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Subject: Brunswick Steam Electric Plant, Unit No. 2
Renewed Facility Operating License No. DPR-62
Docket Nos. 50-324
Unit 2 Cycle 23 Core Operating Limits Report (COLR)

Reference: 1. Letter from Annette H. Pope (Duke Energy) to NRC Document Control Desk, *Unit 2 Cycle 22 Core Operating Limits Report (COLR)*, dated March 23, 2015, ADAMS Accession Number ML15091A406

Ladies and Gentlemen:

Enclosed is a copy of the Core Operating Limits Report (COLR) for Brunswick Steam Electric Plant (BSEP), Unit 2 Cycle 23 operation. Duke Energy Progress, LLC, is providing the enclosed COLR in accordance with Brunswick Unit 2 Technical Specification 5.6.5.d. The enclosed COLR supersedes the report previously submitted by letter dated March 23, 2015 (i.e., Reference 1).

This letter and the enclosed COLR do not contain any regulatory commitments.

Please refer any questions regarding this submittal to Mr. Lee Grzeck, Manager - Regulatory Affairs, at (910) 457-2487.

Sincerely,

Mark McPherson

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WRM/wrm

Enclosure: Brunswick Unit 2, Cycle 23 Core Operating Limits Report

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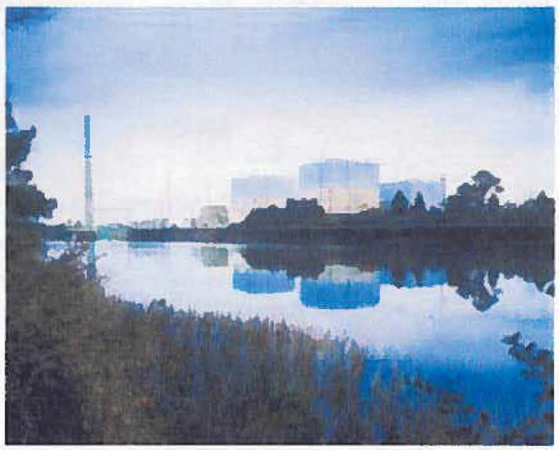
Brunswick Unit 2, Cycle 23 Core Operating Limits Report

BRUNSWICK UNIT 2, CYCLE 23

CORE OPERATING LIMITS REPORT

April 2017



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LIST OF EFFECTIVE PAGES

Page(s)	Revision
1- 41	0

This document consists of 41 total pages.

TABLE OF CONTENTS

Subject	Page
Cover	1
List of Effective Pages	2
Table of Contents	3
List of Tables	4
List of Figures	5
Nomenclature	6
Introduction and Summary	8
APLHGR Limits	9
MCPR Limits	9
LHGR Limits	10
PBDA Setpoints	10
RBM Setpoints	11
Equipment Out-of-Service	11
Single Loop Operation	12
Inoperable Main Turbine Bypass System	12
Feedwater Temperature Reduction	13
Pressure Regulator Out-of-Service	13
References	14

CAUTION
References to COLR Figures or Tables should be made using titles only; Figure and Table numbers may change from cycle to cycle.

LIST OF TABLES

Table	Title	Page
Table 1:	RBM System Setpoints	16
Table 2:	RBM Operability Requirements	17
Table 3:	PBDA Setpoints	18
Table 4:	Exposure Basis for Brunswick Unit 2 Cycle 23 Transient Analysis	19
Table 5:	Power-Dependent $MCPR_p$ Limits NSS Insertion Times - BOC to < EOCLB	20
Table 6:	Power-Dependent $MCPR_p$ Limits TSSS Insertion Times - BOC to < EOCLB	22
Table 7:	Power-Dependent $MCPR_p$ Limits NSS Insertion Times – BOC to < MCE (FFTR/Coastdown)	24
Table 8:	Power-Dependent $MCPR_p$ Limits TSSS Insertion Times – BOC to < MCE (FFTR/Coastdown)	25
Table 9:	Flow-Dependent $MCPR_f$ Limits	26
Table 10:	AREVA Fuel Steady-State $LHGR_{SS}$ Limits	27
Table 11:	AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers NSS Insertion Times - BOC to < EOCLB	28
Table 12:	AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers TSSS Insertion Times - BOC to < EOCLB	30
Table 13:	AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers NSS Insertion Times – BOC to < MCE (FFTR/Coastdown)	32
Table 14:	AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers TSSS Insertion Times – BOC to < MCE (FFTR/Coastdown)	33
Table 15:	AREVA Fuel Flow-Dependent $LHGRFAC_f$ Multipliers	34
Table 16:	AREVA Fuel Steady-State $MAPLHGR_{SS}$ Limits	35

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References to COLR Figures or Tables should be made using titles only; Figure and Table numbers may change from cycle to cycle.

LIST OF FIGURES

Figure	Title or Description	Page
Figure 1:	Stability Option III Power/Flow Map OPRM Operable, Two Loop Operation, 2923 MWt	36
Figure 2:	Stability Option III Power/Flow Map OPRM Inoperable, Two Loop Operation, 2923 MWt	37
Figure 3:	Stability Option III Power/Flow Map OPRM Operable, Single Loop Operation, 2923 MWt	38
Figure 4:	Stability Option III Power/Flow Map OPRM Inoperable, Single Loop Operation, 2923 MWt	39
Figure 5:	Stability Option III Power/Flow Map OPRM Operable, FWTR, 2923 MWt	40
Figure 6:	Stability Option III Power/Flow Map OPRM Inoperable, FWTR, 2923 MWt	41

NOMENCLATURE

2PT	Two Recirculation Pump Trip
APLHGR	Average Planar Linear Heat Generation Rate
APRM	Average Power Range Monitor (Subsystem)
ARTS	APRM/RBM Technical Specification
BOC	Beginning of Cycle
BSP	Backup Stability Protection
BWROG	BWR Owners' Group
CAVEX	Core Average Exposure
COLR	Core Operating Limits Report
CRWE	Control Rod Withdrawal Error
DIVOM	Delta CPR Over Initial MCPR Versus Oscillation Magnitude
EFPD	Effective Full Power Day
EOC	End of Cycle
EOCLB	End of Cycle Licensing Basis
EOFP	End of Full Power
EOOS	Equipment Out-of-Service
F	Flow (Total Core)
FHOOS	Feedwater Heater Out-of-Service
FFTR	Final Feedwater Temperature Reduction
FWTR	Feedwater Temperature Reduction
GE	General Electric
HCOM	Hot Channel Oscillation Magnitude
HPSP	High Power Set Point
HTSP	High Trip Set Point
ICF	Increased Core Flow
IPSP	Intermediate Power Set Point
ITSP	Intermediate Trip Set Point
LCO	Limiting Condition of Operation
LHGR	Linear Heat Generation Rate
$LHGR_{SS}$	Steady-State Maximum Linear Heat Generation Rate
LHGRFAC	Linear Heat Generation Rate Factor
$LHGRFAC_f$	Flow-Dependent Linear Heat Generation Rate Factor
$LHGRFAC_p$	Power-Dependent Linear Heat Generation Rate Factor
LPRM	Local Power Range Monitor (Subsystem)
LPSP	Low Power Set Point
LTA	Lead Test Assembly
LTSP	Low Trip Set Point
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
$MAPLHGR_{SS}$	Steady-State Maximum Average Planar Linear Heat Generation Rate
MAPFAC	Maximum Average Planar Linear Heat Generation Rate Factor

NOMENCLATURE (continued)

$MAPFAC_f$	Flow-Dependent Maximum Average Planar Linear Heat Generation Rate Factor
$MAPFAC_p$	Power-Dependent Maximum Average Planar Linear Heat Generation Rate Factor
$MAPFAC_{SLO}$	Maximum Average Planar Linear Heat Generation Rate Factor when in SLO
MCE	Maximum Core Exposure
MCPR	Minimum Critical Power Ratio
$MCPR_f$	Flow-Dependent Minimum Critical Power Ratio
$MCPR_p$	Power-Dependent Minimum Critical Power Ratio
MELLL	Maximum Extended Load Line Limit
MEOD	Maximum Extended Operating Domain
MSIVOOS	Main Steam Isolation Valve Out-of-Service
NEOC	Near End of Cycle
NFWT	Nominal Feedwater Temperature
NRC	Nuclear Regulatory Commission
NSS	Nominal SCRAM Speed
OLMCPR	Operating Limit Minimum Critical Power Ratio
OPRM	Oscillation Power Range Monitor
OOS	Out-of-Service
P	Power (Total Core Thermal)
PBDA	Period Based Detection Algorithm
PRNM	Power Range Neutron Monitoring (System)
PROOS	Pressure Regulator Out-of-Service
RBM	Rod Block Monitor (Subsystem)
RFWT	Reduced Feedwater Temperature
RPT	Recirculation Pump Trip
RTP	Rated Thermal Power
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
TBV	Turbine Bypass Valve
TBVINS	Turbine Bypass Valves In Service
TBVOOS	Turbine Bypass Valves Out-of-Service (all bypass valves OOS)
TIP	Traversing Incore Probe
TLO	Two Loop Operation
TS	Technical Specification
TSSS	Technical Specification SCRAM Speed

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Introduction and Summary

The Brunswick Unit 2, Cycle 23 COLR provides values for the core operation limits and setpoints required by Technical Specifications (TS) 5.6.5.a.

Required Core Operating Limit (TS 5.6.5.a)	NRC Approved Methodology (TS 5.6.5.b)	Related TS Items
1. APLHGR for TS 3.2.1.	1, 2, 6, 7,16, 17	– TS 3.2.1 LCO (APLHGR) – TS 3.4.1 LCO (Recirculation loops operating) – TS 3.7.6 LCO (Main Turbine Bypass out-of-service)
2. MCPR for TS 3.2.2.	1, 2, 6, 7, 8, 9, 10, 11, 12, 13, 14, 21	– TS 3.2.2 LCO (MCPR) – TS 3.4.1 LCO (Recirculation loops operating) – TS 3.7.6 LCO (Main Turbine bypass out-of-service)
3. LHGR for TS 3.2.3.	2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 20	– TS 3.2.3 LCO (LHGR) – TS 3.4.1 LCO (Recirculation loops operating) – TS 3.7.6 LCO (Main Turbine bypass out-of-service)
4. PBDA setpoint for Function 2.f, APRM - OPRM Upscale, for TS 3.3.1.1.	8, 14, 18, 19, 21	– TS Table 3.3.1.1-1, Function 2.f (APRM - OPRM Upscale) – TS 3.3.1.1, Condition I (Alternate instability detection and suppression)
5. The Allowable Values and power range setpoints for Rod Block Monitor Upscale Functions for TS 3.3.2.1.	6, 8	– TS Table 3.3.2.1-1, Function 1 (RBM upscale and operability requirements)
The required core operating limits and setpoints listed in TS 5.6.5.a are presented in the COLR, have been determined using NRC approved methodologies (COLR References 1 through 21) in accordance with TS 5.6.5.b, have considered all fuel types utilized in B2C23, and are established such that all applicable limits of the plant safety analysis are met in accordance with TS 5.6.5.c.		

In addition to the TS required core operating limits and setpoints, this COLR also includes maps showing the allowable power/flow operating range including the Option III stability ranges.

The generation of this COLR is documented in Reference 30 and is based on analysis results documented in References 27-29.

APLHGR Limits

Steady-state $MAPLHGR_{SS}$ limits are provided for AREVA Fuel (Table 16). These steady-state $MAPLHGR_{SS}$ limits must be modified as follows:

- AREVA Fuel MAPLHGR limits do not have a power, flow, or EOOS dependency.
- The applied MAPLHGR limit is dependent on the number of recirculation loops in operation. The steady-state MAPLHGR limit must be modified by a $MAPFAC_{SLO}$ multiplier when in SLO. $MAPFAC_{SLO}$ has a fuel design dependency as shown below.

The applied TLO and SLO MAPLHGR limits are determined as follows:

$$\text{MAPLHGR Limit}_{TLO} = MAPLHGR_{SS}$$

$$\text{MAPLHGR Limit}_{SLO} = MAPLHGR_{SS} \times MAPFAC_{SLO}$$

where $MAPFAC_{SLO}$ = 0.80 for ATRIUM 10XM and ATRIUM 11 fuel

Linear interpolation should be used to determine intermediate values between the values listed in the table.

MCPR Limits

The MCPR limits presented in Tables 5 through 9 are based on the TLO and SLO SLMCPRs listed in Technical Specification 2.1.1.2 of 1.07 and 1.09, respectively.

- MCPR limits have a core power and core flow dependency. Power-dependent $MCPR_p$ limits are presented in Tables 5 through 8 while flow-dependent $MCPR_f$ limits are presented in Table 9.
- Power-dependent $MCPR_P$ limits are dependent on CAVEX, SCRAM insertion speed, EOOS, fuel design, number of operating recirculation loops (i.e., TLO or SLO), core flow and core thermal power. Values for the CAVEX breakpoints are provided in Table 4. See COLR section titled "Equipment Out-of-Service" for a list of analyzed EOOS conditions. Care should be used when selecting the appropriate limits set.
- The MCPR limits are established such that they bound all pressurization and non-pressurization events.
- The power-dependent $MCPR_p$ limits (Tables 5-8) must be adjusted by an adder of +0.02 when in SLO.

The applied TLO and SLO MCPR limits are determined as follows:

$$\text{MCPR Limit}_{TLO} = (MCPR_p, MCPR_f)_{max}$$

$$\text{MCPR Limit}_{SLO} = (MCPR_p + 0.02, MCPR_f)_{max}$$

Linear interpolation should be used to determine intermediate values between the values listed in the tables. Some of the limits tables show step changes at 26.0%P and 50.0%P. A subset of EOOS limits show an additional step change at 80%P. **IF** performing a hand calculation of a limit **AND** the power is exactly on the breakpoint (i.e. 26.0, 50.0 or 80.0), **THEN** select the most restrictive limit associated with the breakpoint.

LHGR Limits

Steady-state $LHGR_{SS}$ limits are provided for AREVA Fuel (Table 10). These steady-state $LHGR_{SS}$ limits must be modified as follows:

- AREVA Fuel LHGR limits have a core power and core flow dependency. AREVA Fuel power-dependent $LHGRFAC_p$ multipliers (Tables 11-14) and flow-dependent $LHGRFAC_f$ multipliers (Table 15) must be used to modify the steady-state $LHGR_{SS}$ limits (Table 10) for off-rated conditions.
- AREVA Fuel power-dependent $LHGRFAC_p$ multipliers are dependent on CAVEX, SCRAM insertion speed, EOOS, fuel design, core flow and core thermal power. Values for the CAVEX breakpoints are provided in Table 4. See COLR section titled "Equipment Out-of-Service" for a list of analyzed EOOS conditions. Care should be used when selecting the appropriate multiplier set.
- The applied LHGR limit is not dependent on the number of operating recirculation loops. No adjustment to the LHGR limit is necessary for SLO.

The applied LHGR limit is determined as follows:

$$\text{LHGR Limit} = LHGR_{SS} \times (LHGRFAC_p, LHGRFAC_f)_{min}$$

Linear interpolation should be used to determine intermediate values between the values listed in the tables. Some of the limits tables show step changes at 26.0%P and 50.0%P. **IF** performing a hand calculation of a limit **AND** the power is exactly on the breakpoint (i.e. 26.<u>0</u> or 50.<u>0</u>), **THEN** select the most restrictive limit associated with the breakpoint.

PBDA Setpoints

Brunswick Unit 2 has implemented BWROG Long Term Stability Solution Option III (OPRM) with the methodology described in Reference 23. Plant specific analysis incorporating the Option III hardware is described in Reference 24. Reload validation has been performed in accordance with Reference 19. The analysis was performed at 100%P assuming a two pump trip (2PT) and at 45%F assuming steady-state (SS) conditions at the highest rod line power (60.6%). The PBDA setpoints are set such that either the least limiting $MCPR_p$ limit or the least limiting $MCPR_f$ limit will provide adequate protection against violation of the SLMCPR during a postulated reactor instability. Based on the MCPR limits presented in Tables 5 through 9, the required Amplitude Trip Setpoint (**1.10**) is set by the least limiting 100%P $MCPR_p$ limit (1.34) with an allowance for conservative margin, which has an associated Confirmation Count Setpoint (**13**). The PBDA setpoints shown in Table 3 are valid for any feedwater temperature.

Evaluations by GE have shown that the generic DIVOM curves specified in Reference 19 may not be conservative for current plant operating conditions for plants which have implemented Stability Option III. To address this issue, AREVA has performed calculations for the relative change in CPR as a function of the calculated HCOM. These calculations were performed with the RAMONA5-FA code in accordance with Reference 26. This code is a coupled neutronic-thermal-hydraulic three-dimensional transient model for the purpose of determining the relationship between the relative change in ΔCPR and the HCOM on a plant specific basis. The stability-based OLMCPRs are based upon using the most limiting ΔCPR calculated for a given oscillation magnitude or the generic value provided in Reference 19.

In cases where the OPRM system is declared inoperable, Backup Stability Protection (BSP) in accordance with Reference 25 is provided. Analyses have been performed to support operation with nominal feedwater temperature conditions and reduced feedwater temperature conditions (FHOOS and FFTR).

The power/flow maps (Figures 1-6) were validated for B2C23 based on Reference 29 to facilitate operation under Stability Option III as implemented by Function 2.f of Table 3.3.1.1-1 and LCO Condition I of Technical Specification 3.3.1.1. The generation of these maps is documented in Reference 28. All maps illustrate the region of the power/flow map above 25% RTP and below 60% drive flow (correlated to core flow) where the system is required to be enabled. Figures 1-6 were included in the COLR as an operator aid and not a licensing requirement. Figures 5 and 6 are the power/flow maps for use in FWTR.

The maps supporting an operable OPRM (Figures 1, 3 and 5) show a Scram Avoidance Region, which is not a licensing requirement but is an operator aid to illustrate where the OPRM system may generate a scram to avoid an instability event. Note that the STP scram and rod block limits are defined in Technical Specifications, the Technical Requirements Manual, and/or Plant procedures, and are included in the COLR as an operator aid rather than a licensing requirement.

Figures 3 and 4 implement the corrective action for AR-217345 which restricts reactor power to no more than 50% RTP when in SLO with OPRM operable or inoperable. This operator aid is intended to mitigate a spurious OPRM trip signal which could result from APRM noise while operating at high power levels.

RBM Setpoints

The nominal trip setpoints and allowable values of the control rod withdrawal block instrumentation are presented in Table 1 and were determined to be consistent with the bases of the ARTS program (Reference 22). These setpoints will ensure the power-dependent MCPR limits will provide adequate protection against violation of the SLMCPR during a postulated CRWE event. Reference 27 revised these setpoints to reflect changes associated with the installation of the NUMAC PRNM system. RBM operability requirements, consistent with Notes (a) through (e) of Technical Specification Table 3.3.2.1-1, are provided in Table 2.

Equipment Out-of-Service

Brunswick Unit 2, Cycle 23 is analyzed for the following operating conditions with applicable MCPR, APLHGR and LHGR limits.

- Base Case Operation
- SLO
- TBVOOS
- FHOOS
- Combined TBVOOS and FHOOS
- PROOS
- Combined PROOS and TBVOOS
- Combined PROOS and FHOOS
- Combined PROOS, TBVOOS and FHOOS

Base Case Operation as well as the above-listed EOOS conditions assume all the items OOS below. These conditions are general analysis assumptions used to ensure conservative analysis results and were not meant to define specific EOOS conditions beyond those already defined in Technical Specifications.

- Any 1 inoperable SRV
- 2 inoperable TBV (Note that for TBVOOS, TBVOOS/FHOOS, PROOS/TBVOOS and PROOS/TBVOOS/FHOOS all 10 TBVs are assumed inoperable)
- Up to 40% of the TIP channels OOS
- Up to 50% of the LPRMs OOS

Please note that during FFTR/Coastdown, FHOOS is included in Base Case Operation, TBVOOS, PROOS and PROOS/TBVOOS.

Single Loop Operation

Brunswick Unit 2, Cycle 23 may operate in SLO up to a maximum core flow of 45 Mlbm/hr which corresponds to a maximum power level of 71.1% RTP with applicable MCPR, APLHGR and LHGR limits. The following must be considered when operating in SLO:

- SLO is not permitted with RFWT (FHOOS).
- SLO is not permitted with TBVOOS.
- SLO is not permitted with MSIVOOS.

Various indicators on the Power/Flow Maps are provided not as operating limits but rather as a convenience for the operators. The purposes for some of these indicators are as follows:

- The SLO Entry Rod Line is shown on the TLO maps to avoid regions of instability in the event of a pump trip.
- A maximum core flow line is shown on the SLO maps to avoid vibration problems.
- APRM STP Scram and Rod Block nominal trip setpoint limits are shown at the estimated core flow corresponding to the actual drive flow-based setpoints to indicate where the Operator may encounter these setpoints (See LCO 3.3.1.1, Reactor Protection System Instrumentation Function 2.b: Average Power Range Monitors Simulated Thermal Power - High Allowable Value).
- When in SLO, Figures 3 and 4 implement the corrective action for AR-217345 which restricts reactor power to no more than 50% RTP with OPRM operable or inoperable. This operator aid is intended to mitigate a spurious OPRM trip signal which could result from APRM noise while operating at high power levels.

Inoperable Main Turbine Bypass System

Brunswick Unit 2, Cycle 23 may operate with an inoperable Main Turbine Bypass System over the entire MEOD range and cycle with applicable APLHGR, MCPR and LHGR limits as specified in the COLR. An operable Main Turbine Bypass System with only two inoperable bypass valves was assumed in the development of the Base Case Operation limits. Base Case Operation is synonymous with TBVINS. The following must be considered when operating with TBVOOS:

- Three or more inoperable bypass valves renders the entire Main Turbine Bypass System inoperable requiring the use of TBVOOS limits. The TBVOOS analysis supports operation with all bypass valves inoperable.
- Prior to reaching the EOCLB exposure breakpoint, operation with FWTR >10˚F and reactor power ≥ 23% RTP requires use of the TBVOOS/FHOOS limits.
- TBVOOS operation coincident with FHOOS is supported using the combined TBVOOS/FHOOS limits.
- TBVOOS operation coincident with PROOS is supported using the combined PROOS/TBVOOS limits.
- TBVOOS operation coincident with FHOOS and PROOS is supported using the combined PROOS/TBVOOS/FHOOS limits.
- SLO is not permitted with TBVOOS.

Feedwater Temperature Reduction

Brunswick Unit 2, Cycle 23 may operate with RFWT over the entire MEOD range and cycle with applicable APLHGR, MCPR and LHGR limits as specified in the COLR. NFWT is defined as the range of feedwater temperatures from NFWT to NFWT - 10˚F. NFWT and its allowable variation were assumed in the development of the Base Case Operation limits. The FHOOS limits and FFTR/Coastdown limits were developed for a maximum feedwater temperature reduction of 110.3˚F. The following must be considered when operating with RFWT:

- Although the acronyms FWTR, FHOOS, RFWT and FFTR all involve reduced feedwater temperature, the use of FFTR is reserved for cycle energy extension using reduced feedwater temperature at and beyond a core average exposure of EOCLB using FFTR/Coastdown limits.
- Prior to reaching the EOCLB exposure breakpoint, operation with FWTR >10˚F and reactor power ≥ 23% RTP requires use of the FHOOS limits.
- Until a core average exposure of EOCLB is reached, implementation of the FFTR/Coastdown limits is not required even if coastdown begins early.
- When operating with RFWT, the appropriate Stability Option III Power/Flow Maps (Figures 5 and 6) must be used.
- FHOOS operation coincident with TBVOOS is supported using the combined TBVOOS/FHOOS limits.
- FHOOS operation coincident with PROOS is supported using the combined PROOS/FHOOS limits.
- FHOOS operation coincident with TBVOOS and PROOS is supported using the combined PROOS/TBVOOS/FHOOS limits.
- SLO is not permitted with RFWT.
- NFWT limits have **not** been conservatively adjusted to eliminate the need to use RFWT limits below 50% RTP.

Pressure Regulator Out-of-Service

Brunswick Unit 2, Cycle 23 may operate with one main turbine pressure regulator not available over the entire MEOD range and cycle with applicable APLHGR, MCPR and LHGR limits as specified in the COLR. The following must be considered when operating with PROOS:

- Operation with the backup electro-hydraulic control main turbine pressure regulator not available requires the use of PROOS limits. The PROOS analysis supports operation with one pressure regulator not available.
- With TBVINS, prior to reaching the EOCLB exposure breakpoint, operation with FWTR >10˚F and reactor power ≥ 23% RTP requires use of the PROOS/FHOOS limits.
- With TBVOOS, prior to reaching the EOCLB exposure breakpoint, operation with FWTR >10˚F and reactor power ≥ 23% RTP requires use of the PROOS/TBVOOS/FHOOS limits.
- PROOS operation coincident with TBVOOS is supported using the combined PROOS/TBVOOS limits.
- PROOS operation coincident with FHOOS is supported using the combined PROOS/FHOOS limits.
- PROOS operation coincident with TBVOOS and FHOOS is supported using the combined PROOS/TBVOOS/FHOOS limits.

References

In accordance with Brunswick Unit 2 Technical Specification 5.6.5.b, the analytical methods for determining Brunswick Unit 2 core operating limits have been specifically reviewed and approved by the NRC and are listed as References 1 through 21.

1. NEDE-24011-P-A, "GESTAR II - General Electric Standard Application for Reactor Fuel," and US Supplement, Revision 15, September 2005.
2. XN-NF-81-58(P)(A) and Supplements 1 and 2, “RODEX2 Fuel Rod Thermal-Mechanical Response Evaluation Model,” Revision 2, March 1984.
3. XN-NF-85-67(P)(A), “Generic Mechanical Design for Exxon Nuclear Jet Pump BWR Reload Fuel,” Revision 1, September 1986.
4. EMF-85-74(P) Supplement 1(P)(A) and Supplement 2(P)(A), “RODEX2A (BWR) Fuel Rod Thermal-Mechanical Evaluation Model,” Revision 0, February 1998.
5. ANF-89-98(P)(A), “Generic Mechanical Design Criteria for BWR Fuel Designs,” Revision 1, May 1995.
6. XN-NF-80-19(P)(A) Volume 1 and Volume 1 Supplements 1 and 2, “Exxon Nuclear Methodology for Boiling Water Reactors - Neutronic Methods for Design and Analysis,” March 1983.
7. XN-NF-80-19(P)(A) Volume 4, “Exxon Nuclear Methodology for Boiling Water Reactors: Application of the ENC Methodology to BWR Reloads,” Revision 1, June 1986.
8. EMF-2158(P)(A), “Siemens Power Corporation Methodology for Boiling Water Reactors: Evaluation and Validation of CASMO-4/MICROBURN-B2,” Revision 0, October 1999.
9. XN-NF-80-19(P)(A) Volume 3, “Exxon Nuclear Methodology for Boiling Water Reactors, THERMEX: Thermal Limits Methodology Summary Description,” Revision 2, January 1987.
10. XN-NF-84-105(P)(A) Volume 1 and Volume 1 Supplements 1 and 2, “XCOBRA-T: A Computer Code for BWR Transient Thermal-Hydraulic Core Analysis,” February 1987.
11. ANP-10307PA, “AREVA MCPR Safety Limit Methodology for Boiling Water Reactors,” Revision 0, June 2011.
12. ANF-913(P)(A) Volume 1 and Volume 1 Supplements 2, 3, 4, “COTRANSA2: A Computer Program for Boiling Water Reactor Transient Analyses,” Revision 1, August 1990.
13. ANF-1358(P)(A), “The Loss of Feedwater Heating Transient in Boiling Water Reactors,” Revision 3, September 2005.
14. EMF-2209(P)(A), “SPCB Critical Power Correlation,” Revision 3, September 2009.
15. EMF-2245(P)(A), “Application of Siemens Power Corporation's Critical Power Correlations to Co-Resident Fuel,” Revision 0, August 2000.
16. EMF-2361(P)(A), “EXEM BWR-2000 ECCS Evaluation Model,” Revision 0, May 2001.
17. EMF-2292(P)(A), “ATRIUMTM-10: Appendix K Spray Heat Transfer Coefficients,” Revision 0, September 2000.
18. EMF-CC-074(P)(A) Volume 4, “BWR Stability Analysis - Assessment of STAIF with Input from MICROBURN-B2,” Revision 0, August 2000.
19. NEDO-32465-A, “Reactor Stability Detect and Suppress Solutions Licensing Basis Methodology for Reload Applications,” August 1996.
20. BAW-10247PA, “Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors,” Revision 0, April 2008.
21. ANP-10298P-A, “ACE/ATRIUM 10XM Critical Power Correlation,” Revision 1, March 2014.

22. NEDC-31654P, “Maximum Extended Operating Domain Analysis for Brunswick Steam Electric Plant,” February 1989.

23. NEDO-31960-A, “BWR Owners’ Group Long-Term Stability Solutions Licensing Methodology (Supplement 1),” November 1995, NRC ADAMS Accession No. ML14093A211.

24. GENE-C51-00251-00-01, “Licensing Basis Hot Bundle Oscillation Magnitude for Brunswick 1 and 2,” Revision 0, March 2001.

25. OG02-0119-260 “Backup Stability Protection (BSP) for Inoperable Option III Solution,” GE Nuclear Energy, July 17, 2002.

26. BAW-10255PA, “Cycle-Specific DIVOM Methodology Using the RAMONA5-FA Code,” Revision 2, May 2008.

27. BNP Design Calculation 2C51-0001, “Power Range Neutron Monitoring System Setpoint Uncertainty and Scaling Calculation (2-C51-APRM-1 through 4 Loops and 2-C51 RBM-A and B Loops),” Revision 3, May 2004.

28. BNP Design Calculation 0B21-1015, “BNP Power/Flow Maps,” Revision 7, March 2008.

29. ANP-3560P, “Brunswick Unit 2 Cycle 23 Reload Safety Analysis,” Revision 0, January 2017.

30. BNP Design Calculation 2B21-1325, “Preparation of the B2C23 Core Operating Limits Report,” Revision 0.

Table 1

RBM System Setpoints[1]

Setpoint [a]	Setpoint Value	Allowable Value
Lower Power Setpoint (LPSP[b])	≤ 27.7	≤ 29.0
Intermediate Power Setpoint (IPSP[b])	≤ 62.7	≤ 64.0
High Power Setpoint (HPSP[b])	≤ 82.7	≤ 84.0
Low Trip Setpoint (LTSP[c,d])	≤ 117.1	≤ 117.6
Intermediate Trip Setpoint (ITSP[c,d])	≤ 112.3	≤ 112.8
High Trip Setpoint (HTSP[c,d])	≤ 107.3	≤ 107.8
RBM Time Delay (t_{d2})	0 seconds	< 2.0 seconds

a See Table 2 for RBM Operability Requirements.

b Setpoints in percent of Rated Thermal Power.

c Setpoints relative to a full scale reading of 125. For example, ≤ 117.1 means ≤ 117.1/125.0 of full scale.

d Trip setpoints and allowable values are based on a HTSP Analytical Limit of 110.2 with RBM filter.

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1 This table is referred to by Technical Specification 3.3.2.1 (Table 3.3.2.1-1) and 5.6.5.a.5.

Table 2

RBM Operability Requirements[2]

IF the following conditions are met, **THEN RBM Not Required Operable**	
Thermal Power (% rated)	MCPR
≥ 29% and < 90%	≥ 1.86 TLO ≥ 1.89 SLO
≥ 90%	≥ 1.46 TLO

2 Requirements valid for all fuel designs, all SCRAM insertion times and all core average exposure ranges.

Table 3
PBDA Setpoints[3]

Amplitude Trip Setpoint (S_p)	OLMCPR(SS)	OLMCPR(2PT)
1.05	1.16	1.18
1.06	1.18	1.20
1.07	1.19	1.22
1.08	1.21	1.24
1.09	1.23	1.26
1.10	**1.25**	**1.28**
1.11	1.27	1.30
1.12	1.29	1.32
1.13	1.31	1.34
1.14	1.33	1.36
1.15	1.35	1.38
Acceptance Criteria	Off-rated OLMCPR @ 45% Flow	Rated Power OLMCPR

PDBA Setpoint	Setpoint Value
Amplitude Trip (S_p)	**1.10**
Confirmation Count (N_p)	**13**

[3] This table is referred to by Technical Specification 3.3.1.1 (Table 3.3.1.1-1) and 5.6.5.a.4.

Table 4

Exposure Basis[4] for Brunswick Unit 2 Cycle 23 Transient Analysis

Core Average Exposure (MWd/MTU)	Comments
35,915	Breakpoint for design basis rod patterns to EOFP + 15 EFPD (NEOC/EOCLB[5])
37,347	End of cycle with FFTR/Coastdown - Maximum Core Exposure (MCE)

4 The exposure basis for the defined break points is the core average exposure (CAVEX) values shown above regardless of the actual BOC CAVEX value of the As-Loaded Core.

5 NEOC exposure for Unit 2 Cycle 23 is defined as the same as the EOCLB exposure.

Table 5

Power-Dependent $MCPR_p$ Limits[6]

NSS Insertion Times
BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM $MCPR_p$		ATRIUM 11 LTA $MCPR_p$	
Base Case Operation	100.0	1.34		1.45	
	80.0	1.41		1.47	
	50.0	1.62		1.60	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44
TBVOOS	100.0	1.37		1.47	
	80.0	1.41		1.51	
	50.0	1.62		1.61	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
	26.0	2.75	2.56	3.04	2.94
	23.0	2.91	2.76	3.20	3.16
FHOOS	100.0	1.34		1.45	
	80.0	1.41		1.47	
	50.0	1.62		1.60	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44
PROOS	100.0	1.34		1.45	
	80.0	1.42		1.53	
	80.0	1.55		1.70	
	50.0	1.81		2.02	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44

(continued)

6 Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, the TLO MCPRp limits shown above must be adjusted by adding 0.02. SLO not permitted for FHOOS, TBVOOS or MSIVOOS.

Table 5 *(continued)*

Power-Dependent $MCPR_p$ Limits[7]

NSS Insertion Times
BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM $MCPR_p$		ATRIUM 11 LTA $MCPR_p$	
TBVOOS and FHOOS	100.0	1.37		1.47	
	80.0	1.41		1.51	
	50.0	1.62		1.64	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
	26.0	2.82	2.69	3.18	3.10
	23.0	2.99	2.86	3.33	3.30
PROOS and FHOOS	100.0	1.34		1.45	
	80.0	1.42		1.53	
	80.0	1.55		1.70	
	50.0	1.81		2.02	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44
PROOS and TBVOOS	100.0	1.37		1.47	
	80.0	1.42		1.53	
	80.0	1.55		1.70	
	50.0	1.81		2.02	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
	26.0	2.75	2.56	3.04	2.94
	23.0	2.91	2.76	3.20	3.16
PROOS and TBVOOS and FHOOS	100.0	1.37		1.47	
	80.0	1.42		1.53	
	80.0	1.55		1.70	
	50.0	1.81		2.02	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
	26.0	2.82	2.69	3.18	3.10
	23.0	2.99	2.86	3.33	3.30

(end Table 5)

[7] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, the TLO MCPRp limits shown above must be adjusted by adding 0.02. SLO not permitted for FHOOS, TBVOOS or MSIVOOS.

Table 6

Power-Dependent $MCPR_p$ Limits[8]

TSSS Insertion Times
BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM $MCPR_p$		ATRIUM 11 LTA $MCPR_p$	
Base Case Operation	100.0	1.37		1.48	
	80.0	1.41		1.49	
	50.0	1.62		1.60	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44
TBVOOS	100.0	1.39		1.50	
	80.0	1.43		1.54	
	50.0	1.62		1.63	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
	26.0	2.75	2.56	3.04	2.94
	23.0	2.91	2.76	3.20	3.16
FHOOS	100.0	1.37		1.48	
	80.0	1.41		1.49	
	50.0	1.62		1.60	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44
PROOS	100.0	1.37		1.48	
	80.0	1.43		1.55	
	80.0	1.57		1.71	
	50.0	1.82		2.03	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44

(continued)

[8] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, the TLO MCPRp limits shown above must be adjusted by adding 0.02. SLO not permitted for FHOOS, TBVOOS or MSIVOOS.

Table 6 *(continued)*

Power-Dependent $MCPR_p$ Limits[9]

TSSS Insertion Times

BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM $MCPR_p$		ATRIUM 11 LTA $MCPR_p$	
TBVOOS and FHOOS	100.0	1.39		1.50	
	80.0	1.43		1.54	
	50.0	1.62		1.66	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
	26.0	2.82	2.69	3.18	3.10
	23.0	2.99	2.86	3.33	3.30
PROOS and FHOOS	100.0	1.37		1.48	
	80.0	1.43		1.55	
	80.0	1.57		1.71	
	50.0	1.82		2.03	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44
PROOS and TBVOOS	100.0	1.39		1.50	
	80.0	1.43		1.55	
	80.0	1.57		1.71	
	50.0	1.82		2.03	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
	26.0	2.75	2.56	3.04	2.94
	23.0	2.91	2.76	3.20	3.16
PROOS and TBVOOS and FHOOS	100.0	1.39		1.50	
	80.0	1.43		1.55	
	80.0	1.57		1.71	
	50.0	1.82		2.03	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
	26.0	2.82	2.69	3.18	3.10
	23.0	2.99	2.86	3.33	3.30

(end Table 6)

[9] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, the TLO MCPRp limits shown above must be adjusted by adding 0.02. SLO not permitted for FHOOS, TBVOOS or MSIVOOS**.**

Table 7

Power-Dependent MCPR$_p$ Limits[10]

NSS Insertion Times
BOC to < MCE (FFTR/Coastdown)

EOOS Condition	Power (% rated)	ATRIUM 10XM MCPR$_p$		ATRIUM 11 LTA MCPR$_p$	
Base Case	100.0	1.35		1.45	
Operation	80.0	1.41		1.47	
	50.0	1.62		1.60	
(FFTR/FHOOS		> 65%F	≤ 65%F	> 65%F	≤ 65%F
included)	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
(Bounds operation	26.0	2.24	2.13	2.44	2.36
with NFWT)	23.0	2.33	2.21	2.50	2.44
TBVOOS	100.0	1.37		1.47	
	80.0	1.41		1.51	
(FFTR/FHOOS	50.0	1.62		1.64	
included)		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.81	1.70	2.02	1.92
(Bounds operation	26.0	2.22	2.09	2.42	2.33
with NFWT)	26.0	2.82	2.69	3.18	3.10
	23.0	2.99	2.86	3.33	3.30
PROOS	100.0	1.35		1.45	
	80.0	1.42		1.53	
(FFTR/FHOOS	80.0	1.55		1.70	
included)	50.0	1.81		2.02	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
(Bounds operation	50.0	1.81	1.70	2.02	1.92
with NFWT)	26.0	2.22	2.09	2.42	2.33
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44
PROOS	100.0	1.37		1.47	
and	80.0	1.42		1.53	
TBVOOS	80.0	1.55		1.70	
	50.0	1.81		2.02	
(FFTR/FHOOS		> 65%F	≤ 65%F	> 65%F	≤ 65%F
included)	50.0	1.81	1.70	2.02	1.92
	26.0	2.22	2.09	2.42	2.33
(Bounds operation	26.0	2.82	2.69	3.18	3.10
with NFWT)	23.0	2.99	2.86	3.33	3.30

[10] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, the TLO MCPRp limits shown above must be adjusted by adding 0.02. SLO not permitted for FHOOS, TBVOOS or MSIVOOS.

Table 8

Power-Dependent $MCPR_p$ Limits[11]

TSSS Insertion Times
BOC to < MCE (FFTR/Coastdown)

EOOS Condition	Power (% rated)	ATRIUM 10XM $MCPR_p$		ATRIUM 11 LTA $MCPR_p$	
Base Case	100.0	1.37		1.48	
Operation	80.0	1.41		1.49	
	50.0	1.62		1.60	
(FFTR/FHOOS		> 65%F	≤ 65%F	> 65%F	≤ 65%F
included)	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
(Bounds operation	26.0	2.24	2.13	2.44	2.36
with NFWT)	23.0	2.33	2.21	2.50	2.44
TBVOOS	100.0	1.39		1.50	
	80.0	1.43		1.54	
(FFTR/FHOOS	50.0	1.62		1.66	
included)		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	1.82	1.72	2.03	1.93
(Bounds operation	26.0	2.23	2.12	2.43	2.35
with NFWT)	26.0	2.82	2.69	3.18	3.10
	23.0	2.99	2.86	3.33	3.30
PROOS	100.0	1.37		1.48	
	80.0	1.43		1.55	
(FFTR/FHOOS	80.0	1.57		1.71	
included)	50.0	1.82		2.03	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
(Bounds operation	50.0	1.82	1.72	2.03	1.93
with NFWT)	26.0	2.23	2.12	2.43	2.35
	26.0	2.24	2.13	2.44	2.36
	23.0	2.33	2.21	2.50	2.44
PROOS	100.0	1.39		1.50	
and	80.0	1.43		1.55	
TBVOOS	80.0	1.57		1.71	
	50.0	1.82		2.03	
(FFTR/FHOOS		> 65%F	≤ 65%F	> 65%F	≤ 65%F
included)	50.0	1.82	1.72	2.03	1.93
	26.0	2.23	2.12	2.43	2.35
(Bounds operation	26.0	2.82	2.69	3.18	3.10
with NFWT)	23.0	2.99	2.86	3.33	3.30

[11] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service. For single-loop operation, the TLO MCPRp limits shown above must be adjusted by adding 0.02. SLO not permitted for FHOOS, TBVOOS or MSIVOOS.

Table 9

Flow-Dependent $MCPR_f$ Limits[12]

Core Flow (% of rated)	ATRIUM 10XM $MCPR_f$	ATRIUM 11 LTAs $MCPR_f$ [13]
0.0	1.70	1.80
31.0	1.70	1.80
55.0	1.59	--
100.0	1.20	1.20
107.0	1.20	1.20

[12] Limits valid for all SCRAM insertion times and all core average exposure ranges.

[13] "--" indicates that this fuel type does not have a breakpoint at the indicated exposure

Table 10

AREVA Fuel Steady-State $LHGR_{SS}$ Limits

Peak Pellet Exposure (GWd/MTU)	ATRIUM 10XM LHGR (kW/ft)	ATRIUM 11 LTA LHGR[14] (kW/ft)
0.0	15.1	12.2
6.0	14.1	--
18.9	14.1	12.2
54.0	10.6	--
74.4	5.4	6.4

[14] "--" indicates that this fuel type does not have a breakpoint at the indicated exposure

Table 11

AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers[15]

NSS Insertion Times
BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFACp		ATRIUM 11 LTA LHGRFACp	
Base Case Operation	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.92		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64
TBVOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.92		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.43	0.50	0.43	0.50
	23.0	0.40	0.46	0.40	0.46
FHOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.92		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64
PROOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64

(continued)

15 Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service.

Table 11 *(continued)*

AREVA Fuel Power-Dependent LHGRFAC$_p$ Multipliers[16]

NSS Insertion Times
BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFACp		ATRIUM 11 LTA LHGRFACp	
TBVOOS and FHOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.92		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.40	0.46	0.40	0.46
	23.0	0.38	0.43	0.38	0.43
PROOS and FHOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64
PROOS and TBVOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.43	0.50	0.43	0.50
	23.0	0.40	0.46	0.40	0.46
PROOS and TBVOOS and FHOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.40	0.46	0.40	0.46
	23.0	0.38	0.43	0.38	0.43

(end Table 11)

[16] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service.

Table 12

AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers[17]

TSSS Insertion Times
BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFACp		ATRIUM 11 LTA LHGRFACp	
Base Case Operation	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.92		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64
TBVOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.92		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.43	0.50	0.43	0.50
	23.0	0.40	0.46	0.40	0.46
FHOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.92		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64
PROOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64

(continued)

[17] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service.

Table 12 *(continued)*

AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers[18]

TSSS Insertion Times
BOC to < EOCLB

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFACp		ATRIUM 11 LTA LHGRFACp	
TBVOOS and FHOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.92		0.92	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.40	0.46	0.40	0.46
	23.0	0.38	0.43	0.38	0.43
PROOS and FHOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64
PROOS and TBVOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.43	0.50	0.43	0.50
	23.0	0.40	0.46	0.40	0.46
PROOS and TBVOOS and FHOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
	26.0	0.40	0.46	0.40	0.46
	23.0	0.38	0.43	0.38	0.43

(end Table 12)

[18] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service.

Table 13

AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers[19]

NSS Insertion Times

BOC to < MCE (FFTR/Coastdown)

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFACp		ATRIUM 11 LTA LHGRFACp	
Base Case	100.0	1.00		1.00	
Operation	90.0	1.00		1.00	
	50.0	0.92		0.92	
(FFTR/FHOOS		> 65%F	≤ 65%F	> 65%F	≤ 65%F
included)	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
(Bounds operation	26.0	0.64	0.66	0.64	0.66
with NFWT)	23.0	0.60	0.64	0.60	0.64
TBVOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
(FFTR/FHOOS	50.0	0.92		0.92	
included)		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
(Bounds operation	26.0	0.64	0.66	0.64	0.66
with NFWT)	26.0	0.40	0.46	0.40	0.46
	23.0	0.38	0.43	0.38	0.43
PROOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
(FFTR/FHOOS	50.0	0.86		0.86	
included)		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
(Bounds operation	26.0	0.64	0.66	0.64	0.66
with NFWT)	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64
PROOS	100.0	1.00		1.00	
and	90.0	1.00		1.00	
TBVOOS	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
(FFTR/FHOOS	50.0	0.86	0.86	0.86	0.86
included)	26.0	0.64	0.66	0.64	0.66
	26.0	0.40	0.46	0.40	0.46
(Bounds operation	23.0	0.38	0.43	0.38	0.43
with NFWT)					

[19] Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service.

Table 14

AREVA Fuel Power-Dependent $LHGRFAC_p$ Multipliers[20]

TSSS Insertion Times
BOC to < MCE (FFTR/Coastdown)

EOOS Condition	Power (% rated)	ATRIUM 10XM LHGRFACp		ATRIUM 11 LTA LHGRFACp	
Base Case	100.0	1.00		1.00	
Operation	90.0	1.00		1.00	
	50.0	0.92		0.92	
(FFTR/FHOOS		> 65%F	≤ 65%F	> 65%F	≤ 65%F
included)	50.0	0.86	0.86	0.86	0.86
	26.0	0.64	0.66	0.64	0.66
(Bounds operation	26.0	0.64	0.66	0.64	0.66
with NFWT)	23.0	0.60	0.64	0.60	0.64
TBVOOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
(FFTR/FHOOS	50.0	0.92		0.92	
included)		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
(Bounds operation	26.0	0.64	0.66	0.64	0.66
with NFWT)	26.0	0.40	0.46	0.40	0.46
	23.0	0.38	0.43	0.38	0.43
PROOS	100.0	1.00		1.00	
	90.0	1.00		1.00	
(FFTR/FHOOS	50.0	0.86		0.86	
included)		> 65%F	≤ 65%F	> 65%F	≤ 65%F
	50.0	0.86	0.86	0.86	0.86
(Bounds operation	26.0	0.64	0.66	0.64	0.66
with NFWT)	26.0	0.64	0.66	0.64	0.66
	23.0	0.60	0.64	0.60	0.64
PROOS	100.0	1.00		1.00	
and	90.0	1.00		1.00	
TBVOOS	50.0	0.86		0.86	
		> 65%F	≤ 65%F	> 65%F	≤ 65%F
(FFTR/FHOOS	50.0	0.86	0.86	0.86	0.86
included)	26.0	0.64	0.66	0.64	0.66
	26.0	0.40	0.46	0.40	0.46
(Bounds operation	23.0	0.38	0.43	0.38	0.43
with NFWT)					

20 Limits support operation with any combination of any 1 inoperable SRV, 2 inoperable TBV, up to 40% of the TIP channels out-of-service, and up to 50% of the LPRMs out-of-service.

Table 15

AREVA Fuel Flow-Dependent $LHGRFAC_f$ Multipliers[21]

Core Flow (% of rated)	ATRIUM 10XM and ATRIUM 11 LTA $LHGRFAC_f$
0.0	0.58
31.0	0.58
75.0	1.00
107.0	1.00

21 Multipliers valid for all SCRAM insertion times and all core average exposure ranges.

Table 16

AREVA Fuel Steady-State $MAPLHGR_{SS}$ Limits[22, 23]

Average Planar Exposure (GWd/MTU)	ATRIUM 10XM MAPLHGR (kW/ft)	ATRIUM 11 LTA MAPLHGR (kW/ft)
0.0	13.1	10.5
15.0	13.1	10.5
67.0	7.7	5.9

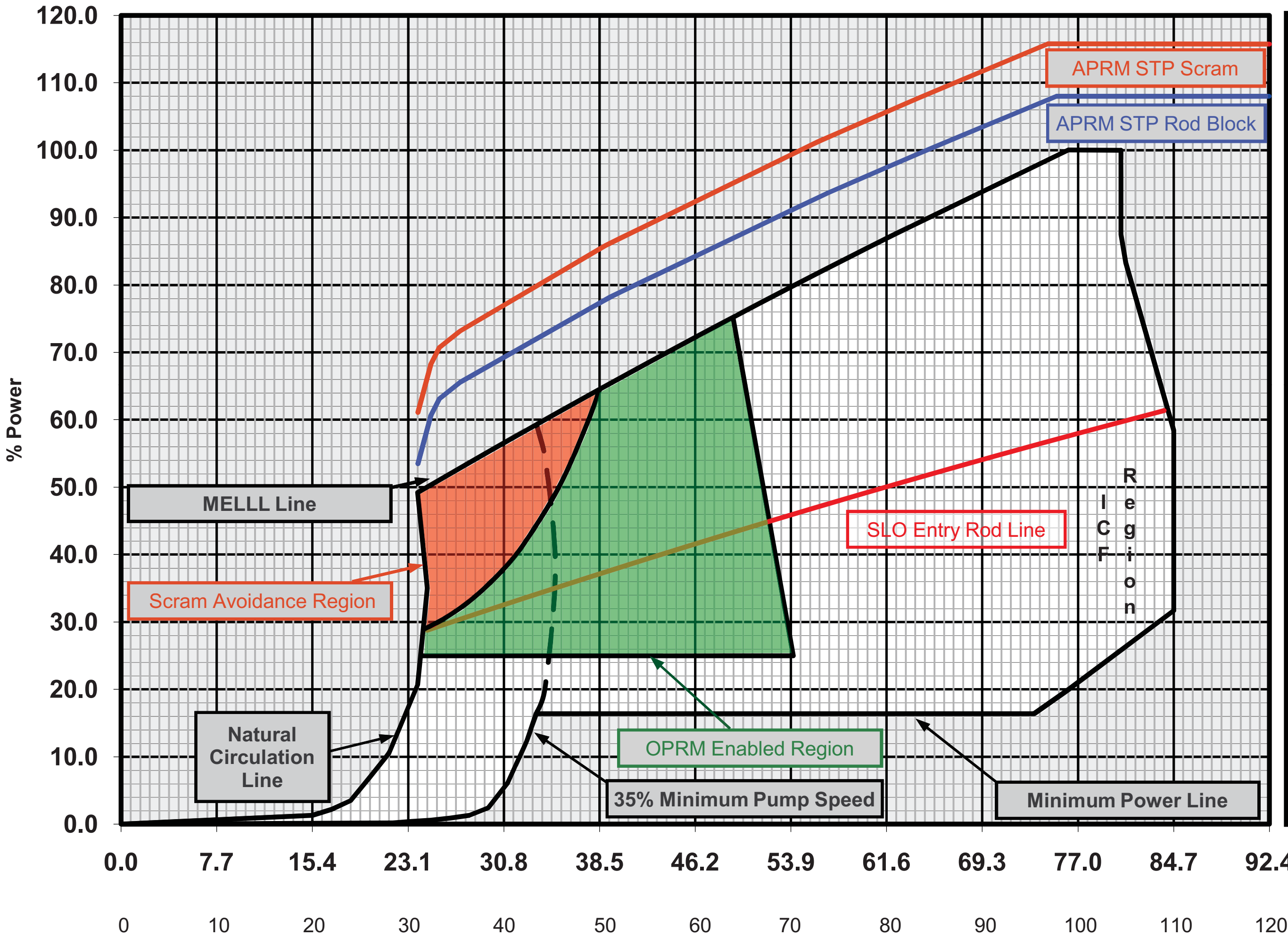
22 AREVA Fuel MAPLHGR limits do not have a power or flow dependency.

23 ATRIUM 10XM and ATRIUM 11 MAPLHGR limits must be adjusted by a 0.80 multiplier when in SLO. SLO not permitted for FHOOS, TBVOOS or MSIVOOS.

Figure 1
Stability Option III Power/Flow Map

OPRM Operable, Two Loop Operation, 2923 MWt

This Figure supports Improved Technical Specification 3.3.1.1 and the Technical Requirements Manual Specification 3.3



Power %	Minimum (MELLL) Core Flow Mlbs/hr	Maximum (ICF) Core Flow Mlbs/hr
100	76.19	80.47
99	75.04	80.47
98	73.89	80.47
97	72.75	80.47
96	71.61	80.47
95	70.49	80.47
94	69.36	80.47
93	68.25	80.47
92	67.13	80.47
91	66.03	80.47
90	64.93	80.47
89	63.83	80.47
88	62.74	80.47
87	61.66	80.51
86	60.58	80.60
85	59.50	80.69
84	58.43	80.79
83	57.37	80.90
82	56.31	81.05
81	55.25	81.21
80	54.20	81.36
79	53.16	81.51
78	52.12	81.67
77	51.08	81.82
76	50.05	81.98
75	49.02	82.13
74	48.00	82.29
73	46.98	82.44
72	45.96	82.60
71	44.95	82.75
70	43.94	82.91
69	42.94	83.06
68	41.94	83.22
67	40.95	83.37
66	39.96	83.52
65	38.97	83.68
64	37.99	83.83
63	37.01	83.99
62	36.04	84.14
61	35.06	84.30
60	34.10	84.45
59	33.13	84.61
58	32.17	84.70

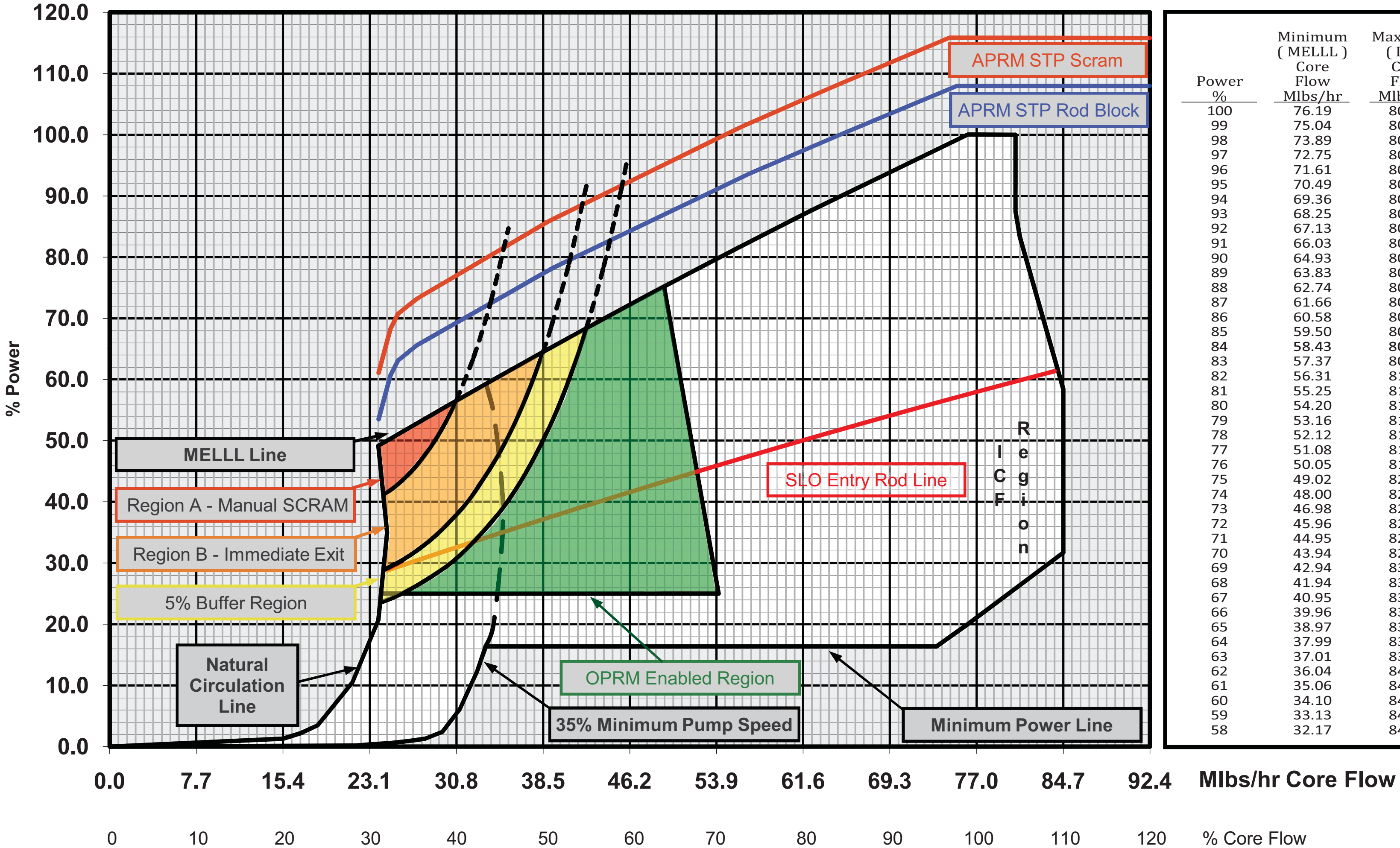
Reference: 0B21-1015, Revision 7

Figure 2

Stability Option III Power/Flow Map

OPRM Inoperable, Two Loop Operation, 2923 MWt

This Figure supports Improved Technical Specification 3.3.1.1 and the Technical Requirements Manual Specification 3.3



Power %	Minimum (MELLL) Core Flow Mlbs/hr	Maximum (ICF) Core Flow Mlbs/hr
100	76.19	80.47
99	75.04	80.47
98	73.89	80.47
97	72.75	80.47
96	71.61	80.47
95	70.49	80.47
94	69.36	80.47
93	68.25	80.47
92	67.13	80.47
91	66.03	80.47
90	64.93	80.47
89	63.83	80.47
88	62.74	80.47
87	61.66	80.51
86	60.58	80.60
85	59.50	80.69
84	58.43	80.79
83	57.37	80.90
82	56.31	81.05
81	55.25	81.21
80	54.20	81.36
79	53.16	81.51
78	52.12	81.67
77	51.08	81.82
76	50.05	81.98
75	49.02	82.13
74	48.00	82.29
73	46.98	82.44
72	45.96	82.60
71	44.95	82.75
70	43.94	82.91
69	42.94	83.06
68	41.94	83.22
67	40.95	83.37
66	39.96	83.52
65	38.97	83.68
64	37.99	83.83
63	37.01	83.99
62	36.04	84.14
61	35.06	84.30
60	34.10	84.45
59	33.13	84.61
58	32.17	84.70

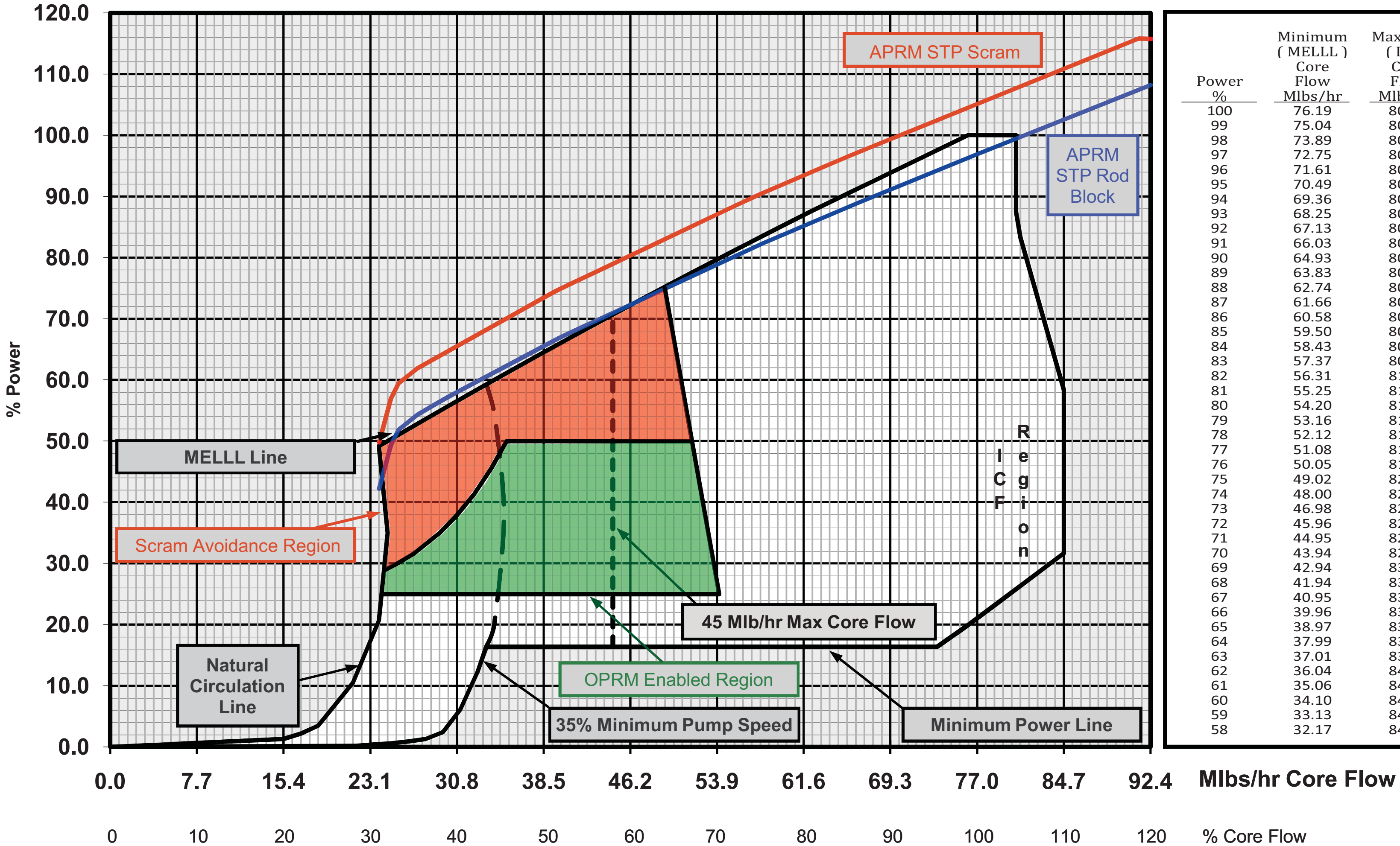
Reference: 0B21-1015, Revision 7

Figure 3

Stability Option III Power/Flow Map

OPRM Operable, Single Loop Operation, 2923 MWt

This Figure supports Improved Technical Specification 3.3.1.1 and the Technical Requirements Manual Specification 3.3



Power %	Minimum (MELLL) Core Flow Mlbs/hr	Maximum (ICF) Core Flow Mlbs/hr
100	76.19	80.47
99	75.04	80.47
98	73.89	80.47
97	72.75	80.47
96	71.61	80.47
95	70.49	80.47
94	69.36	80.47
93	68.25	80.47
92	67.13	80.47
91	66.03	80.47
90	64.93	80.47
89	63.83	80.47
88	62.74	80.47
87	61.66	80.51
86	60.58	80.60
85	59.50	80.69
84	58.43	80.79
83	57.37	80.90
82	56.31	81.05
81	55.25	81.21
80	54.20	81.36
79	53.16	81.51
78	52.12	81.67
77	51.08	81.82
76	50.05	81.98
75	49.02	82.13
74	48.00	82.29
73	46.98	82.44
72	45.96	82.60
71	44.95	82.75
70	43.94	82.91
69	42.94	83.06
68	41.94	83.22
67	40.95	83.37
66	39.96	83.52
65	38.97	83.68
64	37.99	83.83
63	37.01	83.99
62	36.04	84.14
61	35.06	84.30
60	34.10	84.45
59	33.13	84.61
58	32.17	84.70

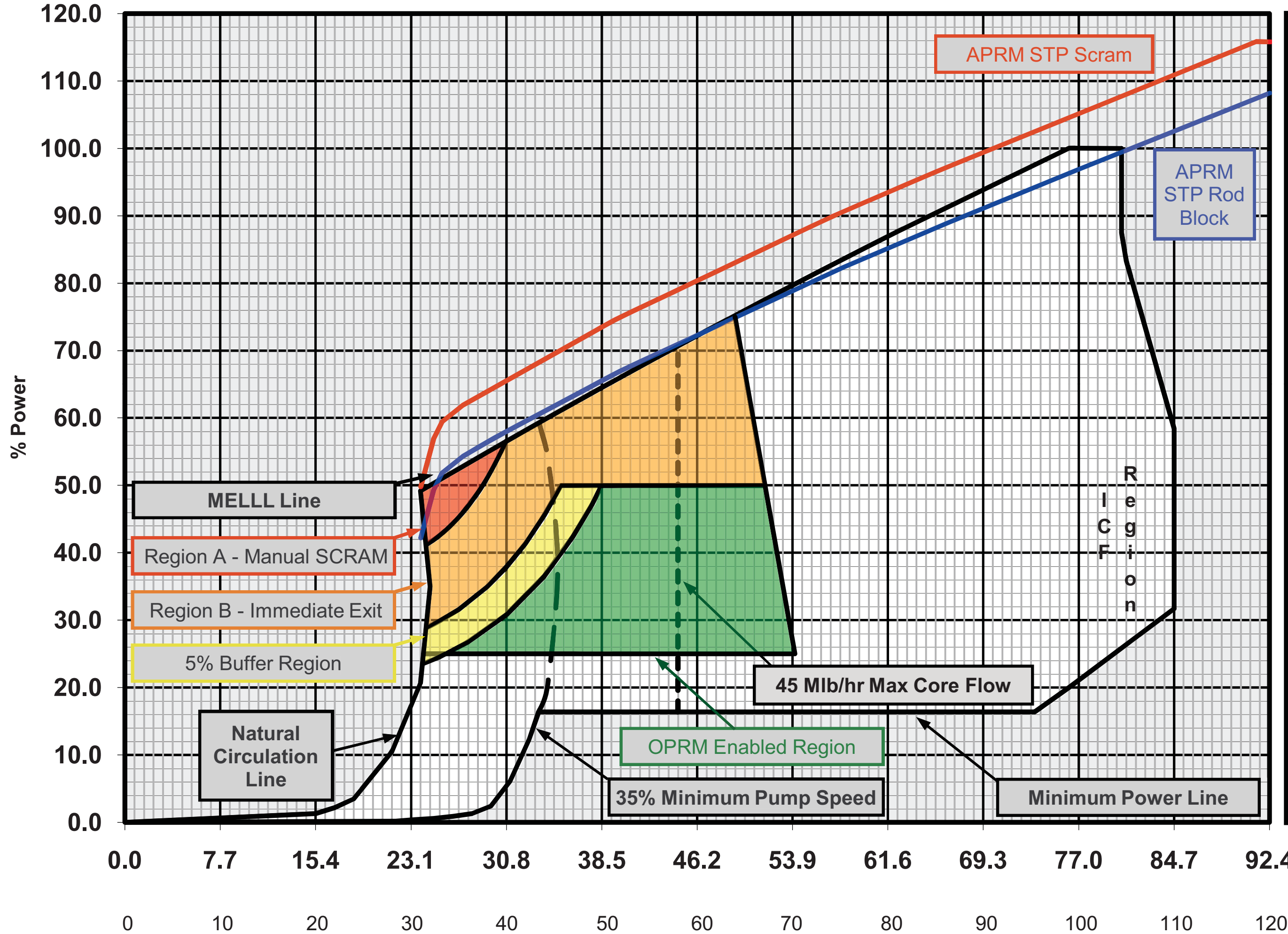
Reference: 0B21-1015, Revision 7

Figure 4

Stability Option III Power/Flow Map

OPRM Inoperable, Single Loop Operation, 2923 MWt

This Figure supports Improved Technical Specification 3.3.1.1 and the Technical Requirements Manual Specification 3.3



Mlbs/hr Core Flow

% Core Flow

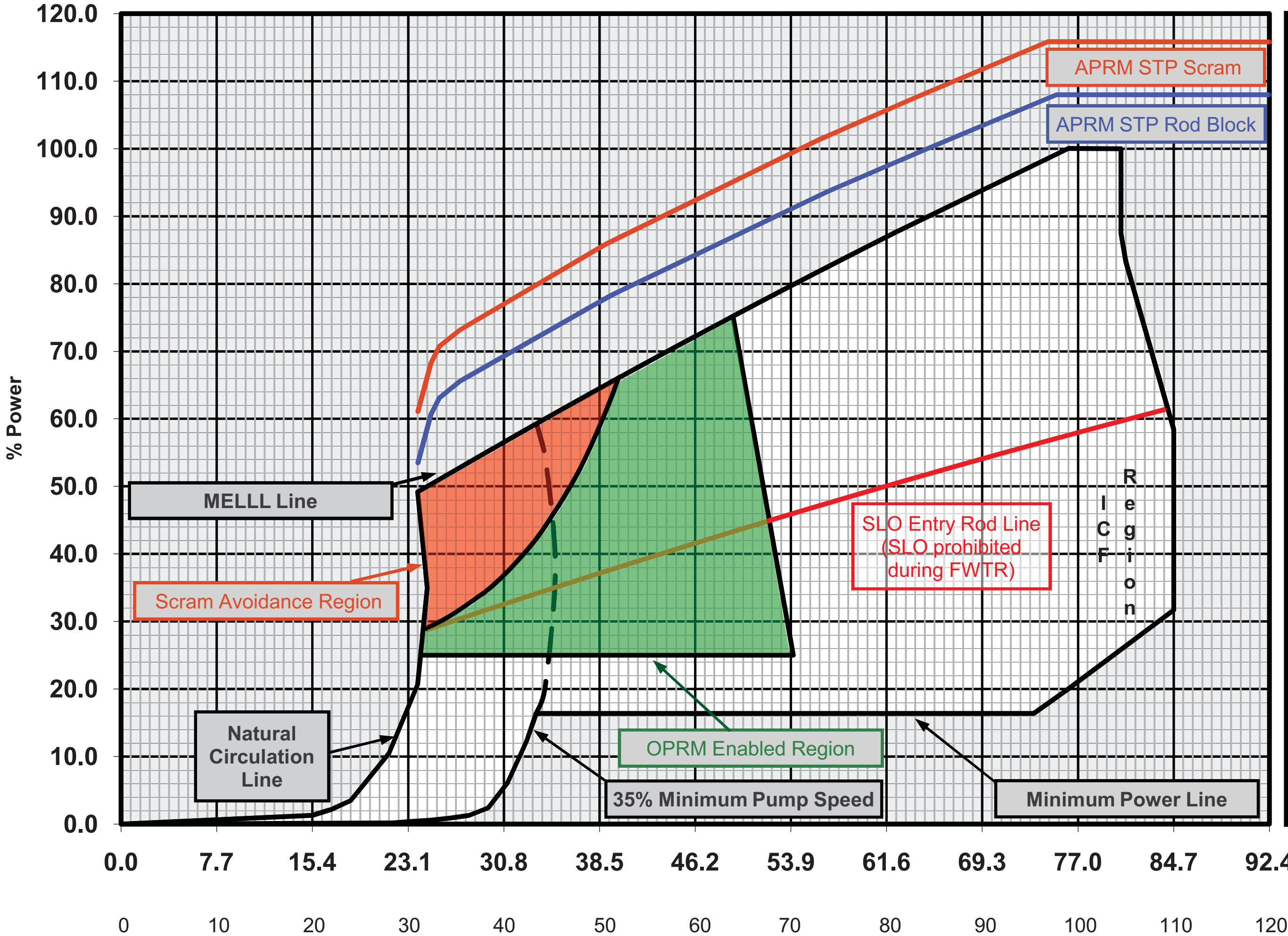
Power %	Minimum (MELLL) Core Flow Mlbs/hr	Maximum (ICF) Core Flow Mlbs/hr
100	76.19	80.47
99	75.04	80.47
98	73.89	80.47
97	72.75	80.47
96	71.61	80.47
95	70.49	80.47
94	69.36	80.47
93	68.25	80.47
92	67.13	80.47
91	66.03	80.47
90	64.93	80.47
89	63.83	80.47
88	62.74	80.47
87	61.66	80.51
86	60.58	80.60
85	59.50	80.69
84	58.43	80.79
83	57.37	80.90
82	56.31	81.05
81	55.25	81.21
80	54.20	81.36
79	53.16	81.51
78	52.12	81.67
77	51.08	81.82
76	50.05	81.98
75	49.02	82.13
74	48.00	82.29
73	46.98	82.44
72	45.96	82.60
71	44.95	82.75
70	43.94	82.91
69	42.94	83.06
68	41.94	83.22
67	40.95	83.37
66	39.96	83.52
65	38.97	83.68
64	37.99	83.83
63	37.01	83.99
62	36.04	84.14
61	35.06	84.30
60	34.10	84.45
59	33.13	84.61
58	32.17	84.70

Reference: 0B21-1015, Revision 7

Figure 5
Stability Option III Power/Flow Map

OPRM Operable, FWTR, 2923 MWt

This Figure supports Improved Technical Specification 3.3.1.1 and the Technical Requirements Manual Specification 3.3



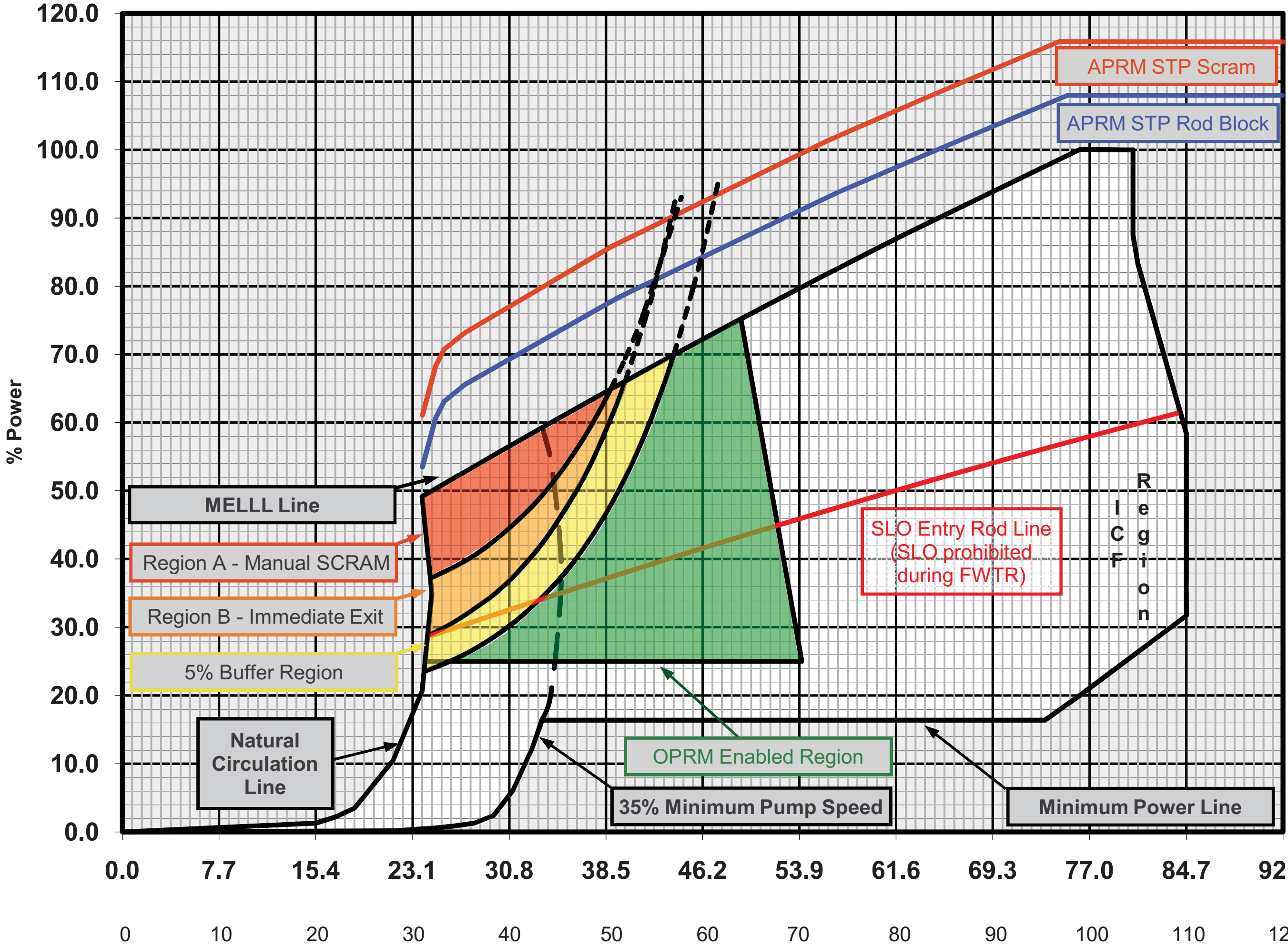
Power %	Minimum (MELLL) Core Flow Mlbs/hr	Maximum (ICF) Core Flow Mlbs/hr
100	76.19	80.47
99	75.04	80.47
98	73.89	80.47
97	72.75	80.47
96	71.61	80.47
95	70.49	80.47
94	69.36	80.47
93	68.25	80.47
92	67.13	80.47
91	66.03	80.47
90	64.93	80.47
89	63.83	80.47
88	62.74	80.47
87	61.66	80.51
86	60.58	80.60
85	59.50	80.69
84	58.43	80.79
83	57.37	80.90
82	56.31	81.05
81	55.25	81.21
80	54.20	81.36
79	53.16	81.51
78	52.12	81.67
77	51.08	81.82
76	50.05	81.98
75	49.02	82.13
74	48.00	82.29
73	46.98	82.44
72	45.96	82.60
71	44.95	82.75
70	43.94	82.91
69	42.94	83.06
68	41.94	83.22
67	40.95	83.37
66	39.96	83.52
65	38.97	83.68
64	37.99	83.83
63	37.01	83.99
62	36.04	84.14
61	35.06	84.30
60	34.10	84.45
59	33.13	84.61
58	32.17	84.70

Reference: 0B21-1015, Revision 7

Figure 6
Stability Option III Power/Flow Map

OPRM Inoperable, FWTR, 2923 MWt

This Figure supports Improved Technical Specification 3.3.1.1 and the Technical Requirements Manual Specification 3.3



Power %	Minimum (MELLL) Core Flow Mlbs/hr	Maximum (ICF) Core Flow Mlbs/hr
100	76.19	80.47
99	75.04	80.47
98	73.89	80.47
97	72.75	80.47
96	71.61	80.47
95	70.49	80.47
94	69.36	80.47
93	68.25	80.47
92	67.13	80.47
91	66.03	80.47
90	64.93	80.47
89	63.83	80.47
88	62.74	80.47
87	61.66	80.51
86	60.58	80.60
85	59.50	80.69
84	58.43	80.79
83	57.37	80.90
82	56.31	81.05
81	55.25	81.21
80	54.20	81.36
79	53.16	81.51
78	52.12	81.67
77	51.08	81.82
76	50.05	81.98
75	49.02	82.13
74	48.00	82.29
73	46.98	82.44
72	45.96	82.60
71	44.95	82.75
70	43.94	82.91
69	42.94	83.06
68	41.94	83.22
67	40.95	83.37
66	39.96	83.52
65	38.97	83.68
64	37.99	83.83
63	37.01	83.99
62	36.04	84.14
61	35.06	84.30
60	34.10	84.45
59	33.13	84.61
58	32.17	84.70

Reference: 0B21-1015, Revision 7