540	68	100	68	130	170
550	68	100	68	130	170
560	68	100	68	130	170
570	68	100	68	130	170
580	68	100	68	130.6	170.6
590	68	100	68	131.4	171.4
600	68	100	68	132.2	172.2
610	68	100	68	132.9	172.9
620	68	100	68	133.6	173.6
630	68	100	68	134.4	174.4
640	68	100	68	135.1	175.1
650	68	100	68	135.8	175.8
660	68	100	68	136.5	176.5
670	68	100	68	137.1	177.1
680	68	100	68.7	137.8	177.8
690	68	100	69.9	138.5	178.5
700	68	100	71	139.1	179.1
710	68	100	72.2	139.8	179.8
720	68	100	73.3	140.4	180.4

Pressure Psig	Bottom Head Curve A (°F)	Upper Vessel & Beltline 54 EFPY Curve A (°F)	Bottom Head Curve B (°F)	Upper Vessel & Beltline 54 EFPY Curve B (°F)	54 EFPY Beltline Curve C (°F)
730	68	100.2	74.4	141	181
740	68	101	75.5	141.6	181.6
750	68	101.9	76.6	142.2	182.2
760	68	102.7	77.6	142.9	182.9
770	68	103.5	78.6	143.4	183.4
780	68	104.2	79.6	144	184
790	68	105	80.6	144.6	184.6
800	68	105.8	81.5	145.2	185.2
810	68	106.5	82.5	145.7	185.7
820	68	107.3	83.4	146.3	186.3
830	68	108	84.3	146.9	186.9
840	68	108.7	85.2	147.4	187.4
850	68	109.4	86	147.8	187.8
860	68	110.1	86.9	148.1	188.1
870	68	110.8	87.7	148.5	188.5
880	68	111.5	88.6	148.9	188.9
890	68	112.2	89.4	149.2	189.2
900	68	112.8	90.2	149.6	189.6
910	68	113.5	91	149.9	189.9
920	68	114.1	91.7	150.3	190.3
930	68	114.8	92.5	150.6	190.6
940	68	115.4	93.3	151	191
950	68	116	94	151.3	191.3
960	68	116.6	94.7	151.6	191.6
970	68.6	117.2	95.5	152	192
980	69.4	117.8	96.2	152.3	192.3
990	70.2	118.4	96.9	152.6	192.6
1000	71	119	97.6	153	193
1010	71.7	119.6	98.2	153.3	193.3
1020	72.5	120.1	98.9	153.6	193.6
1030	73.3	120.7	99.6	153.9	193.9
1035	73.6	121	99.9	154.1	194.1
1040	74	121.3	100.2	154.3	194.3
1050	74.7	121.8	100.9	154.6	194.6
1055	75.1	122.1	101.2	154.7	194.7
1060	75.4	122.4	101.5	154.9	194.9
1070	76.2	122.9	102.1	155.2	195.2
1080	76.9	123.4	102.8	155.5	195.5
1090	77.6	124	103.4	155.8	195.8
1100	78.2	124.5	104	156.2	196.2

Pressure Psig	Bottom Head Curve A (°F)	Upper Vessel & Beltline 54 EFPY Curve A (°F)	Bottom Head Curve B (°F)	Upper Vessel & Beltline 54 EFPY Curve B (°F)	54 EFPY Beltline Curve C (°F)
1105	78.6	124.7	104.3	156.3	196.3
1110	78.9	125	104.6	156.5	196.5
1120	79.6	125.5	105.2	156.8	196.8
1130	80.2	126	105.8	157.1	197.1
1140	80.9	126.5	106.3	157.4	197.4
1150	81.5	127	106.9	157.7	197.7
1160	82.1	127.5	107.5	158	198
1170	82.8	128	108	158.3	198.3
1180	83.4	128.5	108.6	158.6	198.6
1190	84	129	109.1	158.8	198.8
1200	84.6	129.4	109.7	159.1	199.1
1210	85.2	129.9	110.2	159.4	199.4
1220	85.8	130.4	110.8	159.7	199.7
1230	86.3	130.8	111.3	160	200
1240	86.9	131.3	111.8	160.3	200.3
1250	87.5	131.7	112.3	160.6	200.6
1260	88	132.2	112.8	160.8	200.8
1270	88.6	132.6	113.3	161.1	201.1
1280	89.1	133.1	113.8	161.4	201.4
1290	89.7	133.5	114.3	161.7	201.7
1300	90.2	133.9	114.8	162	202
1310	90.7	134.4	115.3	162.2	202.2
1320	91.3	134.8	115.8	162.5	202.5
1330	91.8	135.2	116.2	162.8	202.8
1340	92.3	135.6	116.7	163	203
1350	92.8	136	117.2	163.3	203.3
1360	93.3	136.5	117.6	163.6	203.6
1370	93.8	136.9	118.1	163.8	203.8
1380	94.3	137.3	118.5	164.1	204.1
1390	94.8	137.7	119	164.4	204.4
1400	95.3	138.1	119.4	164.6	204.6

Appendix A

Reactor Vessel Material Surveillance Program

In accordance with 10CFR50, Appendix H, Reactor Vessel Material Surveillance Program Requirements, the first surveillance capsule was removed from the GGNS reactor vessel during refueling outage (RFO)07 and returned to the reactor during RFO-08 without testing.

As described in GGNS Updated Final Safety Analysis Report (UFSAR) Section 5.3.1.6, Material Surveillance, the Integrated Surveillance Program will determine the removal schedule for the GGNS surveillance capsules. The Grand Gulf material surveillance program is administered in accordance with the BWR Vessel and Internals Project Integrated Surveillance Program (BWRVIP ISP). The ISP combines the U.S. BWR surveillance programs into a single integrate program. This program uses similar heats of materials in the surveillance programs of BWRs to represent the limiting materials in other vessels. It also adds data from the BWR Supplemental Surveillance Program (SSP). Per the BWRVIP ISP, no capsules are scheduled to be withdrawn from the Grand Gulf vessel. Other plants will remove and test specimens that represent the Grand Gulf vessel.

Appendix B
GGNS Reactor Pressure Vessel Beltline
EFPY 35 ART Values

Table 4-2a: GGNS Beltline ART Values (35 EFPY)

Component	HEAT	%Cu	%Ni	CF	Fitted or adjusted CF °F	Initial RT_{NDT} °F	¼ T Fluence n/cm²	35 EFPY ΔRT_{NDT} °F	σ_i	σ_Δ	Margin °F	35 EFPY Shift °F	35 EFPY ART °F
PLANT-SPECIFIC CHEMISTRIES PLATES:													
Shell Ring 3 (6)	C2741-1	0.12 (7)	0.64	84		10	1.59E+17	12.5	0	6.3	12.5	25.0	35.0
	C2741-2	0.12 (7)	0.64	84		-10	1.59E+17	12.5	0	6.3	12.5	25.0	15.0
	C27479-1	0.12 (7)	0.64	83		10	1.59E+17	12.4	0	6.2	12.4	24.7	34.7
Shell Ring 2	C2593-2	0.04	0.59	26		-30	1.61E+18	13.5	0	6.7	13.5	27.0	-3.0
	C2594-1	0.04	0.63	26		-10	1.61E+18	13.5	0	6.7	13.5	27.0	17.0
	C2594-2	0.04	0.63	26		0	1.61E+18	13.5	0	6.7	13.5	27.0	27.0
	A1224-1	0.04	0.65	26		0	1.61E+18	13.5	0	6.7	13.5	27.0	27.0
Shell Ring 1 (6)	A1113-1	0.12 (7)	0.65	84		10	1.93E+17	14.1	0	7.0	14.1	28.2	38.2
	C2557-2	0.12 (7)	0.64	84		10	1.93E+17	14.1	0	7.0	14.1	28.1	38.1
	C2506-1	0.12 (7)	0.66	84		-20	1.93E+17	14.1	0	7.1	14.1	28.2	8.2
AXIAL WELDS(1):													
Shell Ring 3 (6)	5P6214B/0331 Single	0.02	0.82	27		-50	1.59E+17	4.0	0	2.0	4.0	8.0	-42.0
	5P6214B/0331 Tandem	0.014	0.70	23		-40	1.59E+17	3.4	0	1.7	3.4	6.8	-33.2
Shell Ring 2	5P6214B/0331 Single	0.02	0.82	27		-50	1.61E+18	14.0	0	7.0	14.0	28.0	-22.0
	5P6214B/0331 Tandem	0.02	0.82	27		-40	1.61E+18	14.0	0	7.0	14.0	28.0	-12.0
Shell Ring 1 (6)	5P6214B/0331 Single	0.02	0.82	27		-50	1.93E+17	4.5	0	2.3	4.5	9.1	-40.9
	5P6214B/0331 Tandem	0.02	0.82	27		-40	1.93E+17	4.5	0	2.3	4.5	9.1	-30.9
CIRCUMFERENTIAL WELDS:													
AB (2)	4P7216/0156 Single	0.03	0.79	41		-40	1.93E+17	6.9	0	3.4	6.9	13.8	-26.2
AB (2)	4P7216/0156 Tandem	0.03	0.81	41		-60	1.93E+17	6.9	0	3.4	6.9	13.8	-46.2
AC(2)	5P6771/0342 Single	0.03	0.88	41		-30	1.59E+17	6.1	0	3.1	6.1	12.2	-17.8
AC (2)	5P6771/0342 Tandem	0.04	0.95	54		-20	1.59E+17	8.0	0	4.0	8.0	16.1	-3.9

Table 4-2a: GGNS Beltline ART Values (35 EFPY) Continued

Component	HEAT	%Cu	%Ni	CF	Fitted or adjusted CF °F	Initial RT_{NDT} °F	¼ T Fluence n/cm²	35 EFPY Δ RT_{NDT} °F	σ_i	σ_Δ	Margin °F	35 EFPY Shift °F	35 EFPY ART °F
NOZZLES:													
N6 Forging (6)	Q2QL2W	0.20	0.83	160		-20	1.13E+17	19.1	0	9.5	19.1	38.1	18.1
N6 Welds (6)	5P6756/0342 Single	0.08	0.93	108		-60	1.13E+17	12.9	0	6.4	12.9	25.7	-34.3
N6 Welds (6)	5P6756/0342 Tandem	0.09	0.92	122		-50	1.13E+17	14.5	0	7.3	14.5	29.1	-20.9
N12 (3)	C2593-2	0.04	0.59	26		-30	1.76E+17	4.1	0	2.1	4.1	8.3	-21.7
N12 (3)	C2594-2	0.04	0.63	26		0	1.76E+17	4.1	0	2.1	4.1	8.3	8.3
N12 Welds (3)	SB166												
BEST ESTIMATE CHEMISTRIES from BWRVIP-135 R3													
Plate	A1224-1	0.035	0.65	23		0	1.61E+18	11.9	0	6.0	11.9	23.9	23.9
Weld	5P6214B/0331 Single	0.019	0.828	26.3		-50	1.61E+18	13.6	0	6.8	13.6	27.3	-22.7
Weld	5P6214B/0331 Tandem	0.019	0.828	26.3		-40	1.61E+18	13.6	0	6.8	13.6	27.3	-12.7
N6 Weld (6)	5P6756/0342 Single	0.080	0.936	108		-60	1.13E+17	12.9	0	6.4	12.9	25.7	-34.3
N6 Weld (6)	5P6756/0342 Tandem	0.080	0.936	108		-50	1.13E+17	12.9	0	6.4	12.9	25.7	-24.3
Weld AC (2)	5P6771/0342 Single	0.034	0.934	46		-30	1.59E+17	6.8	0	3.4	6.8	13.7	-16.3
Weld AC (2)	5P6772/0342 Tandem	0.034	0.934	46		-20	1.59E+17	6.8	0	3.4	6.8	13.7	-16.3
Weld AB (2)	4P7216/0156 Single	0.038	0.82	51.4		-40	1.93E+17	8.6	0	4.3	8.6	17.3	-22.7
Weld AB (2)	4P7216/0156 Tandem	0.038	0.82	51.4		-60	1.93E+17	8.6	0	4.3	8.6	17.3	-42.7
INTEGRATED SURVEILLANCE PROGRAM (BWRVIP-135 R3)													
Plate	A1224-1	0.035	0.65		47.87 (4)	0	1.61E+18	24.8	0	8.5	17.0	41.8	41.8
Weld	5P6214B Single	0.02	0.92		43.28 (4.5)	-50	1.61E+18	22.5	0	11.2	22.5	44.9	-5.1
Weld	5P6214B Tandem	0.02	0.92		43.28 (4.5)	-40	1.61E+18	22.5	0	11.2	22.5	44.9	4.9

Table 4-2a: GGNS Beltline ART Values (35 EFPY) Continued

Notes:

[1] Use of SMAW Heats 422K8511, 627069, 626677, and 627260 was determined to be limited to weld pick-ups at the ID/OD surfaces or initial root pass or sealing at the backing bars which were ground out or subsequently removed. Certified Material Test Reports indicate that no SMAW weld material is present at either the ¼ T or ¾ T Location. Therefore, these heats are not required to be evaluated as part of the beltline region.

[2] Welds AB and AC occur within the extended beltline region, defined as experiencing a fluence >1.0e17 m/cm^2.

[3] The N12 Water Level Instrumentation Nozzle occurs in the beltline region. Because the forging and weld are non-ferritic material, the ART is calculated using the plate heats where the nozzles occur. For GGNS, these nozzles occur in only two (2) of the Shell 2 plates.

[4] The fitted CF (plate material) and adjusted CF (weld material) are determined using the methods defined in RG 1.99, R2, Position 2. Best estimate chemistry is considered.

[5] Weld Heat 56214B is represented by material in BWRVIP-135 R3 with two (2) different chemistries. Recommendations provided in BWRVIP-135 R3 have been employed to determine the surveillance chemistry used for calculating the adjusted CF. The adjusted CF is calculated using the best estimate chemistry to represent the vessel CF – (27/27) x 43.28 = 43.28°F. BWRVIP-135 R3 provides updated data for this weld that has been incorporated in this evaluation.

[6] Shell 1 and Shell 3 and the associated axial welds and nozzles are evaluated based on the extended beltline region.

[7] Copper content is not available; therefore the maximum allowable %Cu was obtained from the vessel design specification.

Appendix C
GGNS Reactor Pressure Vessel Beltline
EFPY 54 ART Values

Table 4-2b: GGNS Beltline ART Values (54 EFPY)

Component	HEAT	%Cu	%Ni	CF	Fitted or adjusted CF °F	Initial RT_{NDT} °F	¼ T Fluence n/cm²	54 EFPY ΔRT_{NDT} °F	σ_i	σ_Δ	Margin °F	54 EFPY Shift °F	54 EFPY ART °F
PLANT-SPECIFIC CHEMISTRIES PLATES:													
Shell Ring 3 (6)	C2741-1	0.12 (7)	0.64	84		10	3.04E+17	18.6	0	9.3	18.6	37.2	47.2
	C2741-2	0.12 (7)	0.64	84		-10	3.04E+17	18.6	0	9.3	18.6	37.2	27.2
	C27479-1	0.12 (7)	0.64	83		10	3.04E+17	18.4	0	9.2	18.4	36.7	46.7
Shell Ring 2	C2593-2	0.04	0.59	26		-30	2.76E+18	16.9	0	8.4	16.9	33.7	3.7
	C2594-1	0.04	0.63	26		-10	2.76E+18	16.9	0	8.4	16.9	33.7	23.7
	C2594-2	0.04	0.63	26		0	2.76E+18	16.9	0	8.4	16.9	33.7	33.7
	A1224-1	0.04	0.65	26		0	2.76E+18	16.9	0	8.4	16.9	33.7	33.7
Shell Ring 1 (6)	A1113-1	0.12 (7)	0.65	84		10	3.63E+17	20.5	0	10.3	20.5	41.1	51.1
	C2557-2	0.12 (7)	0.64	84		10	3.63E+17	20.5	0	10.2	20.5	41.0	51.0
	C2506-1	0.12 (7)	0.66	84		-20	3.63E+17	20.6	0	10.3	20.6	41.1	21.1
AXIAL WELDS(1):													
Shell Ring 3 (6)	5P6214B/0331 Single	0.02	0.82	27		-50	3.04E+17	6.0	0	3.0	6.0	12.0	-38.0-
	5P6214B/0331 Tandem	0.014	0.70	23		-40	3.04E+17	5.1	0	2.5	5.1	10.2	29.8
Shell Ring 2	5P6214B/0331 Single	0.02	0.82	27		-50	2.76E+18	17.5	0	8.8	17.5	35.0	-15.0
	5P6214B/0331 Tandem	0.02	0.82	27		-40	2.76E+18	17.5	0	8.8	17.5	35.0	-5.0
Shell Ring 1 (6)	5P6214B/0331 Single	0.02	0.82	27		-50	3.63E+17	6.6	0	3.3	6.6	13.2	-36.8
	5P6214B/0331 Tandem	0.02	0.82	27		-40	3.63E+17	6.6	0	3.3	6.6	13.2	-26.8
CIRCUMFERENTIAL WELDS:													
AB (2)	4P7216/0156 Single	0.03	0.79	41		-40	3.63E+17	10.1	0	5.0	10.1	20.1	-19.9
AB (2)	4P7216/0156 Tandem	0.03	0.81	41		-60	3.63E+17	10.1	0	2.0	10.1	20.1	-39.9
AC(2)	5P6771/0342 Single	0.03	0.88	41		-30	3.04E+17	9.1	0	4.5	9.1	18.1	11.9
AC (2)	5P6771/0342 Tandem	0.04	0.95	54		-20	3.04E+17	12.0	0	6.0	12.0	23.9	3.9

Table 4-2b: GGNS Beltline ART Values (54 EFPY) Continued

Component	HEAT	%Cu	%Ni	CF	Fitted or adjusted CF °F	Initial RT_{NDT} °F	¼ T Fluence n/cm²	54 EFPY Δ RT_{NDT} °F	σ_i	σ_Δ	Margin °F	54 EFPY Shift °F	5 EFPY ART °F
NOZZLES:													
N6 Forging (6)	Q2QL2W	0.20	0.83	160		-20	2.17E+17	28.9	0	14.5	28.9	57.9	37.9
N6 Welds (6)	5P6756/0342 Single	0.08	0.93	108		-60	2.17E+17	19.5	0	9.8	19.5	39.1	-20.9
N6 Welds (6)	5P6756/0342 Tandem	0.09	0.92	122		-50	2.17E+17	22.1	0	11.0	22.1	44.1	-5.9
N12 (3)	C2593-2	0.04	0.59	26		-30	3.25E+17	6.0	0	3.0	6.0	12.0	-18.0
N12 (3)	C2594-2	0.04	0.63	26		0	3.25E+17	6.0	0	3.0	6.0	12.0	12.0
N12 Welds (3)	SB166												
BEST ESTIMATE CHEMISTRIES from BWRVIP-135 R3													
Plate	A1224-1	0.035	0.65	23		0	2.76E+18	14.9	0	7.5	14.9	29.9	29.9
Weld	5P6214B/0331 Single	0.019	0.828	26.3		-50	2.76E+18	17.1	0	8.5	17.1	34.1	-15.9
Weld	5P6214B/0331 Tandem	0.019	0.828	26.3		-40	2.76E+18	17.1	0	8.5	17.1	34.1	-5.9
N6 Weld (6)	5P6756/0342 Single	0.080	0.936	108		-60	2.17E+17	19.5	0	9.8	19.5	39.1	-20.9
N6 Weld (6)	5P6756/0342 Tandem	0.080	0.936	108		-50	2.17E+17	19.5	0	9.8	19.5	39.1	-10.9
Weld AC (2)	5P6771/0342 Single	0.034	0.934	46		-30	3.04E+17	10.2	0	5.1	10.2	20.4	-9.6
Weld AC (2)	5P6772/0342 Tandem	0.034	0.934	46		-20	3.04E+17	10.2	0	5.1	10.2	20.4	0.4
Weld AB (2)	4P7216/0156 Single	0.038	0.82	51.4		-40	3.63E+17	12.6	0	6.3	12.6	25.2	-14.8
Weld AB (2)	4P7216/0156 Tandem	0.038	0.82	51.4		-60	3.63E+17	12.6	0	6.3	12.6	25.2	-34.8
INTEGRATED SURVEILLANCE PROGRAM (BWRVIP-135 R3)													
Plate	A1224-1	0.035	0.65		47.87 (4)	0	2.76E+18	31.1	0	8.5	17.0	48.1	48.1
Weld	5P6214B Single	0.02	0.92		43.28 (4.5)	-50	2.76E+18	28.1	0	14.0	28.0	56.1	6.1
Weld	5P6214B Tandem	0.02	0.92		43.28 (4.5)	-40	2.76E+18	28.1	0	14.0	28.0	56.1	16.1

Table 4-2b: GGNS Beltline ART Values (54 EFPY) Continued

Notes:

[1] Use of SMAW Heats 422K8511, 627069, 626677, and 627260 was determined to be limited to weld pick-ups at the ID/OD surfaces or initial root pass or sealing at the backing bars which were ground out or subsequently removed. Certified Material Test Reports indicate that no SMAW weld material is present at either the ¼ T or ¾ T Location. Therefore, these heats are not required to be evaluated as part of the beltline region.

[2] Welds AB and AC occur within the extended beltline region, defined as experiencing a fluence >1.0e17 m/cm^2.

[3] The N12 Water Level Instrumentation Nozzle occurs in the beltline region. Because the forging and weld are non-ferritic material, the ART is calculated using the plate heats where the nozzles occur. For GGNS, these nozzles occur in only two (2) of the Shell 2 plates.

[4] The fitted CF (plate material) and adjusted CF (weld material) are determined using the methods defined in RG 1.99, R2, Position 2. Best estimate chemistry is considered.

[5] Weld Heat 56214B is represented by material in BWRVIP-135 R3 with two (2) different chemistries. Recommendations provided in BWRVIP-135 R3 have been employed to determine the surveillance chemistry used for calculating the adjusted CF. The adjusted CF is calculated using the best estimate chemistry to represent the vessel CF – (27/27) x 43.28 = 43.28°F. BWRVIP-135 R3 provides updated data for this weld that has been incorporated in this evaluation.

[6] Shell 1 and Shell 3 and the associated axial welds and nozzles are evaluated based on the extended beltline region.

[7] Copper content is not available; therefore the maximum allowable %Cu was obtained from the vessel design specification.

Page 3 of 3

Appendix D
GGNS Reactor Pressure Vessel P-T Curve
Supporting Plant-Specific Information

Figure 3: Schematic of the GGNS RPV showing arrangement of vessel plates and welds

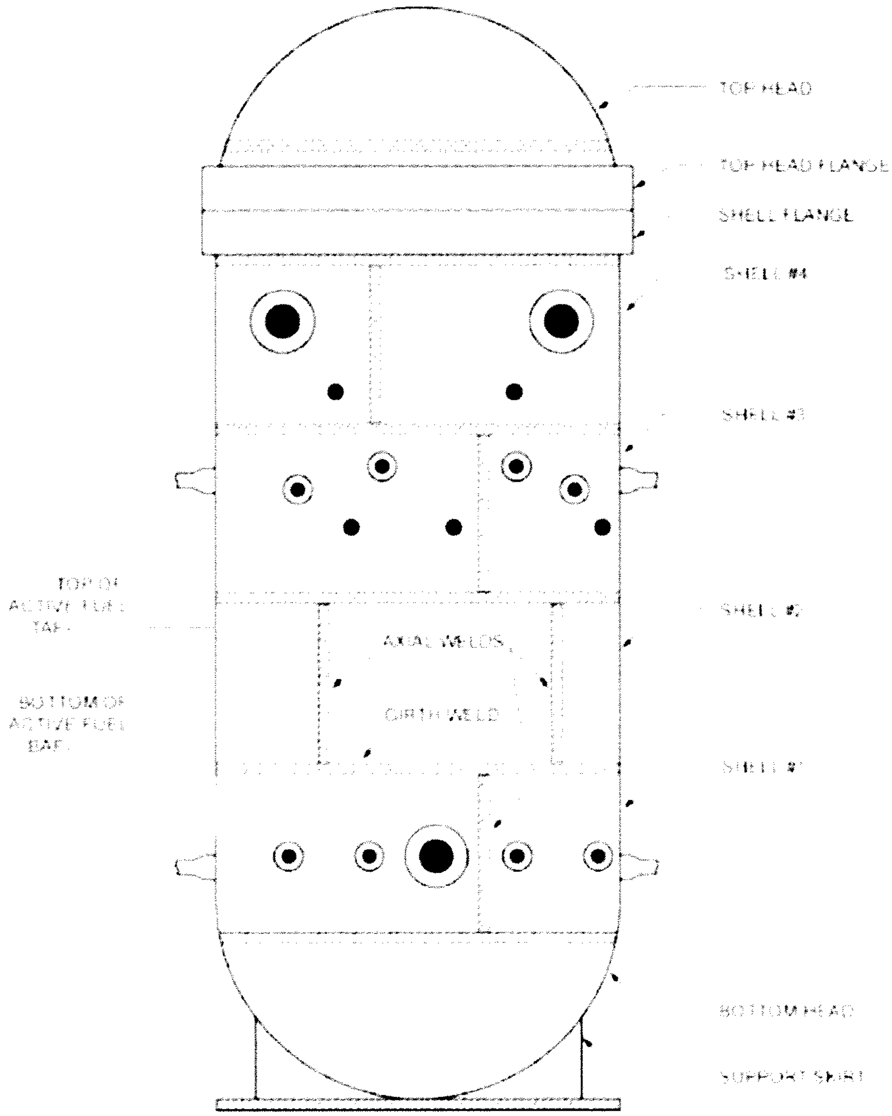

Table 3a: Initial RT_{NDT} Values for GGNS Plate and Flange Materials

Component	Heat	Test Temp (°F)	Charpy Energy (ft-lb)			(T_{NDT}-60) (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
Top Head & Flange								
Top Head Dollar	C2448-3	30	71	51	60	-30	-30	-30
36-2								
Top Head Torus Plates								
36-1-1 thru 36-1-3	C2944-1	70	52	55	53	10	-20	10
36-1-4 thru 36-1-6	B6727-2	40	52	52	50	-20	-20	-20
Top Head Flange								
32-1	48D1682-1-1	30	85	101	113	-30	-30	-30
Shell Courses & Shell Flange								
Shell Flange	48D1141-1-1	30	105	87	81	-30	-30	-30
27-1								
Upper Shell Plates	C2815-2	70	53	51	56	10	0	10
24-1-1	C2788-2	70	61	51	50	10	-10	10
24-1-2	C2779-2	70	50	53	57	10	0	10
24-1-3	C2788-1	70	58	52	53	10	-20	10
24-1-4								
Upper Intermediate Plates								
23-1-1	C2741-2	50	54	68	66	-10	-10	-10
23-1-2	C2779-1	70	52	50	54	10	-10	10
23-1-3	C2741-1	70	66	54	50	10	-30	10
Lower Intermediate Plates								
22-1-1	C2593-2	20	52	60	61	-40	-30	-30
22-1-2	C2954-1	50	56	50	62	-10	-10	-10
22-1-3	C2594-2	40	67	50	50	-20	0	0
22-1-4	A1224-1	60	52	74	52	0	-20	0
Lower Shell Plates								
21-1-1	A1113-1	70	62	58	60	10	-20	10
21-1-2	C2557-2	70	64	63	72	10	-20	10
21-1-3	C2506-1	40	50	61	71	-20	-30	-20
Bottom Head								
Bottom Head Dollar								
13-1	C2630-2	60	55	53	51	0	-40	0
Bottom Head Torus Plates								
13-2-L	C2539-2	70	53	51	50	10	-20	10
13-2-R	C2539-2	70	53	51	50	10	-20	10
13-3-L	A1145-2	50	51	60	52	-10	-10	-10
13-3-R	A1145-1	70	53	69	55	10	-10	10

Table 3b: Initial RT_{NDT} Values for GGNS Nozzle Materials

Component	Heat	Test Temp (°F)	Charpy Energy (ft-lb)			$(T_{NDT}-60)$ (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
N1 Recirculation Outlet Nozzle								
49-1-1	Q2QL1W	40	105	104	86	-20	-20	-20
49-1-2	Q2QL1W	40	112	96	96	-20	-20	-20
N2 Recirculation Inlet Nozzle								
52-1-1	Q2QL1W	30	62	90	110	-30	-20	-20
52-1-2	Q2QL1W	40	91	70	93	-20	-20	-20
52-1-3	Q2QL1W	30	96	108	77	-30	-20	-20
52-1-4	Q2QL1W	40	85	89	52	-20	-20	-20
52-1-5	Q2QL1W	40	94	70	81	-20	-20	-20
52-1-6	Q2QL4W	40	77	86	72	-20	-20	-20
52-1-7	Q2QL1W	40	60	50	67	-20	-20	-20
52-1-8	Q2QL4W	40	81	67	62	-20	-20	-20
52-1-9	Q2QL1W	40	78	104	86	-20	-20	-20
52-1-10	Q2QL1W	30	80	78	62	-20	-20	-20
52-1-11	Q2QL1W	40	92	112	103	-20	-20	-20
52-1-12	Q2QL1W	30	80	78	62	-30	-20	-20
N3 Steam Outlet Nozzle								
56-1-1	Q2Q65W	30	118	128	121	-30	-20	-20
56-1-2	Q2Q65W	40	113	80	68	-20	-20	-20
56-1-3	Q2Q65W	40	135	125	115	-20	-20	-20
56-1-4	Q2Q65W	40	118	97	103	-20	-20	-20
N4 Feedwater Nozzle								
59-1-1	Q2Q65W	30	74	98	128	-30	-20	-20
59-1-2	Q2Q65W	30	54	98	104	-30	-20	-20
59-1-3	Q2Q65W	30	112	118	140	-30	-20	-20
59-1-4	Q2Q65W	30	76	86	80	-30	-20	-20
59-1-5	Q2Q65W	30	83	109	98	-30	-20	-20
59-1-6	Q2Q65W	30	110	82	98	-30	-20	-20
N5 Core Spray Nozzles								
63-1-1	Q2QL2W	40	71	76	55	-20	-20	-20
63-1-2	Q2QL2W	30	57	95	90	-30	-20	-20
N6 RHR/LPCI Nozzle								
67-1-1	Q2QL2W	40	63	58	70	-20	-20	-20
67-1-2	Q2QL2W	40	70	60	71	-20	-20	-20
67-1-3	Q2QL2W	40	98	108	103	-20	-20	-20
N7 Top Head Spry Nozzle								
71-1	Q2QL13QT	40	83	70	81	-20	-20	-20
Blind Flange 72-2	C2448-3	30	71	51	60	-30	-30	-30
N8 Top Head Spare Nozzle								
74-1	Q2QL19QT	40	85	56	80	-20	-20	-20
Blind Flange 75-1	C2448-3	30	71	51	60	-30	-30	-30
N9 Jet Pump Instrument Nozzle								
77-1-1	Q2QL1W	40	113	111	108	-20	-20	-20
77-1-2	Q2QL1W	20	82	78	79	-40	-20	-20
N10 CRD HYD Return Nozzle								
80-1	Q2QL4W	30	70	58	73	-30	-20	-20
N11 and N18 Core ΔP Nozzle								
84-1-1 and 84-1-2	SB166							
N12 and N13 Instrument Nozzles								
88-1-1 thru 88-1-8	Stainless Steel							
N14 Instrument Nozzles								
91-1-1 thru 91-1-4	Stainless Steel							
N15 Drain Nozzle								
93-1-1 thru 91-1-2	719282	30	180	209	239	-30	-30	-30
N16 Instrument Vibration Nozzles								
95-1	Q2QL4W	30	68	63	54	-30	-20	-20
Blind Flange 95-2	C2448-3	30	71	51	60	-30	-30	-30`
N17 Seal Leak Detector Nozzle								
99-1	SB166							

Table 3c: Initial RT_{NDT} Values for GGNS Weld Materials

Component	Heat or Heat / Flux / Lot	Test Temp (°F)	Charpy Energy (ft-lb)			(T_{NDT}-60) (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
Top Head Welds								
Top Head Torus to Dollar Plate (AH)	540892/J424B27AE	0	65	62	62	-60	-70	-60
	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	401P2871/H430B27AF	10	75	76	107	-50	-70	-50
	412L4711/A423B27AH	0	72	83	95	-60	-90	-60
	07R458/S403B27AG	0	59	61	70	-60	-60	-60
	L83978/J414B27AD	-20	51	52	81	-80	-80	-60
Top Head Flange to Torus (AG)	401P2871/H430B27AF	10	75	75	107	-50	-70	-50
	402P3162/H426B27AE	-10	60	54	68	-70	-70	-70
	412L4711/A423B27AH	0	72	83	95	-60	-90	-60
	07R458/S403B27AG	0	59	61	70	-60	-60	-60
	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	640892/J424B27AE	0	55	62	62	-60	-70	-60
	412P3611/J417B27AF	-20	52	65	69	-80	-80	-60
	401S0371/B504B27AE	-20	61	64	77	-80	-60	-60
Top Head Upper Torus Meridional Welds								
DH, DJ, DK, DM, DN, DP	422K8511/G313A27AD	-20	65	74	127	-50	-50	-60
DH, DJ, DN, DP	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
DH, DJ, DK, DM, DN, DP	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
DH, DJ, DK, DM, DN, DP	629865/A421A27AD	-10	69	70	88	-70	-90	-70
DH, DJ, DK, DM, DN, DP	402P3162/H426B27AE	-10	60	54	68	-70	-70	-70
DH	07R458/S403B27AG	0	59	61	70	-60	-60	-60
Cylindrical Shell Circumferential Welds								
Shell Flange to Upper Shell (AE)	5P6756/Linde 124/0342 (Single)	0	55	66	63	-80	-80	-60
	5P6756/Linde 124/0342 (Tandem)	10	64	72	77	-50	-90	-50
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	629865/A421B27AD	-10	69	70	88	-70	-80	-70
	540892/J424B27AE	0	55	62	62	-60	-70	-60
	07R458/S403B27AG	0	59	61	70	-60	-60	-60
	401P2871/H430B27AF	10	75	76	107	-50	-70	-50
Upper Shell to Upper-Intermediate Shell (AD)								
	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
	412L4711/A423B27AH	0	72	83	95	-60	-90	-60
	401P2871/H430B27AF	10	75	76	107	-50	-70	-50
	5P6771/Linde 124/0342 (Single)	30	78	53	68	-30	-30	-30
	5P6771/Linde 124/0342 (Tandem)	40	77	81	83	-20	-20	-20
	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	640892/J424B27AE	0	55	62	62	-60	-70	-60
Upper-intermediate shell to lower intermediate Shell (AC)	401P2871/H430B27AF	10	75	76	107	-50	-70	-50
	07R458/S403B27AG	0	59	61	70	-60	-60	-60
	412L4711/A423B27AH	0	72	83	95	-60	-90	-60
	5P6771/Linde 124/0342 (Single)	30	78	53	68	-30	-30	-30
	5P6771/Linde 124/0342 (Tandem)	40	77	81	83	-20	-20	-20
Lower-Intermediate Shell to Lower Shell (AB)	4P7216/Linde 124/0156 (Single)	20	51	59	53	-40	-70	-40
	4P7216/Linde 124/0156 (Tandem)	0	64	71	63	-60	-50	-60
Lower Shell to Bottom Head (AA)	5P6214B/Linde 124/0342 (Single)	10	51	56	57	-50	-20	-20
	5P6214B/Linde 124/0342 (Tandem)	40	70	67	62	-20	-20	-20
	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	401S0371/B504B27AE	-20	61	84	77	-80	-60	-60
	401P2871/H430B27AF	10	75	76	107	-50	-70	-50
	412P3611/J417B27AF	-20	52	65	69	-50	-80	-80
	02R486/J404B27AG	-10	52	64	66	-70	-90	-70
	L83978/J414B27AD	-20	51	52	81	-50	-80	-80

Table 3c: Initial RT_{NDT} Values for GGNS Weld Materials, Continued

Component	Heat or Heat / Flux / Lot	Test Temp (°F)	Charpy Energy (ft-lb)			(T_{NDT}-60) (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
Cylindrical Shell Vertical Welds								
Welds within Lower Shell Ring								
BA, BB, BC	627260/B322A27AE	30	52	56	51	-30	-40	-30
BA, BB, BC	624063/C228A27A	10	57	59	68	-50	-60	-50
BA, BB, BC	627069/C312A27AG	0	72	64	78	-60	-60	-60
BA	626677/C301A27A	40	53	51	54	-20	-40	-20
BC	624039/D205A27A	-30	64	61	69	-90	-90	-90
BC	492L487/A421B27AE	0	50	51	57	-60	-90	-60
BC	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
BA, BB, BC	5P6214B/Linde 124/0331 (Single)	10	56	50	54	-50	-50	-50
BA, BB, BC	5P6214B/Linde 124/0331 (Tandem)	10	50	61	64	-50	-40	-40
Welds within Lower Intermediate Shell Ring								
BD, BE, BF, BG	627260/B322A27AE	30	52	56	51	-30	-40	-30
BD, BE, BF, BG	624063/C228A27A	10	57	59	68	-50	-60	-50
BD, BE, BF, BG	626677/C301A27A	40	53	51	54	-20	-40	-20
BD, BE, BF, BG	627069/C312A27AG	0	72	64	78	-60	-40	-60
BD, BE, BF, BG	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
BD, BE, BF, BG	5P6214B/Linde 124/0331 (Single)	10	56	50	54	-50	-50	-50
BD, BE, BF, BG	5P6214B/Linde 124/0331 (Tandem)	10	50	61	64	-50	-40	-40
Welds with Upper-intermediate Shell Ring								
BH, BJ, BK	627069/B322A27AE	30	52	56	51	-30	-40	-30
BH, BJ, BK	626677/C301A27A	40	53	51	54	-20	-40	-20
BH, BJ, BK	6240603/B312A27A	10	57	59	68	-50	-60	-50
BH, BJ, BK	627069/C312A27AG	0	72	64	78	-60	-60	-60
BH, BJ, BK	5P6214B/Linde 124/0331 (Single)	10	56	50	54	-50	-50	-50
BH, BJ, BK	5P6214B/Linde 124/0331 (Tandem)	10	50	61	64	-50	-40	-40
BJ	624039/D205A27A	-30	64	61	69	-90	-90	-90
Welds within Upper Shell Ring								
BM, BN, BP, BR	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
BM, BN, BP, BR	626677/C301A27A	40	53	51	54	-20	-40	-20
BM, BN, BP, BR	627260/B322A27AE	30	52	56	51	-30	-40	-30
BP	627184/C314A27AH	10	53	66	63	-50	-70	-50
BM, BN, BP, BR	627069/C312A27AG	0	72	64	78	-60	-60	-60
BM, BN, BP, BR	5P6214B/Linde 124/0331 (Single)	10	56	50	54	-50	-50	-50
BM, BN, BP, BR	5P6214B/Linde 124/0331 (Tandem)	10	50	61	64	-50	-40	-40
Bottom Head Welds								
DA	492L4871/A421A27AD	0	50	51	57	-60	-90	-60
DA, DC, DD	422K851/G313A27AD	-20	65	74	127	-80	-80	-80
DC, DD	5P6214B/Linde 124/0331 (Single)	10	56	50	54	-50	-50	-50
DC, DD	5P6214B/Linde 124/0331 (Tandem)	10	50	61	64	-50	-40	-40
DC, DD	627260/B322A27AE	30	52	56	51	-30	-40	-30
DC, DD	626677C301A27A	40	53	51	54	-20	-40	-20
DC, DD	627069/C312A27AG	0	72	64	76	-60	-60	-60
Support Skirt to Bottom Head	5P5657/Linde 124/0931 (Single)	0	51	55	68	-60	-60	-60
	5P5657/Linde 124/0931 (Tandem)	0	51	57	55	-60	-80	-60
	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	402P3162/H426B27AE	-10	60	54	68	-70	-70	-70
CA, CB, CG	422K851/G313A27AD	-20	65	74	127	-80	-80	-80
CA, CB	492l4871/A421B27AF	10	56	58	61	-50	-80	-50
CA, CB, CG	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
Shroud Support to Vessel Welds								
Shroud Support to Lower Shell	Inconel							
Shroud Support to Bottom Head	'Inconel 182							

Table 3c: Initial RT_{NDT} Values for GGNS Weld Materials, Continued

Component	Heat or Heat / Flux / Lot	Test Temp (°F)	Charpy Energy (ft-lb)			(T_{NDT}-60) (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
Nozzle Welds								
N1 Recirculation Outlet	05T776/I314A27AH	-10	69	72	61	-70	-70	-70
	627069/C31AA27AG	0	72	64	78	-60	-60	-60
	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	5P5657/Linde 124/0931 (Single)	0	51	55	68	-60	-60	-60
	5P5657/Linde 124/0931 (Tandem)	0	51	57	55	-60	-80	-60
	402P3162/H426B27AE	-10	60	54	68	-70	-70	-70
	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	626677/C301A27A	40	53	51	54	-20	-40	-20
	624063/C228A27A	10	57	59	68	-50	-50	-50
N2 Recirculation Inlet	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
	627260/B322A27AE	30	52	56	51	-30	-40	-30
	626677/C301A27A	40	53	51	54	-20	-40	-20
	627069/C312A27AG	0	72	64	78	-60	-60	-60
	5P5657/Linde 124/0931 (Single)	0	51	55	68	-60	-60	-60
	5P5657/Linde 124/0931 (Tandem)	0	51	57	55	-60	-80	-60
	627184/C314A27AH	10	53	66	63	-50	-70	-50
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	05T776/L314A27AH	-10	69	72	61	-70	-70	-70
	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	5P5657/Linde 124/0342 (Single)	0	55	66	63	-60	-60	-60
	5P5657/Linde 124/0342 (Tandem)	10	64	72	77	-50	-50	-50
	04T931/A428B27AG	0	65	69	72	-60	-90	-60
	402P3162/H426B27AE	-10	60	54	68	-70	-70	-70
	624063/C228A27A	10	57	59	68	-50	-60	-50
N3 Steam Dome	401P2871/H430B27AF	10	75	76	107	-50	-70	-50
	402P3162/H426B27AE	-10	60	54	68	-70	-70	-70
	629665/A421A27AD	-10	69	70	88	-70	-90	-70
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	05T776/L314A27AH	-10	69	72	81	-70	-70	-70
	04T931/A428B27AG	0	65	69	72	-60	-90	-60
	07R458/S403B27AG	0	59	61	70	-60	-60	-60
	412L4711/A42B27AH	0	72	83	95	-60	-90	-60
	5P6756/Linde 124/0342 (Single)	0	55	66	63	-60	-60	-60
	5P6576/Linde 124/0342 (Tandem)	10	64	72	77	-50	-50	-50
	3P4955/Linde 124/0342 (Single)	40	51	52	55	-20	-40	-20
	3P4955/Linde 124/0342 (Tandem)	30	60	65	52	-30	-20	-20
	5P6771/Linde 124/0342 (Single)	30	78	53	68	-30	-30	-30
	5P6771/Linde 124/0342 (Tandem)	40	77	81	83	-20	-20	-20
N4 Feedwater Nozzle	492I4871/A421B27AE	0	50	51	57	-60	-90	-60
	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
	626677/C301A27A	40	53	51	54	-20	-40	-20
	627069/C312A27AG	0	72	64	78	-60	-60	-60
	5P5657/Linde 124/0931 (Single)	0	51	55	68	-60	-60	-60
	5P5657/Linde 124/0931 (Tandem)	0	51	57	55	-60	-60	-60
	627184/C314A27AH	10	53	66	63	-50	-70	-50
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	04T931/A428B27AG	0	65	69	72	-60	-90	-60
	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	07R458/S403B27AG	0	59	61	70	-60	-60	-60
	402P3162/H426B27AE	-10	60	54	68	-70	-70	-70
	401P2871/H430B27AF	10	75	76	107	-50	-70	-50

Table 3c: Initial RT_{NDT} Values for GGNS Weld Materials, Continued	Heat or Heat / Flux / Lot	Test Temp (°F)	Charpy Energy (ft-lb)	(T_{NDT}-60) (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)

Component								
N5 Core Spray Nozzles	22K8511/G313A27AD	-20	65	74	127	-80	-80	-80
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	5P6756/Linde 124/0342 (Single)	0	55	66	63	-60	-60	-60
	5P6756/Linde 124/0342 (Tandem)	10	64	72	77	-50	-50	-50
	05T776/L314A27AH	-10	69	72	81	-70	-70	-70
	627069/C31AA27AG	0	72	64	78	-60	-60	-60
N6 LPCI Nozzle	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
	04T931/A428B27AG	0	65	69	72	-60	-90	-60
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	5P6756/Linde 124/0342 (Single)	0	55	66	63	-60	-60	-60
	5P6756/Linde 124/0342 (Tandem)	10	64	72	77	-50	-50	-50
	05T776/L314A27AH	-10	69	72	81	-70	-70	-70
N7 Top Head Spray Nozzle	401SS0371/B504B27AE	-20	61	84	77	-80	-60	-60
	02R486/J404B27AG	-10	52	64	66	-70	-90	-70
	412P3611/J417B27AF	-20	52	65	69	-80	-80	-80
	L83978/J414B27AF	-20	51	52	81	-80	-80	-80
	412L4711/A423B27AH	0	72	83	95	-60	-90	-60
N8 Top Head Spare Nozzle	629665/A421A27AD	-10	69	70	88	-70	-90	-70
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	04T931/A428B27AG	0	65	69	72	-60	-90	-60
	05T776/L314A27AH	-10	69	72	81	-70	-70	-70
	627260/B322A27E	30	52	56	51	-30	-40	-30
N9 Jet Pump Instrumentation Nozzle	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	04T931/A428B27AG	0	65	69	72	-60	-90	-60
	05T776/L314A27AH	-10	69	72	81	-70	-70	-70
	627260/B322A27AE	30	52	56	51	-30	-40	-30
N10 CRD HYD Return Nozzle	Inconel							
N12, N13, N14 Instrument Nozzles								
KA	Inconel 182							
Weld PAD Buildup N13	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
Weld PAD Buildup N13	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
Weld PAD Buildup N12, N13	627184/C314A27AH	10	53	66	63	-50	-70	-50
Weld PAD Buildup N13	05T776/L314A27AH	-10	69	72	81	-70	-70	-70
N15 Drain Nozzle	5P6756 no lot	-20	94	97	105	-80	-60	-60
	626677/C301A27A	40	53	51	54	-20	-40	-20
	627260/B322A27AE	30	52	56	51	-30	-40	-30
	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
N16 Vibration Instrumentation Nozzle	402P3162/H426B27AE	-10	60	54	68	-70	-70	-70
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
	04T931/A428B27AG	0	65	69	72	-60	-90	-60
	05T776/L314A27AH	-10	69	72	81	-70	-70	-70
N17 Seal Leak Detection Noizzle	Inconel							

Table 3c: Initial RT_{NDT} Values for GGNS Weld Materials, Continued

Component	Heat or Heat / Flux / Lot	Test Temp (°F)	Charpy Energy (ft-lb)			(T_{NDT}-60) (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
Appurtenance Welds Thermocouple Pads Shell Flange, Shell Ring #4, Top Head Flange, FW Nozzle	629665/A421A27AD	-10	69	70	88	-70	-90	-70
Bottom Heat (Sets 15, 16, 17)	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
Top Head Lifting Lugs	629665/A421A27AD	-10	69	70	88	-70	-90	-70
	L83978/J414B27AD	-20	51	52	81	-80	-80	-80
	401S0371/B504B27AE	-20	61	84	77	-80	-60	-60
	412P3611/J417B27AF	-20	52	65	69	-80	-80	-80
Guide Rod Bracket	Stainless Steel							
Steam Dryer Support Bracket	Stainless Steel							
Steam Dryer Hold Down Brackets to Top Head	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
Core Spray Bracket	Stainless Steel							
Core Spray Pad Buildup	629865/A421A27AD	-10	69	70	88	-70	-90	-70
	627184/C314A27AH	10	53	66	63	-50	-70	-50
	04T931/A428B27AG	0	65	69	72	-60	-90	-60
	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
	492L4871/A421B27AF	10	55	58	61	-50	-80	-50
Refueling Bellows to Shell Flange								
RA	627069/C312A27AG	0	72	64	78	-60	-60	-60
RA	422K8511/G313A27AD	-20	65	74	127	-80	-80	-80
RA	492L4871/A421B27AE	0	50	51	57	-60	-90	-60
RA	492L4871/A421B27AF	10	56	58	61	-50	-80	-50
RH	06590D	40	84	80	52	-20	-20	-20
RH	640968/D524M1AF	-20	81	87	98	-80	-40	-40
RH	401S2011/C506M1AG	40	122	111	123	-20	-20	-20
Jet Pump Riser Pads	627184/C314A27AH	10	53	66	63	-50	-70	-50
Feedwater Sparger Bracket	Stainless Steel							
Surveillance Bracket Pads	Stainless Steel							

Table 3d: Initial RT_{NDT} Values for GGNS Appurtenance and Bolting Materials

Component	Heat or Heat / Flux / Lot	Test Temp (°F)	Charpy Energy (ft-lb)			(T_{NDT}-60) (°F)	Drop Weight NDT (°F)	RT_{NDT} (°F)
Appurtenances								
Support Skirt Forging								
10-1-1	B7128-3	70	53	52	50	10	50	10
10-1-2	B7128-4	10	58	54	50	-50	-40	-40
Support Skirt Base Plate								
10-2-1 thru 10-2-3	R0588-1	40	113	108	118	-20	-10	-10
10-2-4 thru 10-2-6	R0666-1	60	62	64	62	10	-10	10
Support Skirt Extension								
9-1-1 thru 9-1-2	B7036-2	50	60	55	59	-10	-20	-10
Jet Pump Support								
20-1-1 thru 20-1-4	Inconel							
20-2-1 thru 20-5-1	Inconel							
Jet Pump Riser Pads	Stainless Steel							
Shroud Support								
20-4-1 thru 20-4-14	Inconel							
Shroud Support Ring								
20-3-1 thru 20-3-2	Inconel							
Shroud Support Stubs								
17-1-1 thru 17-1-14	Inconel							
Guide Rod Brackets								
106-1-1 thru 106-1-2	Stainless Steel							
Guide Rod Bracket Pads	Stainless Steel							
Steam Dryer Support Brackets								
106-1-1 thru 106-1-6	Stainless Steel							
Steam Dryer Support Bracket Weld	Stainless Steel							
Steam Dryer Hold Down Brackets								
110-1-1 thru 110-1-6	C3072-1A	30	52	61	51	-30	-40	-30
Core Spray Brackets								
116-1-1 thru 116-1-8	Stainless Steel							
Refueling Bellows Skirt								
46-2-1 thru 46-2-3	A2457-9H	100	66	68	69	40	-	40
Extension Bar								
46-1-1 thru 46-1-6	R0503-1	60	57	56	68	0	0	0
Refueling Bellows Bar								
46-1-1 thru 46-1-6	A2457-7	60	50	50	52	0	-20	0
Refueling Bellows Base Plate								
46-3-1 thru 46-3-6	B7891-7A	20	71	67	92	-40	-40	-40
Surveillance Specimen Bracket Pads	Stainless Steel							
Feedwater Sparger Brackets								
112-1-1 thru 112-1-12	Stainless Steel							
Top Head Lifting Lugs								
43-1-1 thru 43-1-4	C2445-3	30	71	51	60	-30	-30	-30

Component	Heat	Test Temp (°F)	Charpy Energy (ft-lb)			Min Lat Exp (mils)	LST (°F)
STUDS							
Closure							
38-1	84025	10	48	50	48	28	10
38-1	84025	10	49	48	53	29	10
N7, N8, N16							
72-4 and 96-4	11312	10	49	50	51	27	10
Nuts							
Closure							
39-5	83706	10	50	51	54	28	10
N7, N8, N16							
72-5	11312	10	49	50	51	27	10
Washers							
Closure Washers							
39-6	83706	10	60	51	54	28	10

Table 4: GGNS RPV Beltline P-T Curve Input Tables

Adjusted RT_{NDT} = Initial RT_{NDT} + Shift	A = 0 + 42.6 = 42.6°F ~ 43°F (Based on ART Values
Vessel Height	H = 869.75 inches
Bottom of Active Fuel Height	B = 216.3 inches
Vessel Radius (to bass metal)	R = 126.69 inches
Minimum Vessel Wall Thickness (without clad)	T = 6.4375 inches

Table 5: GGNS Definition of RPV Beltline Region

Component	Elevation (inches from RPV "0")
Shell #2 – Top of Active Fuel (TAF)	366.3"
Shell #2 – Bottom of Active Fuel (BAF)	216.3
Shell #2 – Top of Extended Beltline Region (35 EFPY)	381.7"
Shell #1 – Bottom of Extended Beltline Region (35 EFPY)	203.4"
Centerline of Recirculation Outlet Nozzle in Shell #1	172.3"
Top of Recirculation Outlet Nozzle in Shell #1	197.7"
Centerline of Recirculation Inlet Nozzle N2 in Shell #1	197.0"
Centerline of 2" Water Level Instrumentation Nozzle in Shell #2	366.0"

[1] The beltline region is defined as any location where the peak neutron fluence is expected to exceed or equal 1.0e17 n/cm^2.

Based on the above, it is concluded that none of the GGNS reactor vessel plates, nozzles, or welds, other than those included in the Adjusted Reference Temperature Table, are in the beltline region.