Duke Energy, *Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2 Maximum Extended Load Line Limit Analysis Plus* (M+SAR), DUKE-0B21-1104-000(NP) [Redacted], July 2016

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July 2016

SAFETY ANALYSIS REPORT
FOR
BRUNSWICK STEAM ELECTRIC PLANT
UNITS 1 AND 2
MAXIMUM EXTENDED LOAD LINE LIMIT ANALYSIS PLUS

Non-Proprietary Information

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EXECUTIVE SUMMARY

This report summarizes the results of all significant safety evaluations (SEs) that justify the expansion of the core flow (CF) operating domain for the Brunswick Steam Electric Plant Units 1 and 2 (BSEP). The changes expand the operating domain in the region of operation with less than rated core flow (RCF), but do not increase the licensed power level or the maximum CF. The expanded operating domain is identified as MELLLA+.

The scope of evaluations required to support the expansion of the CF operating domain to the MELLLA+ boundary is contained in the licensing topical report (LTR) NEDC-33006P-A, "Maximum Extended Load Line Limit Analysis Plus," referred to as the M+LTR (Reference 1). This report provides a systematic disposition of the M+LTR subjects applied to BSEP, including performance of plant-specific assessments and confirmation of the applicability of generic assessments to support a MELLLA+ operating domain expansion.

It is not the intent of this report to address all the details of the analyses and evaluations reported herein. Only previously NRC-approved or industry-accepted methods were used for the analyses of accidents and transients. Therefore, because the safety analysis methods have been previously addressed, the details of the methods are not presented for review and approval in this report. Also, event and analysis descriptions that are already provided in other licensing reports or the Updated Final Safety Analysis Report (UFSAR) are not repeated within this report.

The MELLLA+ operating domain expansion is applied as an incremental expansion of the operating boundary without changing the maximum licensed power or CF, or the current plant vessel dome pressure. This report supports operation of BSEP at a current licensed thermal power (CLTP) of 2,923 MWt with CF as low as 85% of RCF. The MELLLA+ operating domain expansion does not require major plant system modifications. The MELLLA+ operating domain expansion involves changes to the operating power/CF map and changes to a small number of instrument setpoints. Because there are no increases in the operating pressure, power, steam flow rate, and feedwater (FW) flow rate, there are no significant effects on the plant systems outside of the nuclear steam supply system (NSSS). There is a potential increase in the steam moisture content at certain times while operating in the MELLLA+ operating domain. The effects of the potential increase in moisture content on plant systems have been evaluated and determined to be acceptable. The MELLLA+ operating domain expansion does not cause additional requirements to be imposed on any of the safety, balance-of-plant (BOP), electrical, or auxiliary systems. No changes to the power generation and electrical distribution systems are required as a result of the MELLLA+ operating domain expansion.

Evaluations of the reactor, engineered safety features (ESFs), power conversion, emergency power, support systems, environmental issues, and design basis accidents (DBAs) were performed. The following conclusions summarize the results of the evaluations presented in this report.

- All safety aspects of the plant that are affected by MELLLA+ operating domain expansion were evaluated.

- There is no change in the existing design basis and licensing basis acceptance criteria of the plant.
- Evaluations were performed using NRC-approved or industry-accepted analytical methods.
- Where applicable, more recent industry codes and standards were used.
- No major hardware modifications to safety-related equipment are required to support MELLLA+ operating domain expansion.
- Systems and components affected by MELLLA+ were reviewed to assure that there is no significant challenge to any safety system.
- Potentially affected commitments to the NRC were reviewed.
- Planned changes not yet implemented have also been reviewed for the effects of MELLLA+.

This report summarizes the results of the SEs needed to justify a licensing amendment to allow the MELLLA+ operating domain expansion to a minimum CF rate of 85% of RCF at 100% CLTP. These SEs demonstrate that the MELLLA+ operating domain expansion can be accommodated:

- without a significant increase in the probability or consequences of an accident previously evaluated;
- without creating the possibility of a new or different kind of accident from any accident previously evaluated; and
- without exceeding any presently existing regulatory limits or acceptance criteria applicable to the plant that might cause a reduction in a margin of safety.

Therefore, the requested MELLLA+ operating domain expansion does not involve a significant hazards consideration.

ACRONYMS

Term	Definition
1RPT & 2RPT	One and Two Recirculation Pump Trip
ABSP	Automatic Backup Stability Protection
AC	Alternating Current
ADS	Automatic Depressurization System
AL	Analytical Limit
ALARA	As Low As Reasonably Achievable
ANSI	American National Standards Institute
AOO	Anticipated Operational Occurrence
AOP	Abnormal Operating Procedure
AP	Annulus Pressurization
APLHGR	Average Planar Linear Heat Generation Rate
APRM	Average Power Range Monitor
ARI	Alternate Rod Insertion
ART	Adjusted Reference Temperature
ARTS	APRM / RBM / Technical Specifications
ASME	American Society of Mechanical Engineers
Atom %	Percentage of one kind of atom relative to total number of atoms
ATWS	Anticipated Transient Without Scram
ATWS/I	Anticipated Transient Without Scram With Instability
ATWS-RPT	Anticipated Transient Without Scram – Recirculation Pump Trip
AV	Allowable Value
BOC	Beginning of Cycle
BOP	Balance-of-Plant
BOL	Beginning of Life
BSEP	Brunswick Steam Electric Plant Units 1 and 2
BSP	Backup Stability Protection

Term	Definition
BTP	Branch Technical Position
BTU/lbm	British Thermal Unit per Pound Mass
BTU/sec-°F	BTU per Second - Degree Fahrenheit
BWR	Boiling Water Reactor
BWRVIP	Boiling Water Reactor Vessel and Internals Project
CB&I	Chicago Bridge and Iron
CCF	Common Cause Failure
CDA	Confirmation Density Algorithm
CDF	Core Damage Frequency
CF	Core Flow
CFR	Code of Federal Regulations
CHF	Critical Heat Flux
CLTP	Current Licensed Thermal Power (2923 MWt)
CLTR	Constant Pressure Power Uprate LTR
CO	Condensation Oscillation
COLR	Core Operating Limits Report
CPR	Critical Power Ratio
CRD	Control Rod Drive
CRGT	Control Rod Guide Tube
CRWE	Control Rod Withdrawal Error
CS	Core Spray
CSA	Criticality Safety Analysis
CSC	Containment Spray Cooling
CST	Condensate Storage Tank
DBA	Design Basis Accident
DBE	Design Basis Earthquake
DC	Direct Current

Term	Definition
DEG	Double Ended Guillotine
DIR	Design Input Request
DOR	Division of Responsibility
DRF	Design Record File
DSS-CD	Detect and Suppress Solution – Confirmation Density
DTR	Draft Task Report
ECCS	Emergency Core Cooling System
EFPY	Effective Full Power Years
ELTR1	Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate Licensing Topical Report
EOC	End of Cycle
EOCLB	EOC Licensing Basis
EOOS	Equipment Out-of-Service
EOP	Emergency Operating Procedure
EOR	End of Rated
EPFOD	Extended Power / Flow Operating Domain
EPU	Extended Power Uprate (same as CLTP for BSEP, 2923 MWt)
ESF	Engineered Safety Feature
°F	Degrees Fahrenheit
FAC	Flow Accelerated Corrosion
FDL	Fuel Design Limits(s)
FDLRX	Fuel Design Limit Ratio (aka MFLPD)
FFWTR	Final Feedwater Temperature Reduction
FIV	Flow-Induced Vibration
FSTF	Full Scale Test Facility
ft-lbs	Foot-Pounds
ft^3	Cubic Feet

Term	Definition
FTR	Final Task Report
FW	Feedwater
FWCF	Feedwater Controller Failure
FWCS	Feedwater Control System
FWHOOS	Feedwater Heater(s) Out of Service
GE	General Electric
GEH	GE-Hitachi Nuclear Energy Americas LLC
GESTAR	General Electric Standard Application for Reactor Fuel
GL	Generic Letter
GNF	Global Nuclear Fuel
gpm	Gallons per Minute
HCTL	Heat Capacity Temperature Limit
HELB	High Energy Line Break
HPCI	High Pressure Coolant Injection
HWC	Hydrogen Water Chemistry
IASCC	Irradiation Assisted Stress Corrosion Cracking
ICF	Increased Core Flow
IGSCC	Intergranular Stress Corrosion Cracking
IPE	Individual Plant Examination
IRM	Intermediate Range Monitor
ISP	Integrated Surveillance Program
JPSL	Jet Pump Sensing Line
kW/ft	Kilowatt per Foot
LAR	License Amendment Request
lb/sec-ft^2	Pounds per Seconds per Square Feet
lbm/hr	Pounds Mass Per Hour
LCO	Limiting Condition for Operation

Term	Definition
LERF	Large Early Release Frequency
LFWH	Loss of Feedwater Heater
LHGR	Linear Heat Generation Rate
LHGRFACf	Flow-dependent LHGR multiplier
LHGRFACp	Power-dependent LHGR multiplier
LL3/L1	Reactor Vessel Level Low-Low-Low Water Level Setpoint (Level 1).
LOCA	Loss-of-Coolant Accident
LOFW	Loss of Feedwater
LOOP	Loss of Off-Site Power
LPCI	Low Pressure Coolant Injection
LPRM	Local Power Range Monitor
LRNB	Load Rejection Without Turbine Bypass Valves Available
LTR	Licensing Topical Report
LTS	Long Term Solution
MAPLHGR	Maximum Average Planar Linear Heat Generation Rate
MCO	Moisture Carryover
MCPR	Minimum Critical Power Ratio
MCPRf	Flow-dependent MCPR limit
MCPRp	Power-dependent MCPR limit
MCR	Main Control Room
MELLLA	Maximum Extended Load Line Limit Analysis
MELLLA+	Maximum Extended Load Line Limit Analysis Plus
MFLCPR	Maximum Fraction of Limiting Critical Power Ratio
MFLPD	Maximum Fraction of Limiting Power Density (aka FDLRX)
Mlbm/hr	Millions of Pounds Mass per Hour
M+LTR	MELLLA+ Licensing Topical Report NEDC-33006P-A

Term	Definition
M+LTR SER	M+LTR Safety Evaluation Report
MOC	Middle of Cycle
MOV	Motor Operated Valve
MS	Main Steam
M+SAR	MELLLA+ Safety Analysis Report (Plant Specific Safety Analysis Report)
MSIV	Main Steam Isolation Valve
MSIVC	Main Steam Isolation Valve Closure
MSIVF	Main Steam Isolation Valve Closure with Scram on High Flux
MSLBA	Main Steam Line Break Accident
MWe	Megawatt-Electric
MWt	Megawatt-Thermal
n/cm^2	Neutrons per Square Centimeter (Measurement for Fluence)
NCL	Natural Circulation Line
NFPA	National Fire Protection Association
NFSV	New Fuel Storage Vault
NPSH	Net Positive Suction Head
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
NUMAC	Nuclear Measurement Analysis and Control
OLMCPR	Operating Limit Minimum Critical Power Ratio
OLTP	Original Licensed Thermal Power (2436 MWt)
OOS	Out-of-Service
OPRM	Oscillation Power Range Monitor
PBDA	Period Based Detection system
PCT	Peak Cladding Temperature
ppm	Parts per Million

Term	Definition
PRA	Probabilistic Risk Assessment
PRFO	Pressure Regulator Failure - Open
PRNM	Power Range Neutron Monitoring
PRNMS	Power Range Neutron Monitoring System
psi	Pounds per Square Inch
psia	Pounds per Square Inch - Absolute
psid	Pounds per Square Inch - Differential
psig	Pounds per Square Inch - Gauge
P-T	Pressure-Temperature
PULD	Plant Unique Load Definition
PWP	Project Work Plan
QAP	Quality Assurance Program
QSTF	Quarter Scale Test Facility
RAI	Request for Additional Information
RBM	Rod Block Monitor
RCF	Rated Core Flow
RCIC	Reactor Core Isolation Cooling
RCPB	Reactor Coolant Pressure Boundary
RE	Responsible Engineer
RG	Regulatory Guide
RHR	Residual Heat Removal
RIPD	Reactor Internal Pressure Difference
RMCS	Reactor Manual Control System
RPIS	Rod Position Information System
RPM	Revolutions per Minute
RPT	Recirculation Pump Trip
RPV	Reactor Pressure Vessel

Term	Definition
RRS	Reactor Recirculation System
RSAR	Reload Safety Analysis Report (AREVA equivalent to GEH SRLR)
RSLB	Recirculation Suction Line Break
RT_{NDT}	Reference Temperature of Nil Ductility Transition
$RWCURT_{NDT}$	Reactor Water Cleanup
RWE	Rod Withdrawal Error
S_{AD}	Amplitude Discriminator Setpoint (DSS-CD)
SBO	Station Blackout
SDC	Shutdown Cooling
SDM	Shut Down Margin
SE	Safety Evaluation
sec	Second(s)
SER	Safety Evaluation Report
SF-BATT	Single Failure of Battery (DC) Power
SF-LPCI	Single Failure of a Low Pressure Coolant Injection valve
SFSP	Spent Fuel Storage Pool
SLC	Standby Liquid Control
SLCS	Standby Liquid Control System
SLMCPR	Safety Limit Minimum Critical Power Ratio
SLO	Single (Recirculation) Loop Operation
SPC	Suppression Pool Cooling
SRLR	GEH Supplemental Reload Licensing Report
SRM	Source Range Monitor
SRO	Strongest Rod Out
SRP	Standard Review Plan
SRV	Safety Relief Valve

Term	Definition
SRVDL	Safety Relief Valve Discharge Line
SRVOOS	Safety Relief Valve – Out of Service
STP	Simulated Thermal Power
TAF	Top of Active Fuel
TBVOOS	Turbine Bypass Valves Out-of-Service
T_{FW}	Feedwater Temperature
THI	Thermal-Hydraulic Instability
TIP	Traversing In-core Probe
TLO	Two (Recirculation) Loop Operation
T-M	Thermal-Mechanical
TR	Task Report
TS	Technical Specification
TSD	Task Scoping Document
TSSS	Technical Specification Scram Speed
TSV	Turbine Stop Valve
TTNB	Turbine Trip Without Turbine Bypass Valves Available
TTWBP	Turbine Trip With Bypass
UFSAR	Updated Final Safety Analysis Report
UHS	Ultimate Heat Sink
US	United States
USE	Upper Shelf Energy
VPF	Vane Passing Frequency
W_d	Recirculation Drive Flow
w/o	Without
wt.%	Percent by Weight

1.0 INTRODUCTION

This report summarizes the results of all significant SEs performed that justify the expansion of the operating boundary that would permit BSEP operation at a CLTP of 2,923 MWt (120% original licensed thermal power (OLTP)) with CF as low as 85% of RCF. This report is based on previously approved operation at Extended Power Uprate (EPU) conditions at BSEP as approved by the US NRC in Reference 53. The changes expand the operating domain in the region of operation with less than RCF, but do not increase the licensed power level or the maximum CF. The expanded operating domain is identified as MELLLA+.

The scope of evaluations required to support the expansion of the CF operating domain to the MELLLA+ boundary is contained in the LTR NEDC-33006P-A, "Maximum Extended Load Line Limit Analysis Plus," referred to as the M+LTR (Reference 1). This report provides a systematic disposition of the M+LTR subjects applied to BSEP, including performance of plant-specific assessments and confirmation of the applicability of generic assessments to support a MELLLA+ operating domain expansion.

The MELLLA+ operating domain expansion does not require major plant hardware modifications. In accordance with Limitation and Condition 12.2 of the NRC safety evaluation report (SER) for MELLLA+ (Reference 1), referred to as the M+LTR SER, BSEP will implement the Detect and Suppress Solution – Confirmation Density (DSS-CD) solution, with limitations and conditions as identified in the DSS-CD LTR SER (Reference 49), consistent with the M+LTR. It should be noted that NEDC 33147P A Revision 4 does not contain any limitations and conditions. DSS-CD requires a revision to the existing stability solution software. The operating domain expansion involves changes to the operating power/CF map and changes to a small number of instrument setpoints. Because there are no increases in the operating pressure, power, steam flow rate, and FW flow rate, there are no significant effects on the plant hardware outside of the NSSS. There is a potential increase in the steam moisture content at certain times while operating in the MELLLA+ operating domain. The effects of the potential increase in moisture content on plant hardware have been evaluated and determined to be acceptable. The MELLLA+ operating domain expansion does not cause additional requirements to be imposed on any of the safety, BOP, electrical, or auxiliary systems. No changes to the power generation and electrical distribution systems are required due to the introduction of MELLLA+.

The generic MELLLA+ LTR, NEDC-33006P-A, is a product of GEH while BSEP currently operates with AREVA fuel. For this reason, the safety evaluations provided in this document are the results of analyses from both GEH and AREVA. For the GEH analyses, this report addresses applicable limitations and conditions as described in the M+LTR SER and as contained in the LTR NEDC-33173P-A, "Applicability of GE Methods to Expanded Operating Domains," referred to as the Methods LTR (Reference 2).

The disposition of each limitation and condition is discussed along with the relevant section of this report. A complete listing of the required M+LTR SER, Methods LTR SER, and DSS-CD

LTR SER limitations and conditions and the sections of this report which address them is presented in Appendices A, B, and C, respectively.

The applicability of AREVA methods to the MELLLA+ operating domain is addressed separately in ANP-3108P, "Applicability of AREVA BWR Methods to Brunswick Extended Power Flow Operating Domain", (Reference 60).

1.1 REPORT APPROACH

The evaluations provided in this report demonstrate that the MELLLA+ operating domain expansion can be accomplished within the applicable safety design criteria. Many of the SEs and equipment assessments previously performed for the BSEP EPU are unaffected because the MELLLA+ operating domain expansion effects are limited to the NSSS system.

This BSEP MELLLA+ safety analysis report (M+SAR) follows the same structure and content as the M+LTR (Reference 1). Two dispositions of the evaluation topics are used to characterize the MELLLA+ evaluation scope. Topics are dispositioned as either "Generic" or "Plant-Specific" as described in Sections 1.1.1 and 1.1.2, respectively.

1.1.1 Generic Assessments

Generic assessments are those SEs that can be dispositioned by:

- Providing or referencing a bounding analysis for the limiting conditions;
- Demonstrating that there is a negligible effect due to MELLLA+;
- Identifying the portions of the plant that are unaffected by the MELLLA+ power/flow map operating domain expansion; or
- Demonstrating that the sensitivity to MELLLA+ is small enough that the required plant cycle-specific reload analysis process is sufficient and appropriate for establishing the MELLLA+ licensing basis in accordance with M+LTR SER Limitation and Condition 12.3.c and as defined in the General Electric Standard Application for Reactor Fuel (GESTAR) or by analysis using the NRC approved AREVA codes such as those listed in Table 1-1a.

  As per M+LTR SER Limitation and Condition 12.4, the plant-specific MELLLA+ application shall provide the plant-specific thermal limits assessment and transient analysis results. Considering the timing requirements to support the reload, the fuel and cycle-dependent analyses including the plant-specific thermal limits assessment may be submitted by supplementing the initial M+SAR. Additionally, the Reload Safety Analysis Report (RSAR), equivalent to the Supplemental Reload Licensing Report (SRLR), for the initial MELLLA+ implementation cycle shall be submitted for NRC staff confirmation.

  Some of the SEs affected by MELLLA+ are fuel operating cycle (reload) dependent. Reload dependent evaluations require that the reload fuel design, core loading pattern, and operational plan be established so that analyses can be performed to establish core operating limits. The reload analysis demonstrates that the core design for MELLLA+ meets the applicable NRC evaluation criteria and limits documented in Reference 3.

[[

]] No plant can enter the MELLLA+ operating domain unless the appropriate reload core analysis is performed, all licensing criteria are satisfied, and the operating limits are appropriately documented. Otherwise, the plant would be in an unanalyzed condition. Based on current requirements, the reload analysis results are documented in the RSAR (SRLR equivalent) and the applicable core operating limits are documented in the plant-specific Core Operating Limits Report (COLR).

BSEP will supplement this M+SAR with the fuel and cycle dependent analysis including the plant-specific thermal limits assessment. Additionally, BSEP will submit the RSAR for the initial MELLLA+ implementation cycle for NRC staff confirmation.

As required by M+LTR SER Limitation and Condition 12.5.a, BSEP will modify Technical Specification (TS) 3.4.1 to recognize that single loop operation (SLO) operation is prohibited in the MELLLA+ operating domain. This information is presented in the BSEP MELLLA+ license amendment request (LAR) package.

As required by M+LTR SER Limitation and Condition 12.3.b, the applicability of the generic assessments to BSEP is identified and confirmed in the applicable sections. In the event that the generic assessment presented in the M+LTR is not applicable to BSEP, a plant-specific evaluation per Section 1.1.2 is completed to demonstrate the acceptability of the MELLLA+ operating domain expansion.

1.1.2 Plant-Specific Evaluation

A BSEP-specific evaluation is provided for SEs not categorized as Generic. Where applicable, the assessment methodology in References 1, 3, 4, 5, 6, or 60 is provided. As required by M+LTR SER Limitation and Condition 12.3.a, the plant-specific evaluations are reported consistent with the content, structure, and level of detail indicated in the M+LTR.

The plant-specific evaluations performed and reported in this document use plant-specific values to model the actual plant systems, transient response, and operating conditions.

1.1.3 Computer Codes and Methods

NRC-approved or industry-accepted computer codes and calculational techniques are used in the evaluations for the MELLLA+ operating domain. The primary computer codes used for BSEP evaluations are listed in Table 1-1 for GEH and Westinghouse and Table 1-1a for AREVA. The application of these codes complies with the limitations, restrictions, and conditions specified in the approving NRC SER. Exceptions to the use of the code or special conditions of the applicable SER are included as notes to Table 1-1 and Table 1-1a.

The Methods LTRs NEDC-33173P-A (Reference 2) for GEH and ANP-3108 (Reference 60) for AREVA document the evaluations supporting the conclusions in this section that the application ranges of GEH and AREVA codes and methods are adequate in the MELLLA+ operating domain. In accordance with the M+LTR SER Limitation and Condition 12.1, the range of mass fluxes and power/flow ratios in the AREVA ACE/ATRIUM 10XM critical power correlation database and the GEXL equivalent database for ATRIUM 10XM fuel covers the intended MELLLA+ operating domain. The database includes low flow, high qualities, and void fractions beyond the application of the GEXL-PLUS equivalent or the AREVA ACE correlations in the MELLLA+ operating domain.

As required by M+LTR SER Limitation and Condition 12.23.2, the BSEP-specific ODYN and TRACG calculation input parameters are provided in Table 9-3 and calculation results are provided in Tables 9-4 and 9-5.

As discussed in Section 1.0, consistent with M+LTR SER Limitation and Condition 12.2, the specific limitations and conditions associated with the M+LTR, Methods LTR, and DSS-CD LTR are discussed along with the relevant section of this report. A complete listing of the required M+LTR SER, Methods LTR SER, and DSS-CD LTR SER limitations and conditions and the sections of this report which address them, as well as additional comments, is presented in Appendices A, B, and C respectively.

1.1.4 Scope of Evaluations

Sections 2.0 through 11.0 provide evaluations of the MELLLA+ operating domain expansion on the respective topics. The scope of the evaluations is summarized in the following sections.

Section 2.0, Reactor Core and Fuel Performance: Core and fuel performance parameters are confirmed for each fuel cycle, and will be evaluated and documented in the RSAR (SRLR equivalent) and COLR for each fuel cycle that implements the MELLLA+ operating domain.

Section 3.0, Reactor Coolant and Connected Systems: Evaluations of the NSSS components and systems are performed in the MELLLA+ operating domain. Because the reactor operating pressure and the CF are not increased by MELLLA+, the effects on the reactor coolant and connected systems are minor. These evaluations confirm the acceptability of the MELLLA+ changes to process variables in the NSSS.

Section 4.0, Engineered Safety Features: The effects of MELLLA+ operating domain expansion on the containment, emergency core cooling systems (ECCS), standby gas treatment system (SGTS), and other ESFs are evaluated. The operating pressure for ESF equipment is not increased because operating pressure and safety relief valve (SRV) setpoints are unchanged as a result of MELLLA+.

Section 5.0, Instrumentation and Control: The instrumentation and control systems and analytical limits (ALs) for setpoints are evaluated to establish the effects of MELLLA+ operating domain expansion on process parameters. The scope of MELLLA+ effects on the controls and setpoints is limited because the MELLLA+ parameter variations are limited to the core.

Section 6.0, Electrical Power and Auxiliary Systems: Because the power level is not changed by MELLLA+, the electrical power and distribution systems are not affected. The auxillary systems have been previously evaluated to ensure they are capable of supporting safe plant operation at CLTP, which is unchanged by MELLLA+ operating domain expansion.

Section 7.0, Power Conversion Systems: Because the pressure, steam flow, and FW flow do not change as a result of MELLLA+ operating domain expansion, the power conversion systems are not affected by MELLLA+.

Section 8.0, Radwaste Systems and Radiation Sources: The liquid and gaseous waste management systems are not affected by the MELLLA+ operating domain changes. However, slightly higher loading of the condensate demineralizers is possible if the moisture carryover (MCO) in the reactor steam increases. The radiological consequences are evaluated to show that applicable regulations are met.

Section 9.0, Reactor Safety Performance Evaluations: The UFSAR anticipated operational occurrences (AOOs), DBAs, and special events are reviewed as part of the MELLLA+ evaluation.

Section 10.0, Other Evaluations: High energy line break (HELB) and environmental qualification evaluations for the MELLLA+ operating domain are confirmed to demonstrate the operability of plant equipment at MELLLA+ conditions. The effects on the individual plant examination (IPE) are evaluated to demonstrate there is no significant change to the BSEP vulnerability to severe accidents.

Section 11.0, Licensing Evaluations: The effect on TSs, the Environmental Assessment and the No Significant Hazards Consideration are provided as a part of the accompanying LAR.

1.1.5 Product Line Applicability

The M+LTR describes processes, evaluations, and dispositions applicable to GEH boiling water reactor (BWR) product lines BWR/3, BWR/4, BWR/5, and BWR/6. As such, the M+LTR process is applicable to BSEP, a BWR/4.

1.1.6 Report Generation and Review Process

GEH Scope

This M+SAR represents several years of project planning activities, engineering analysis, technical verification, and technical review. The final stages of the M+SAR preparation include M+SAR integration, additional review, on-site review committee review, and submittal to NRC. The BSEP MELLLA+ project relied on the generic M+LTR (Reference 1) submitted to and approved by the NRC (Reference 1).

The project began with the respective GEH and Duke Energy Project Managers creating a project work plan (PWP). This PWP, developed in accordance with GEH engineering procedures, was used to define the plant-specific work scope, inputs and outputs required for project activities. A division of responsibility (DOR) between Duke Energy and GEH was used to further develop the work scope and assign responsible engineers (REs) from each organization. A task scoping document (TSD) applicable for each GEH task was created, reviewed, and approved by Duke Energy prior to any technical work being performed. Each GEH task RE submitted a design input request (DIR) to the Duke Energy task RE interface to define the correct plant information for use in the GEH task analysis and evaluation. Additional DIRs were submitted as the project continued. A plant-specific M+SAR "shell" was created that contains the appropriate depth of information (but not the specifics) expected in the final M+SAR.

All pertinent information is captured in an individual task design record file (DRF) maintained by the GEH RE with oversight by the respective engineering manager. Each DRF contains the quality assurance records applicable to the task, which includes evidence of design verification.

A draft task report (DTR) was created for every GEH task. The DTR includes a description of the analysis performed, inputs, methods applied, results obtained and includes input to the applicable M+SAR section(s). The DTR with M+SAR input was verified, in accordance with the GEH quality assurance program (QAP), by a GEH technical verifier and a GEH Regulatory Affairs verifier, with oversight by the responsible GEH technical manager and GEH Project Manager. The DTR with M+SAR input was transmitted by the GEH Project Manager to Duke Energy and reviewed by the Duke Energy RE and other Duke Energy engineers, as appropriate. Subsequent comments were resolved between the GEH and the Duke Energy REs and a final task report (FTR) with M+SAR input was developed. The FTR with M+SAR input was again verified (whether or not there were changes to the document), in accordance with the GEH QAP, by a GEH technical verifier and a GEH Regulatory Affairs verifier, with oversight by the responsible GEH technical manager and GEH Project Manager. The GEH Project Manager transmitted the FTR with M+SAR input to the Duke Energy Project Manager.

For the BSEP MELLLA+ project, Duke Energy personnel:

1. Conducted multidisciplinary technical reviews of GEH evaluation reports (DTRs with M+SAR input and FTRs with M+SAR input) to ensure:
   i. Appropriate use of design inputs;
   ii. Consistency with the M+LTR; and
   iii. Design basis and licensing basis requirements were addressed.
2. Provided technical review results, in the form of detailed comments, to GEH performers;
3. Participated in discussions with GEH REs to address and resolve comments; and
4. Controlled the application of the Duke Energy off-site services process to GEH.

The Regulatory Affairs RE integrated the individual M+SAR sections creating a Draft M+SAR that was verified, in accordance with the GEH QAP, by another GEH Regulatory Affairs engineer, with oversight by the GEH Regulatory Affairs Services Licensing Manager and the GEH Project Manager. The GEH Project Manager transmitted the verified Draft M+SAR to

Duke Energy where it received another complete review by Duke Energy's technical personnel, project staff, and Licensing staff.

Duke Energy personnel generated questions and comments, which were responded to by GEH's technical and Regulatory Affairs personnel. The M+SAR was then presented to the Duke Energy's on-site review committee. After resolution of any final comments, the final M+SAR was submitted to the NRC.

A technical assessment of GEH's work was performed by Duke Energy. The scope of these assessments included work performed by GEH and Global Nuclear Fuel (GNF) in support of the BSEP MELLLA+ project. Participating in those activities were representatives of BSEP mechanical/structural, nuclear, and reactor engineering disciplines, and project engineering. The BSEP team reviewed design inputs, analysis methodologies, and results in the GEH DRFs. The reviews included discussion with GEH technical task performers to obtain a thorough understanding of GEH analysis methods.

1.1.7 Report Generation and Review Process

Duke Energy Scope

As noted in Section 1.1.6 above, a DOR between Duke Energy and GEH was used to further develop the work scope and assign REs from each organization. Tasks assigned to Duke Energy REs were performed under the Duke Energy 10 Code of Federal Regulations (CFR) 50, Appendix B QAP, where applicable. The Duke Energy assigned tasks were performed internally by Duke Energy engineers or contracted out to engineering consulting firms on the Duke Energy approved supplier list. Where applicable, the contractors applied a 10 CFR 50, Appendix B QAP.

Duke Energy internal tasks were prepared, reviewed, and approved in accordance with applicable procedures.

For contracted tasks, a TSD applicable for each task was created, reviewed, and approved by Duke Energy prior to any technical work being performed. This work scope formed the basis for the MELLLA+ task. The design inputs were then collected, reviewed, and forwarded to the engineering consultant, in accordance with applicable procedures.

DTRs were created that included a description of the analysis performed, inputs, methods applied, results obtained and included input to the applicable M+SAR section(s). Duke Energy engineering personnel, MELLLA+ project personnel, and Duke Energy subject matter experts, as appropriate, reviewed the DTR with M+SAR section, and an integrated set of comments on the DTR were forwarded for comment resolution and incorporation into the FTR. FTRs, when issued, are processed through the Duke Energy engineering review process as a final verification of acceptability and retained as quality records in the Duke Energy nuclear records management system.

1.1.8 Report Generation and Review Process

AREVA Scope

Consistent with the division of responsibility established between Duke Energy and AREVA, the AREVA work scope focused on the reload fuel analyses. In broad terms, this included fuel and core design, the ASME overpressure evaluation, and establishing the thermal operating limits and backup stability regions. The tasks performed by AREVA were prepared, reviewed and approved consistent with AREVA's quality assurance procedures.

In support of the AREVA MELLLA+ work scope, design and analysis inputs were provided by Duke Energy in a Brunswick plant parameters document. These inputs were used to perform the AREVA work scope to support the M+SAR.

Descriptions of the analyses performed, inputs, methodology, and results were transmitted to Duke Energy for review and approval. Duke Energy personnel reviewed the M+SAR input and the supporting documentation and provided comments. Responses to the comments were prepared by AREVA and subsequently accepted by Duke Energy.

1.2 Operating Conditions and Constraints

1.2.1 Power/Flow Map

The BSEP power/flow map including the MELLLA+ operating domain expansion is shown in Figure 1-1. [[

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All lines on the power/flow map in Figure 1-1, other than those associated with the MELLLA+ operating domain expansion, are unchanged by MELLLA+.

In accordance with M+LTR SER Limitation and Condition 12.5.c, BSEP currently includes the power/flow maps in the COLR for each cycle. BSEP will continue to include the power/flow maps in the COLR once the MELLLA+ operating domain expansion is approved.

The MELLLA+ operating domain extends from 55% of RCF at 77.6% of CLTP to 85% of RCF at 100% of CLTP. Normal core performance characteristics for plant power/flow maneuvers at near full power can be accomplished above 55% of RCF. Due to stability considerations at high power and low CF, the MELLLA+ operating domain was not extended below 55% of RCF. The reactor operating conditions following an unplanned event could stabilize at a power/flow point outside the allowed operating domain. If this occurs the operator must reduce power or increase flow in accordance with plant procedures to place the plant back into the allowed operating domain.

The steady state core thermal power to CF ratio for operation in the MELLLA+ operating domain is listed in Table 1-3. Each point listed is in compliance with the Methods LTR SER Limitation and Condition 9.3 of 50 MWt/Mlbm/hr with the exception of the point of low flow / high power, point 'M' (55% of RCF / 77.6% of CLTP), on Figure 1-1. The point on the power/flow map is only marginally above the limit and is not used for extended periods of operation. Because the limitation is not intended to place operational restrictions on the plant (Reference 2), the BSEP MELLLA+ Power/Flow map remains as shown in Figure 1-1, without any additional restrictions.

When BSEP exceeds the power-to-flow ratio of 50 MWt/Mlbm/hr at 55% of RCF, the limitation with respect to the conservatism of the power distribution uncertainties were evaluated and do not apply. The results of this assessment are provided in Section 2.2.5.

1.2.2 Reactor Heat Balance

The nominal rated reactor heat balance is not affected by MELLLA+. The changes in the reactor heat balance resulting from the MELLLA+ operating range expansion are only those that are a result of the decrease in recirculation pump heat and the decrease in core inlet enthalpy as a result of the lower flow operating domain.

1.2.3 Core and Reactor Conditions

As mentioned previously, the MELLLA+ operating domain expansion results in changes to the core and reactor.

Table 1-2 compares maximum extended load line limit analysis (MELLLA) and MELLLA+ thermal-hydraulic operating conditions for BSEP. The differences shown in Table 1-2 are typical of other BWR plants analyzed for MELLLA+ operating domain expansion, and the core operating conditions listed in Table 1-3 represent the maximum allowed power-to-flow ratio state points within the boundaries of the MELLLA+ operating domain. [[

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The decay heat is principally a function of the reactor power level and the irradiation time. The MELLLA+ operating domain expansion does not alter either of these two parameters, and therefore, there is no first order effect on decay heat. Enrichment, exposure, void fraction, power history, cycle length, and refueling batch fraction have a second order effect on decay heat. [[

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1.2.4 Operational Enhancements

The following table provides the performance improvement and/or equipment out-of-service (EOOS) features applicable to BSEP and whether they are allowed in the MELLLA+ operating domain. The table also dispositions other operational enhancements that were discussed in the M+LTR (Reference 1).

Operational Enhancements	M+LTR Disposition	BSEP Result
Feedwater Heater Out-of-Service (FWHOOS)	Not Allowed	Not Included
Increased Core Flow (ICF)	Allowed	Included
Single Loop Operation	Not Allowed	Not Included
Safety Relief Valve - Out-of-Service (SRVOOS) (1 valve)	Allowed	Included
Turbine Bypass Valves Out-of-Service (TBVOOS)	Allowed	Included
Main Steam Isolation Valve (MSIV) Out-of-Service	Allowed	Included
1 Automatic Depressurization System (ADS) Valve Out-of-Service (OOS)	Allowed	Included
24 Month Cycle	Allowed	Included

The evaluations performed in support of MELLLA+ operating domain expansion consider each of the operational enhancements listed as "Allowed". Because the operational enhancements are considered as a part of the design inputs for evaluations performed in support of MELLLA+ operating domain expansion, these operational enhancements are evaluated across the scope of this M+SAR and are therefore not dispositioned in a specific section.

BSEP has the operating flexibility options of FWHOOS and Final Feedwater Temperature Reduction (FFWTR) at MELLLA, but not at MELLLA+. The BSEP MELLLA+ LAR includes a proposed license condition that prevents operation in the MELLLA+ domain with reduced feedwater temperature. This effectively prohibits FFWTR as an operating strategy within the MELLLA+ domain. The effects from this license condition were evaluated, and the results were found to be acceptable. This license condition satisfies M+LTR SER Limitation and Condition 12.5.b.

SLO in the MELLLA+ operating domain is not proposed. The present licensing basis for SLO will remain available per plant TSs. As required by M+LTR SER Limitation and Condition 12.5.a, TS 3.4.1 is being modified as shown in the Duke Energy MELLLA+ LAR package to specify that SLO is prohibited in the MELLLA+ operating domain.

1.3 SUMMARY AND CONCLUSIONS

This M+SAR documents the results of analyses necessary to expand the operating domain of the BSEP plant to include the MELLLA+ operating domain. This document conforms to the scope, content and structure described in the M+LTR, which the NRC has determined "is acceptable for referencing in licensing applications for GE-designated BWRs to the extent specified and under the limitations and conditions delineated in the TR [task report] and in the enclosed final SE [safety evaluation]."

Table 1-1 Computer Codes Used in the M+SAR Evaluations

Task	Computer Code*	Version or Revision	NRC Approved	Comments
Reactor Heat Balance	ISCOR	09	Y(1)	NEDE-24011P Rev. 0 SER
Thermal-Hydraulic Stability	ODYSY ISCOR PANACEA TRACG	05 09 11 04	Y Y(1) Y(4) Y(8)	NEDE-33213P-A NEDE-24011P Rev. 0 SER NEDE-30130P-A NEDC-33075P-A Rev. 8
Reactor Internal Pressure Differences (RIPDs)	LAMB TRACG ISCOR	07 02 09	(2) (3) Y(1)	NEDE-20566P-A, September 1986 NRC TAC No. M90270, Sept. 1994 NEDE-24011P Rev. 0 SER
Reactor Recirculation System (RRS)	BILBO	04V	(6)	NEDE-23504, Feb. 1977 (Reference 7)
Containment System Response	M3CPT LAMB	05 08	Y (2)	NEDO-10320, April 1971, NEDO-20533, June 1974 (References 8 and 9), NUREG-0661 (Reference 10) NEDE-20566P-A, September 1986 (Reference 11)
Anticipated Transient Without Scram (ATWS)	ODYN STEMP PANACEA TASC ISCOR TRACG	10 04 11 03A 09 04	Y (5) Y(4) Y Y(1) N(7)	NEDC-24154P-A, Supplement 1 –Vol. 4 (Reference 12) NEDC-32084P-A Rev. 2 (Reference 13) NEDE-24011P Rev. 0 SER
Reactor Pressure Vessel (RPV) Fluence	DORT	3.1	N(9)	Westinghouse Report WCAP-17660-NP, Rev. 0 , November 2012 (Reference 15)

* The application of these codes to the MELLLA+ analyses complies with the limitations, restrictions, and conditions specified in the approving NRC SER where applicable for each code. The application of the codes also complies with the SERs for the MELLLA+ programs.

Notes for Table 1-1:

(1) The ISCOR code is not approved by name. However, in the SER supporting approval of NEDE-24011P Revision 0 by the May 12, 1978 letter from D. G. Eisenhut (NRC) to R. Gridley (GE), the NRC finds the models and methods acceptable for steady-state thermal-hydraulic analysis, and mentions the use of a digital computer code. The referenced digital computer code is ISCOR. The use of ISCOR to provide core thermal-hydraulic information in RIPDs, transient, ATWS, stability, and loss-of-coolant accident (LOCA) applications is consistent with the approved models and methods.

(2) The LAMB code is approved for use in ECCS-LOCA applications (NEDE-20566P-A), but no approving SER exists for the use of LAMB for the evaluation of RIPDs or containment system response. The use of LAMB for these applications is consistent with the model description of NEDE-20566P-A.

(3) NRC has reviewed and accepted the TRACG application for the flow-induced loads on the core shroud as stated in NRC SER TAC No. M90270.

(4) The physics code PANACEA (PANAC) provides inputs to the transient code ODYN. The use of PANACEA Version 11 in this application was initiated following approval of Amendment 26 of GESTAR II by letter from S. A. Richards (NRC) to G. A. Watford (GE) Subject: "Amendment 26 to GE Licensing Topical Report NEDE-24011P-A, GESTAR II Implementing Improved GE Steady-State Methods," (TAC NO. MA6481), November 10, 1999.

(5) The STEMP code uses fundamental mass and energy conservation laws to calculate the suppression pool heatup. The use of STEMP was noted in NEDE-24222, "Assessment of BWR Mitigation of ATWS, Volume I & II (NUREG-0460 Alternate No. 3) December 1, 1979." The code has been used in ATWS applications since that time. There is no formal NRC review and approval of STEMP or the ATWS topical report.

(6) Not a safety analysis code that requires NRC approval. The code application is reviewed and approved by GEH for "Level-2" application and is part of GEH's standard design process. Also, the application of this code has been used in previous power uprate submittals.

(7) The TRACG04 code is not approved by the NRC for long-term ATWS calculations including ATWS with depressurization and ATWS with core instability. However, TRACG04 is used as a best-estimate code, while ODYN remains as the licensing basis code for ATWS consistent with the NRC SE for NEDC-33006P. The use of TRACG04 for the best-estimate TRACG ATWS analysis is also consistent with the NRC SE for NEDC-33006P. TRACG04 is approved by the NRC for application to ATWS overpressure transients in NEDE-32906P Supplement 3-A, "Migration to TRACG04 / PANAC11 from TRACG02 / PANAC10 for TRACG AOO and ATWS Overpressure Transients," April 2010.

(8) TRACG04 application with DSS-CD is documented in NEDC-33075P-A Revision 8 (Reference 49).

(9) The DORT code is an industry-accepted computer code for vessel fluence calculations.

Table 1-1a Computer Codes Used in the M+SAR Evaluations by AREVA

Task	Computer Code	NRC Approved	Comments
Reactor Heat Balance	HTBAL MICROBURN-B2	(1) Y	 EMF-2158(P)(A) R0, 10/99
Reactor Core and Fuel Performance	CASMO-4 MICROBURN-B2 XCOBRA SAFLIM3D RODEX4	Y Y Y (2) Y Y	EMF-2158(P)(A) R0, 10/99 EMF-2158(P)(A) R0, 10/99 XN-NF-80-19(P)(A) V3, R2, 1/87 ANP-10307(P)(A) R0, 6/11 BAW-10247PA R0, 2/08
Thermal Hydraulic Stability	STAIF	Y	EMF-CC-074(P)(A) V4, RO
ECCS-Loss of Coolant Accident (LOCA)	RELAX HUXY RODEX2	Y Y Y (4)	EMF-2361(P)(A) R0, 5/01 XN-CC-33(A) R1, 11/75 XN-NF-81-58(P)(A) R2, 3/84 EMF-85-74(P) S1 (P)(A) and S2(P)(A), 8/86
AOO Transient Analysis	MICROBURN-B2 COTRANSA2 XCOBRA XCOBRA-T RODEX2	Y Y (3) Y Y (3) Y (4)	EMF-2158(P)(A) R0, 10/99 ANF-913(P)(A) V1, R1, 8/90 XN-NF-80-19(P)(A) V3, R2, 1/87 XN-NF-84-105(P)(A) V1, S1 and S2, 2/87 XN-NF-81-58(P)(A) R2, 3/84 EMF-85-74(P) S1 (P)(A) and S2(P)(A), 8/86
ASME and ATWS Overpressurization	COTRANSA2 RODEX2	Y Y (4)	ANF-913(P)(A) V1, R1, 8/90 XN-NF-81-58(P)(A) R2, 3/84 EMF-85-74(P) S1 (P)(A) and S2(P)(A), 8/86

The application of these codes to the MELLLA+ analyses complies with the limitations and restrictions, and conditions specified in the approving NRC SER where applicable for each code. The application of the codes also complies with SERs for the extended power uprate programs.

1. HTBAL is not explicitly approved by the NRC but it is a stand-alone version the heat balance routine included in the NRC-approved MICROBURN-B2 code documented in EMF-2158(P)(A).
2. The approval of XCOBRA is included in the approval of the THERMEX methodology in XN-NF-80- 19 (P)(A) Vol 3 Rev. 2.
3. The list of events for which COTRANSA2 and XCOBRA-T can be used was expanded in the clarification acceptance in Letter, S. Richards (NRC) to J. F. Mallay (FANP), "Siemens Power Corporation RE: Request for Concurrence on Safety Evaluation Report Clarifications (TAC No. MA6160)," May 31, 2000.
4. The impact of thermal conductivity degradation on licensing analyses is discussed in Reference 60.

Table 1-2 Comparison of Thermal-Hydraulic Parameters

Parameter	MELLLA 120% OLTP, 99% Core Flow Normal FWT	MELLLA 120% OLTP, 99% Core Flow Reduced FWT	MELLLA+ 120% OLTP, 85% Core Flow Normal FWT	MELLLA+ 93% OLTP, 55% Core Flow Normal FWT
Thermal Power (MWt)	2,923	2,923	2,923	2,268
Dome Pressure (psia)	1,045	1,045	1,045	1,010
Recirculation System Flow Rate (Mlbm/hr) per Loop	16.9	16.9	14.5	9.4
Steam Flow Rate (Mlbm/hr)	12.780	11.120	12.765	9.500
Feedwater Flow Rate (Mlbm/hr)	12.754	11.094	12.739	9.474
Feedwater Temperature (°F)	431.4	321.1	431.3	403.0
Core Flow (Mlbm/hr)	76.23	76.23	65.45	42.35
Core Inlet Enthalpy (BTU/lbm)	528.0	514.1	524.7	508.4
Core Average Void Fraction	0.51	0.45	0.54	0.54
Average Core Exit Void Fraction	0.72	0.69	0.76	0.77

Table 1-3 Core Thermal Power to Core Flow Ratio at Steady-State and Off-Rated Conditions

Steady-State Operation	Point on the P/F Map	Core Thermal Power (MWt / % CLTP)	Core Flow (Mlbm/hr /% rated)	Power-to-Flow Ratio (MWt / Mlbm/hr)
Current Operating Domain 100% Rated Core Flow	E	2,923 / 100	77.00 / 100	37.96
Current Operating Domain 99% Rated Core Flow	D	2,923 / 100	76.23 / 99	38.34
MELLLA+ Operating Domain 85% Rated Core Flow	N	2,923 / 100	65.45 / 85	44.66
MELLLA+ Operating Domain 55% Rated Core Flow	M	2,268 / 77.6	42.35 / 55	53.55
Current Operating Domain /MELLLA+ 55% Rated Core Flow	L	2,000 / 68.4	42.35 / 55	47.23

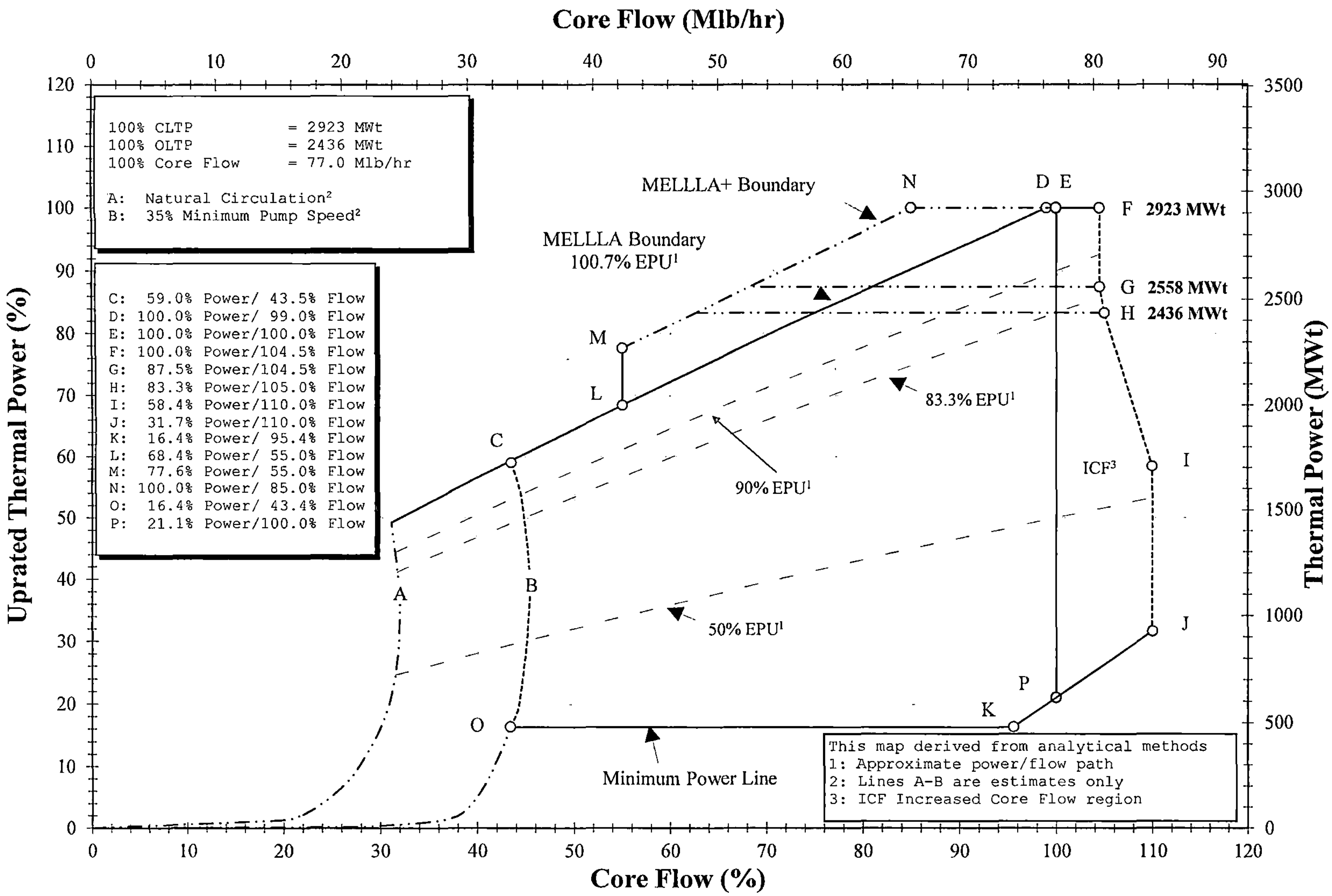

Figure 1-1 Power/Flow Operating Map for MELLLA+

2.0 REACTOR CORE AND FUEL PERFORMANCE

This section addresses the applicable evaluations involving reactor core and fuel performance for the MELLLA+ Extended power / flow operating domain (EPFOD). The major evaluations are as follows:

Section	Topic	M+LTR Disposition	BSEP Result
2.1	Fuel Design and Operation	Plant Specific	Acceptable
2.2	Thermal Limits Assessment	Plant Specific	Acceptable
2.3	Reactivity Characteristics	Plant Specific	Acceptable
2.4	Stability	Plant Specific	Acceptable
2.5	Reactivity Control	Generic	Confirmed

BSEP currently uses the AREVA ATRIUM™[a] 10XM fuel design and at the time of MELLLA+ initial implementation the reactor cores will contain only this design.

2.1 FUEL DESIGN AND OPERATION

The effect of MELLLA+ on the fuel design and operation is described below. The primary topics addressed in this evaluation are:

Topic	M+ LTR Disposition	BSEP Result
Fuel Product Line Design	Plant Specific	Acceptable (see Section 2.1.1)
Core Design	Plant Specific	Acceptable (see Section 2.1.2)
Fuel Thermal Margin Monitoring Threshold	Plant Specific	Acceptable (see Section 2.1.2)

2.1.1 Fuel Product Line

Implementation of the MELLLA+ EPFOD does not require any changes to the fuel mechanical design and therefore no changes in fuel product line are required. BSEP will continue to use the AREVA ATRIUM 10XM fuel design for future MELLLA+ operating cycles. As stated previously, at the time of initial MELLLA+ implementation the BSEP reactor cores will contain only the ATRIUM 10XM fuel design. Therefore, the following evaluation addresses the potential impact of the MELLLA+ EPFOD on the ATRIUM 10XM fuel design.

The M+ LTR generically addresses the impact of MELLLA+ on the fuel product line by stating that the fuel design limits (FDL) are established for all new fuel product lines as part of the fuel introduction. This is also true for the AREVA ATRIUM 10XM fuel design; however, it should

[a] ATRIUM is a trademark of AREVA Inc.

be noted that continued applicability of the thermal-mechanical FDL is confirmed for each operating cycle as part of the reload licensing process.

The ATRIUM 10XM thermal-mechanical FDL for BSEP has been established using the NRC approved RODEX4 methodology (Reference 67). This methodology has been included as part of BSEP Technical Specification (TS) 5.6.5.b since the initial introduction of the ATRIUM 10XM fuel design. The application of this methodology includes a cycle-specific confirmation of the continued applicability of the FDL which includes validation that the underlying thermal-mechanical criteria continue to be met during expected operation. For a MELLLA+ operating cycle this reload evaluation will include the impact of the depletion with the EPFOD using the specific core configuration for that cycle. This is consistent with the M+LTR SER Limitation and Condition 12.3.e[b] of the M+ LTR..

The BSEP ATRIUM 10XM thermal-mechanical FDL has been confirmed to remain applicable to the MELLLA+ EPFOD for both an equilibrium cycle and the reference cycle core designs.

2.1.2 Core Design and Fuel Thermal Monitoring Threshold

The basis for not monitoring thermal limits below the thermal monitoring threshold is the large margin to thermal limits as described in the TS Bases. Therefore, with these large margins, there are no transients that have limiting consequences when initiated from powers below the established threshold.

The maximum licensed power level and the fuel design do not change as a result of MELLLA+ implementation. The CLTP will remain at 2923 MWt and BSEP will continue to use the AREVA ATRIUM 10XM fuel design. Since there is no change in core power, the average bundle power and average core power density remain unchanged. Because there is no change in the average power density there is no change required in the fuel thermal monitoring threshold.

MELLLA+ implementation does not require changes to the BSEP fuel design and the thermal-mechanical FDL is confirmed to remain applicable for each operating cycle. This also supports the conclusion that no change is required to the fuel thermal monitoring threshold.

The MELLLA+ EPFOD allows for higher bundle power to flow conditions. The M+ LTR recognizes that this may cause the range of void fraction, axial and radial power shape, and control rod positions in the core to change slightly. Even with these changes, the individual fuel bundles are required to remain within the allowable thermal limits. These thermal limits are calculated and/or confirmed on a cycle-specific basis and provided in the RSAR. These limits are then included in the cycle-specific COLR which is used to support operation of the core during that cycle.

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[b] SER Limitation and Conditions section 12.3 addresses concurrent changes. While the use of ATRIUM 10XM is not a change to the BSEP licensing basis it does represent a change from the approval basis of NEDC-33006-A which assumed the use of the GNF GE-14 fuel design.

Operation with the lower flows allowed by the MELLLA+ EPFOD will increase the core average void fraction when compared to operation at the same power level in the MELLLA operating domain. This increase in core average void fraction is driven by the corresponding increase in the in-channel power to flow ratio. The potential for bypass region voiding may increase with MELLLA+ EPFOD operation due to the lower total core flow. {{

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The most significant impact of voiding in the bypass would be the impact on the LPRM reading. Limitation and Condition 9.17, as described in Appendix A of this report, limits the allowable bypass voiding at the LPRM levels. A confirmatory evaluation of bypass voiding for MELLLA+ conditions has been performed for an equilibrium cycle which uses {{ }} to estimate the potential for localized bypass boiling. This {{ }} to specifically determine a bounding local void distribution in the core. The model is conservative in that it {{ }} The impact on an LPRM location is calculated {{ }} the location. The results of this evaluation indicate a maximum bypass void fraction slightly more than 0.3% at the topmost LPRM 'D' level in the core which represents an insignificant impact to the LPRM response. These results are provided in Table 2-2 and correspond to state points on the MELLLA+ upper boundary at 100% power. As indicated in the discussion on Limitation and Condition 9.17 in Appendix A of this report, cycle-specific validation that the allowable bypass voiding at the LPRM levels has been met will be included in the RSAR.

The following information is provided to document various core design and fuel monitoring parameters for each cycle exposure state point consistent with Limitation and Condition 9.24 of the GEH Methods LTR SER. The parameters are compared against an experience base taken from a subset of the plants addressed in the BSEP EPFOD methods applicability document (Reference 60).

Table 2-1	Peak Nodal Exposures
Figure 2-1	Peak Bundle Power vs Cycle Exposure
Figure 2-2	Flow in Peak Bundle vs Cycle Exposure
Figure 2-3	Exit Void Fraction for Peak Bundle vs Cycle Exposure
Figure 2-4	Maximum Channel Exit Void Fraction vs Cycle Exposure
Figure 2-5	Core Average Exit Void Fraction vs Cycle Exposure
Figure 2-6	Peak LHGR vs Cycle Exposure

In accordance with M+LTR SER Limitation and Condition 12.24.2, the exit void fraction for the peak power bundle is included in Figure 2-3 for both MELLLA+ and EPU (pre-MELLLA+) conditions.

Quarter core maps assuming mirror symmetry are provided in Figure 2-7 through Figure 2-15 showing the bundle power, bundle operating linear heat generation rate (LHGR), and minimum critical power ratio (MCPR) for beginning of cycle (BOC) (0 MWd/MTU), middle of cycle (MOC) (9,000 MWd/MTU), and end of rated (EOR) (18,831.2 MWd/MTU) conditions. These maps represent an ATRIUM 10XM MELLLA+ equilibrium cycle design for BSEP. The maximum fuel design limit ratio (FDLRX) occurs at 17,0000 MWd/MTU (Figure 2-16). The maximum fraction of limiting critical power ratio (MFLCPR) occurs at 18,000 MWd/MTU (Figure 2-17). In Figure 2-7 through Figure 2-9, the bundle power is dimensionless. To obtain the bundle power in MWt, multiply each number by a factor of 5.22. This factor equals 2,923/560, where 2,923 MWt is the rated thermal power and 560 is the total number of fuel bundles in the core.

Table 2-1 includes a comparison of the peak nodal exposure for various plants including both the BSEP reference Cycle 19 and a BSEP equilibrium cycle at MELLLA+ conditions. The BSEP MELLLA+ equilibrium cycle has the highest peak nodal exposure in this table, slightly higher than a comparison BWR/6 plant. Equilibrium cycles are often used as a demonstration to show the potential fuel utilization for a specific bundle design. This generally means targeting smaller batch sizes with a corresponding increase in the batch average discharge exposure. The AREVA ATRIUM 10XM fuel design is subject to a 62.0 GWd/MTU peak rod average exposure licensing limit[c]. {{

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Also included in this table is a MELLLA depletion for the same reference cycle 19 design which provides a more direct demonstration of the impact of the change in operating domain on the peak nodal exposure. Comparison of the MELLLA versus MELLLA+ depletion for the BSEP reference cycle shows only small changes in the peak burnup due to MELLLA+ operation.

Figure 2-1, Figure 2-2, and Figure 2-6 show that the BSEP MELLLA+ EPFOD is in the expected range as compared to the reference plants. Figure 2-3 through Figure 2-5 show that exit voiding at BSEP when operating with MELLLA+ EPFOD is higher compared to other plants. The expected impact of MELLLA+ EPFOD on BSEP can also be seen with an increase in void fraction when compared with MELLLA operation. Figure 2-7 through Figure 2-9 show the relative bundle power for BOC, MOC, and EOR, respectively. Figure 2-10 through Figure 2-12 show the operating LHGR for BOC, MOC, and EOR, respectively. Figure 2-13 through Figure 2-15 show the MCPR for BOC, MOC, and EOR, respectively. Figure 2-7 through Figure

[c] BSEP is subject to a more limiting 60 GWd/MTU limit due to a previous NRC commitment (Reference 79).

2-17 show that the general operational conditions for BSEP in the MELLLA+ operating domain are within expected parameters.

Therefore, BSEP meets the intent of the M+LTR in regard to core design and the fuel thermal monitoring threshold.

2.2 THERMAL LIMITS ASSESSMENT

Assurance that regulatory limits are not exceeded during postulated anticipated operational occurrences and accidents is accomplished by applying operating limits on the fuel. This section discusses the impact that MELLLA+ EPFOD operation has on these thermal limits. Consistent with the current practice, cycle-specific thermal limits are established or confirmed each reload based on the cycle-specific core configuration. The effect of MELLLA+ EPFOD on the MCPR safety and operating limits, MAPLHGR limits, and LHGR limits is described below.

The BSEP Cycle 19 MELLLA+ critical power analyses supporting References 75 and 78 were performed using the Reference 63 version of the ACE/ATRIUM 10XM critical power correlation, consistent with the Technical Specifications in place for BSEP Unit 1 Cycle 19. The BSEP Technical Specifications have recently been updated to reference a more recent NRC-approved revision of the ACE/ATRIUM 10XM critical power correlation (Reference 64). All future BSEP design and licensing analyses supporting MELLLA+ operation will use the recently approved revision of the correlation (Reference 64). {{

}}

The topics addressed in this evaluation are:

Topic	M+ LTR Disposition	BSEP Result
Safety Limit MCPR	Plant Specific	Acceptable (see Section 2.2.1)
Operating Limit MCPR	Plant Specific	Acceptable (see Section 2.2.2)
MAPLHGR Limit	Plant Specific	Acceptable (see Section 2.2.3)
LHGR Limit	Plant Specific	Acceptable (see Section 2.2.4)
Power-to-Flow Ratio	Plant Specific	Acceptable (see Section 2.2.5)

2.2.1 Safety Limit Minimum Critical Power Ratio (SLMCPR)

The Safety Limit Minimum Critical Power Ratio (SLMCPR) analysis reflects the actual plant core loading pattern and planned operation and is performed for each reload core. In the event that the cycle-specific SLMCPR is not bounded by the current BSEP Technical Specification (TS) value, a license amendment request (LAR) will be submitted to change the TS. The cycle-specific SLMCPR will be determined using the methodology defined in Reference 65 which is already included as part of BSEP TS 5.6.5.b.

The two-loop operation (TLO) SLMCPR analyses will be performed for the minimum and maximum core flow conditions associated with rated power (85% and 104.5% of rated core flow), as well as the maximum core power at 55% core flow for the Brunswick operating power/flow map. For the maximum core flow state point, the TLO core flow uncertainty will be used. The analyses for the minimum core flow at full power and the 55% core flow state points will use the single-loop operation core flow uncertainty as discussed in Section 2.2.1.1 of the M+LTR SER and is consistent with the M+LTR SER Limitation and Condition 12.6. SLMCPR results for the representative cycle are presented in Reference 78.

Consistent with the generic disposition in the M+ LTR and current reload requirements; the SLMCPR for BSEP will be evaluated for the reload core prior to MELLLA+ implementation.

2.2.2 Operating Limit Minimum Critical Power Ratio (OLMCPR)

The Operating Limit Minimum Critical Power Ratio (OLMCPR) is calculated by adding the change in MCPR due to the limiting Anticipated Operational Occurrence (AOO) event to the SLMCPR. The OLMCPR is determined on a cycle-specific basis from the results of the reload transient analysis. The cycle specific analysis results are documented in the Reload Safety Analysis Report (RSAR), and included in the cycle-specific COLR. The MELLLA+ operating conditions do not change the methods used to determine this limit.

Consistent with the generic disposition in the M+LTR, the OLMCPR for BSEP will be evaluated for the reload core prior to MELLLA+ implementation.

2.2.3 Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) Limits

The Maximum Average Planar Linear Heat Generation Rate (MAPLHGR) limits ensure that the plant does not exceed regulatory limits established in 10CFR50.46. Section 4.3, Emergency Core Cooling System Performance, presents the evaluation to demonstrate that the plant meets the regulatory limits in the MELLLA+ operating domain. The reload analysis determines the MAPLHGR operating limit for each reload fuel bundle design and the limits are documented in the cycle specific COLR.

2.2.4 Linear Heat Generation Rate (LHGR) Limits

The M+LTR describes that LHGR limits ensure that the plant does not exceed the fuel thermal-mechanical design limits. The LHGR limit is determined by the AREVA fuel rod thermal-mechanical RODEX4 methodology (Reference 67) which is already included as part of BSEP TS 5.6.5.b. A cycle-specific validation of the LHGR limits is performed that includes the impact of expected operation. This validation includes the use of operation in the MELLLA+ EPFOD.

The reload analysis confirms that the LHGR limits for each reload fuel bundle design are acceptable and establishes any required power or flow dependent LHGR setdowns to ensure that the thermal-mechanical fuel design limits are protected. These results, including the LHGR limits and any required power or flow dependent LHGR setdowns, are documented in the cycle-specific RSAR and provided in the COLR.

Implementation of the BSEP LHGR limits and any required setdowns ensure the plant does not exceed the thermal-mechanical FDL. BSEP continues to use the ATRIUM 10XM fuel product line. The MELLLA+ operating conditions do not change the methods used to determine the LHGR limits. The LHGR limits for BSEP are evaluated for each reload core which will include cores designed for MELLLA+ EPFOD operation.

2.2.5 Power-to-Flow Ratio

MELLLA+ submittals for other plants have addressed the potential for exceeding a core power to flow ratio of 50 MWt/Mlbm/hr at any state point in the allowed operating domain. BSEP may exceed this figure of merit only near point "M" of the P/F map, Figure 1-1, as presented in Table 1-3.

It is noted that the power to flow ratio figure of merit addresses Limitation and Condition 9.3 of the GE MELLLA+ methods applicability LTR (Reference 2) is not applicable to the AREVA methods used to design and license the BSEP reactor cores. The intent of this figure of merit is to provide assurance that the methodology specific power distribution uncertainties remain applicable to the expanded operating domain. For the use of AREVA methodology at BSEP this is addressed in a separate EPFOD methods applicability report (Reference 60). Specifically, Section C.2 of Reference 60 addresses the applicability of uncertainties including gamma scan comparisons. Power distribution uncertainties used with AREVA methods remain applicable to BSEP when operating in the MELLLA+ EPFOD.

2.3 REACTIVITY CHARACTERISTICS

The effect of MELLLA+ on strongest rod out (SRO) shutdown margin, standby liquid control system (SLCS) shutdown margin, and hot excess reactivity is described below. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Hot Excess Reactivity	Plant Specific	Acceptable (see Section 2.3.1)
SRO Shutdown Margin	Plant Specific	Acceptable (see Section 2.3.2)
SLCS Shutdown Margin	Plant Specific	Acceptable (see Section 2.3.3)

2.3.1 Hot Excess Reactivity

Hot excess reactivity is a parameter of interest to operation for two reasons: 1) the magnitude determines the required rod density, and 2) the rate of change of reactivity may determine when adjustments to this rod density are required to compensate. Both the core hot excess magnitude and reactivity swing (i.e., flatness of the hot excess reactivity curve) are controlled during the cycle bundle and core design process.

The hot excess reactivity magnitude is controlled in the core design process to ensure that enough rod density is available to compensate for unexpected variations in the core reactivity while maintaining the ability to control the margin to the licensed thermal limits. For example, an excessively high magnitude for hot excess reactivity may result in too many rods inserted to effectively control power peaking thereby affecting thermal limits during operation. On the opposite extreme, a very low hot excess reactivity could potentially result in a condition at which full power could not be achieved if the core reactivity was lower than predicted.

Currently operating BWRs maintain rated core power between control rod sequence exchanges by adjusting reactivity through changes in either the core flow or with minor adjustments in the control rod inventory. Reactors operating at EPU conditions without an extended flow window such as MELLLA+ have a reduced capability to accomplish these reactivity adjustments with changes in core flow. One method of compensating for this reduced capability is to perform additional minor rod adjustments between control rod sequence exchanges. An alternate approach has been to design these EPU cores with flatter hot excess reactivity curves versus exposure to reduce the need for frequent reactivity changes. Both methods have been employed to support current EPU operations.

The larger flow window available with a MELLLA+ EPFOD allows for increased use of core flow adjustments for reactivity changes. The lower flow and corresponding higher average void conditions available with MELLLA+ operation can increase the observed hot excess magnitude at near end of rated conditions due to potentially higher plutonium production. This impact on hot excess reactivity is relatively small and does not affect safety. Furthermore, any potential increase is mitigated by a combination of both the cycle design process and the ability of the increased flow window to accommodate changes in reactivity during plant operation.

The MELLLA+ EPFOD operating conditions do not change the methods used to evaluate hot excess reactivity. The continued applicability of the AREVA methods to the MELLLA+ EPFOD is addressed in Reference 60.

An evaluation has been provided for the reference core as documented in Table 3.4 of ANP-3013P (Reference 75). The reference core demonstrates acceptable hot excess reactivity results for a MELLLA+ EPFOD design.

2.3.2 Strongest Rod Out Shutdown Margin

The licensing requirement to meet a minimum Strongest Rod Out (SRO) cold shutdown margin is found in BSEP TS 3.1.1. The specific requirement is to demonstrate that a minimum of 0.38 %Δk/k shutdown margin with the SRO if the highest worth rod is determined analytically, or 0.28 %Δk/k if the highest worth rod is determined by test. Compliance with this Technical Specification requirement is verified with a shutdown margin demonstration performed during the initial startup of each cycle. The TS also requires completion of this surveillance after criticality following any fuel movements or control rod replacements within the core. Normally, the demonstration utilizes the higher analytically based criteria.

Each operating cycle is designed to meet the shutdown margin requirements specified by TS 3.1.1 to ensure that the core can be made subcritical with the highest reactivity worth control rod fully withdrawn (and the remaining blades inserted) at the most reactive condition throughout the cycle. This requirement is included in the generic fuel design criteria in Section 5.4 of ANF-89-98(P)(A) (Reference 76). Section 5.4 of Reference 77 indicates that compliance with this requirement for the ATRIUM 10XM fuel design is demonstrated with the cycle-specific calculations.

The calculations involved in the cycle-specific analysis of the shutdown margin use the NRC approved CASMO-4 / MICROBURN-B2 methodology, EMF-2158(P)(A) (Reference 68). The continued applicability of this methodology to EPFOD conditions showing that it remains within its approval basis and SER restrictions, is addressed in ANP-3108P (Reference 60).

Furthermore, significant margin exists to the existing TS criterion due to the practice of using a design target significantly larger than the criterion combined with small observed variations in the cold critical target from cycle to cycle. Therefore, it is concluded based upon observed results and the margin available that the acceptance criterion referred to in the BSEP Technical Specifications remains valid for operation at MELLLA+ EPFOD conditions.

The impact of MELLLA+ EPFOD operation is primarily related to operation with higher average void fraction. This results in a higher plutonium production and corresponding increased hot reactivity later in the operating cycle which in turn can decrease hot-to-cold reactivity differences. Consequently smaller cold shutdown margins may result from cores designed for operation with the MELLLA+ EPFOD. However, this potential loss in margin can be accommodated through the core design process within current design and TS cold shutdown margin requirements. All minimum Strongest Rod Out (SRO) shutdown margin requirements apply to cold most reactive conditions, and are maintained without change. The most reactive temperature at and near EOC conditions will have a tendency to increase with MELLLA+ EPFOD operation since an increased fraction of fissions is occurring in the plutonium isotopes. AREVA performs the shutdown margin evaluation at a range of temperatures to ensure that the most reactive condition is captured.

An evaluation has been provided for the reference core as documented in Tables 2.1 and 3.4 of ANP-3013P (Reference 75). The reference core was shown to exhibit a minimum cold SRO shutdown margin of 1.29 %Δk/k at BOC. The values shown in bold in Table 3.4 represent minimum shutdown margin values that occur at temperatures above 68 °F, which included all cycle exposures greater than or equal to 14,000 MWd/MTU. This core minimum SRO cold shutdown margin is also reported in the cycle-specific RSAR and is included in Section 7.5 of Reference 78 for the reference core design.

Based on the previous discussions and the demonstration provided with the representative ATRIUM 10XM equilibrium core in ANP-3013P (Reference 75), it has been shown that the required cold SRO shutdown margin can be achieved for MELLLA+ EPFOD through appropriate fuel and core design. Because plant reactivity margins are established in accordance with approved methodology for each core reload and the Technical Specification acceptance criterion remains applicable, the assessment of these topics for MELLLA+ EPFOD at BSEP is acceptable.

2.3.3 Standby Liquid Control System (SLCS) Shutdown Margin

The Standby Liquid Control System (SLCS) is designed to shut down the reactor from rated power conditions to cold shutdown in the postulated situation that some or all of the control rods cannot be inserted. This manually operated system pumps a sodium pentaborate solution into the vessel, to provide neutron absorption and achieve a subcritical reactor condition. The SLCS is designed to inject over a wide range of reactor operating pressures.

The lower flows available with a MELLLA+ EPFOD can result in higher core average void fractions at rated power with a corresponding increase in plutonium production. As previously stated, this higher plutonium content can increase the core reactivity at or near EOC conditions when compared to non-MELLLA+ operation. While this increase in EOC reactivity may decrease SLCS margins at higher cycle exposures, this has minimal impact on the minimum SLCS shutdown margin since SLCS is typically limiting at BOC conditions. This BOC limiting behavior is due to the higher poison content of the fuel (i.e. gadolinia for current BWR designs) at beginning of life (BOL) since the gadolinia competes for each neutron. The effectiveness of the injected boron increases with cycle exposure as the gadolinia within the fuel is depleted. This behavior is not credited and SLCS analyses are performed for each reload core over the cycle to ensure that the most limiting condition is evaluated. The depletion impacts of MELLLA+ EPFOD operation are included in this evaluation so any potential increase in EOC reactivity is included.

The calculations involved in the cycle-specific analysis of the SLCS shutdown margin use the NRC approved CASMO-4 / MICROBURN-B2 methodology, EMF-2158(P)(A) (Reference 68). Application of this methodology to MELLLA+ EPFOD conditions remains within its approval basis and SER restrictions, as addressed in ANP-3108P (Reference 60).

A SLCS shutdown margin evaluation was performed for the reference cycle assuming a system boron concentration of 720 ppm natural Boron equivalent at 70 °F. SLCS performance modifications that increase the weight percent of the Boron-10 isotope have no effect on the SLCS shutdown margin calculation as long as a minimum the 720 ppm natural Boron equivalent at 70 °F is maintained. The results using this boron concentration demonstrate minimum SLCS shutdown margin of 2.67 %Δk/k assuming a short EOC N-1, as shown in Tables 2.1 and 3.4 of ANP-3013P (Reference 75). This minimum corresponds to a short EOC cycle N-1 shutdown and occurs at BOC for cycle N. {{

}} The minimum SLCS shutdown margin result is also documented in the RSAR for each reload cycle, Section 7.3 of Reference 78 for the reference cycle.

Therefore, the SLCS system will continue to meet the required shutdown margin capability for MELLLA+ EPFOD conditions.

2.4 STABILITY

The DSS-CD stability solution (Reference 49) has been shown to provide an early trip signal upon instability inception prior to any significant oscillation amplitude growth and minimum critical power ratio (MCPR) degradation for both core-wide and regional mode oscillations. BSEP will implement the DSS CD solution consistent with the M+LTR (Reference 1) and DSS CD LTR (Reference 49). DSS-CD implementation includes any limitations and conditions in the applicable DSS-CD SER (Reference 49). In accordance with DSS-CD LTR SER Limitation and Condition 5.1 (Reference 49), because BSEP is implementing DSS-CD using the NRC-approved GEH Option III platform, a plant-specific review is not required. There were no changes proposed in the bounding uncertainty or in the process to bound the uncertainty in the MCPR documented in Reference 1.

Topic	M+LTR Disposition	BSEP Result
DSS-CD Setpoints	Generic	Confirmed
Armed Region	Generic	Confirmed
Backup Stability Protection (BSP)	Generic	Confirmed

2.4.1 DSS-CD Setpoints

[[

]] As a part of DSS-CD implementation, the applicability checklist is incorporated into the reload evaluation process. DSS-CD implementation also includes incorporation of appropriate [[ ]] analyses to be performed if a specific reload analysis [[ ]] DSS-CD is incorporated per the requirements of the DSS-CD LTR. This implementation requires that a process for reviewing the DSS-CD setpoints for each reload analysis is in place. [[ ]] no further review of MELLLA+ is necessary to evaluate the adequacy of the DSS-CD setpoints.

BSEP will incorporate the DSS-CD solution consistent with the requirements of the DSS-CD LTR. Implementation of DSS-CD in accordance with the DSS-CD LTR ensures that BSEP incorporates the applicability checklist into the reload evaluation process and documents the results of the applicability checklist review. DSS-CD implementation per the DSS-CD LTR also ensures that BSEP incorporates appropriate [[ ]] analyses to be performed if a specific reload analysis [[ ]]

A plant-specific review procedure has been established to confirm that the generic DSS-CD licensing basis is applicable to plant-specific designs. If the generic DSS-CD licensing basis is not applicable to a plant-specific design, additional analyses are necessary to demonstrate applicability. The standard plant-specific review process consists of an applicability checklist, confirming that the generic applicability envelope, as defined in Section 4.0 of Reference 49, is not exceeded. The plant-specific applicability checklists are provided in Tables 6-1 and 6-2 of Reference 49 for two loop operation (TLO) and SLO, respectively. If any checklist criterion is not met as a result of a plant-specific design change that may affect reactor stability performance, the DSS-CD plant-specific procedures (Tables 6-3 and 6-4 of Reference 49) are performed to demonstrate adequate SLMCPR protection and to extend the DSS-CD applicability envelope.

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]] The expansion of the DSS-CD licensing basis extended applicability envelope is performed per Reference 49. Therefore, BSEP MELLLA+ plant-specific stability evaluations comply with M+LTR SER Limitation and Condition 12.3.f.

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Methods LTR SER Limitation and Condition 9.18 (Reference 2) for the stability setpoints is not applicable to DSS-CD [[

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The CDA setpoint calculation formula and the adjustable parameters values are defined in the DSS-CD LTR (Reference 49). In accordance with DSS-CD LTR SER Limitation and Condition 5.2 (Reference 49), a reference to the latest approved DSS-CD LTR is included in the proposed changes to the BSEP TS.

2.4.1.1 DSS-CD Diversity

The diverse means for the safety trip function performed by the DSS-CD algorithms at BSEP for a postulated common-mode failure of the nuclear measurement analysis and control (NUMAC) power range neutron monitoring system (PRNMS) is manual operator action. The basis that the diverse means is unlikely to be subject to the same common-mode failure that would disable the DSS-CD safety function is documented below.

The OPRM system (supporting either the DSS-CD or Option III solution) is designed to automatically detect and suppress anticipated power oscillations. The postulated common cause failure (CCF), assumed to result in comprehensive loss of PRNMS functionality, would also disable the OPRM system (i.e., CDA for DSS-CD and period based detection algorithm (PBDA) for Option III). The loss of PRNMS functionality would also disable the automatic backup stability protection (ABSP) function of DSS-CD because the APRM system would no longer be available.

As described in Section 7 and in the TS changes documented in the approved DSS-CD LTR NEDC-33075P-A, Revision 8 (Reference 49), if both the OPRM system is inoperable and the ABSP function cannot be implemented or is inoperable, the licensed stability solution becomes the BSP Manual Regions with the BSP Boundary, which is manually implemented through administrative actions. This is essentially the same backup approach utilized in Option III for the PBDA algorithm. In the Option III solution there is only one BSP option, which is provided by the BSP Manual Regions and associated operator actions.

The postulated CCF in the PRNMS results in the system providing valid indications of plant conditions until the stability transient occurs, at which time they become anomalous. In the case of power oscillations, PRNMS indications of power and flow would track consistently with other plant indicators as they change to a statepoint where the potential exists for high growth-rate power oscillations (i.e., the upper left corner of the power/flow map), but fail to provide any protection when large amplitude oscillations begin to occur.

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The BSEP operating procedure requires immediate action to reduce reactor power in order to mitigate possible high growth-rate power oscillations following unanticipated core flow reduction events, such as [[ ]] Besides the indications that a 2RPT occurred, the operators would know the statepoint because the status of recirculation pumps is provided independent of PRNMS; flow information is available from the recirculation flow system, and power level information is available from either the electrical power output or a core thermal power calculation. Furthermore, the reactor recirculation flow system, rod position information system (RPIS), reactor manual control system (RMCS), and manual scram are unaffected by the CCF. Thus, the plant is able to cope with the CCF because it can determine that defensive steps are necessary and execute those steps via immediate actions (i.e., [[ ]]). Because the SLMCPR is not exceeded throughout this event, the acceptance criteria provided in BTP 7-19 are automatically met.

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The ABSP is an alternative stability solution in the event that CDA becomes inoperable. However, ABSP is designed to prevent the core from operating in regions with high potential for THI. Therefore, a postulated CCF of the ABSP would mean that the automatic scram would not occur when the reactor is operating in the BSP Scram region. The procedures for immediate action to scram the reactor as discussed above would apply. The immediate actions provide a diverse and independent method to assure reactor protection in the event of a postulated stability event with an ABSP (or PRNMS) CCF.

In summary, the BSEP evaluation of the CCF for the PRNMS with DSS-CD was performed to disposition undetected power oscillations using the acceptance criteria provided in BTP 7-19. It was determined that sufficient redundancy and diversity exists so that the plant has the ability to cope with any CCF in the PRNMS with Option III or DSS-CD.

2.4.2 Armed Region

The M+LTR recognizes that the DSS-CD LTR specifies the OPRM Armed Region for MELLLA+ operation. Per the DSS-CD LTR and the M+LTR, the OPRM Armed Region is generically defined as the region on the power/flow map at the MCPR monitoring threshold of 25% OLTP and rated recirculation drive flow ≤ 75% (Reference 49). For a power-uprated plant, the MCPR monitoring threshold may be scaled to a lower percent value. This scaled value defines the armed region boundary in this situation (Reference 49). For BSEP, the MCPR monitoring threshold is 23.0% of EPU (TS 3.2.2). As a result, the OPRM Armed Region for BSEP is defined as the region on the power/flow map with power ≥ 23.0% of EPU and rated recirculation drive flow ≤ 75%. The OPRM Armed Region for BSEP is illustrated in Figure 2-18.

The generic boundaries of the OPRM Armed Region are approved as a part of the DSS-CD LTR. [[

]] no further review of MELLLA+ is necessary to evaluate the adequacy of the OPRM Armed Region.

Because BSEP is implementing the DSS-CD solution consistent with the DSS-CD LTR, no further review of MELLLA+ is necessary to evaluate the adequacy of the OPRM Armed Region.

2.4.3 Backup Stability Protection

The M+LTR recognizes that the DSS-CD LTR defines the BSP along with a generic process for confirming that the BSP requirements are met in each reload analysis. This BSP may be used when the OPRM system is temporarily inoperable. Implementation of DSS-CD per the DSS-CD LTR requires that the alternate stability protection approach is confirmed on a cycle-specific basis to demonstrate adequacy to each reload cycle. [[

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no further review of MELLLA+ is necessary to evaluate the adequacy of the BSP.

Implementation of DSS-CD in accordance with the DSS-CD LTR requires that BSEP confirm that the BSP approach is adequate as a part of the reload analysis. Because BSEP is implementing the DSS-CD solution consistent with the requirements of the DSS-CD LTR, no further review of the BSP is required.

Reference 49 describes two BSP options that are based on selected elements from three distinct constituents. The three constituents are:

1. BSP Manual Regions that comprise plant-specific Scram (Region I) and Controlled Entry (Region II) regions in the licensed power/flow operating domain and associated manual operator actions (Section 7.2 of Reference 49).
2. BSP Boundary that defines the operating domain portion where potential instability events can be effectively addressed by specific operator actions (Section 7.3 of Reference 49).
3. ABSP Scram Region, which comprises an automatic reactor scram region initiated by the APRM flow-biased scram setpoint (Section 7.4 of Reference 49).

The two BSP options are:

Option 1: Consists of the BSP Manual Regions, BSP Boundary, and associated operator actions.

Option 2: Consists of the ABSP Scram Region, as implemented by the APRM flow-biased scram setpoint, Region II, and associated operator actions.

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The TS changes contained in Reference 49 delineate specific implementation requirements for both BSP options when the OPRM system is declared inoperable. BSP region statepoints are calculated on the high flow control line (HFCL) and the NCL on a plant- and cycle-specific basis and are at least as conservative as the base BSP regions described in Reference 49. The BSP Scram and Controlled Entry Region boundaries are developed by connecting the corresponding statepoints on the HFCL and the NCL using the boundary shape function (generic shape function (GSF)) defined in Section 7.2.1 of the DSS-CD LTR (Reference 49). The manual Scram Region forms the basis for the ABSP APRM simulated thermal power (STP) setpoints. The BSP Manual Regions, BSP Boundary, and the ABSP APRM STP setpoints are confirmed or established on a cycle-specific basis. The application of ABSP complies with M+LTR SER Limitation and Condition 12.7.

The proposed TS changes for implementation of DSS-CD include a revised Action I and a new TS 5.6.7, which would require, in part, submittal of a special report within 90 days. The special report would include the plans and schedule to restore the required instrument channels to operable status. However, if the ABSP is not implemented consistent with proposed Action I, then the proposed Action J would require, in part, restoration of the inoperable channels within 120 days. The above complies with M+LTR SER Limitation and Condition 12.3.g.

The BSP Manual Regions and the BSP Boundary are cycle-specific and are established or confirmed for each reload and the results are documented in the RSAR (SRLR equivalent).

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The implementation of the ABSP APRM STP setpoints for BSEP DSS-CD is determined per the process described in this section.

2.5 Reactivity Control

The control rod drive (CRD) system controls core reactivity by positioning neutron absorbing control rods within the reactor and scramming the reactor by rapidly inserting control rods into the core. No change is made to the control rods or drive system due to MELLLA+. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Scram Time Response	Generic	Confirmed
CRD Positioning and Cooling	Generic	Confirmed
CRD Integrity	Generic	Confirmed

2.5.1 Control Rod Scram

The generic disposition of the Control Rod Scram topic in the M+LTR describes that for BWR/3, BWR/4, and BWR/5 plants the Hydraulic Control Unit accumulators supply the initial scram pressure and, as the scram continues, the reactor becomes the primary source of pressure to complete the scram. [[

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Consistent with the generic disposition discussed above, the BSEP Hydraulic Control Unit accumulators supply the initial scram pressure and, as the scram continues, the reactor becomes the primary source of pressure to complete the scram. The BSEP reactor dome pressure is 1,045 psia (1,030 psig) and does not change as a result of MELLLA+ operating domain expansion. Therefore, the generic disposition is applicable to BSEP in that [[

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Consistent with the generic disposition in the M+LTR, [[ ]]

2.5.2 Control Rod Drive Positioning and Cooling

The generic disposition of the Control Rod Drive Positioning and Cooling topic in the M+LTR describes that [[ ]] As a result of MELLLA+, there is no increase in temperature and [[ ]] Therefore, the CRD positioning and cooling functions are not affected by MELLLA+.

Consistent with the generic disposition discussed above, for BSEP, the reactor coolant temperature does not increase. [[ ]]

The CRD positioning and cooling functions evaluation for BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

2.5.3 Control Rod Drive Integrity

The generic disposition of the CRD Integrity topic in the M+LTR describes that the postulated abnormal operating conditions for the CRD design assume a failure of the CRD system pressure-regulating valve that applies the maximum pump discharge pressure to the CRD mechanism internal components. This postulated abnormal pressure bounds the American Society of Mechanical Engineers (ASME) reactor overpressure limit. [[ ]] no further evaluation of CRD integrity is required as result of MELLLA+.

Consistent with the generic disposition discussed above, the BSEP CRD mechanism has been analyzed for an abnormal pressure operation (the application of the maximum CRD pump discharge pressure) that bounds the ASME reactor pressure vessel (RPV) overpressure condition. [[ ]] Also, as stated in Section 3.1, for the ASME RPV overpressure condition, the peak RPV bottom head pressure is unchanged and remains less than the limit of 1,375 psig. [[ ]] and no further evaluation of CRD integrity is required as result of MELLLA+.

The CRD integrity assessment evaluation for BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

2.6 Additional Limitations and Conditions Related to Reactor Core and Fuel Performance

For that subset of limitations and conditions relating to Reactor Core and Fuel Design, which did not fit conveniently into the organizational structure of the M+LTR, the required information is presented here. The information is identified by either the M+LTR SER (Reference 1) limitation and condition or the Methods LTR SER (Reference 2) limitation and condition to which it relates.

2.6.1 TGBLA/PANAC Version

In accordance with Methods LTR SER Limitation and Condition 9.1, TGBLA06 and PANAC11 have been used to develop the BSEP equilibrium core for the MELLLA+ stability and ATWS evaluations. Subsequent GEH analyses were performed using these or later NRC approved versions of the neutronic methods.

2.6.2 M+LTR SER Limitation and Condition 12.24.1

M+LTR SER Limitation and Condition 12.24.1 requires that the TRACG supporting analyses use the actual flow conditions. [[

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2.6.3 Applicability of AREVA Methods to MELLLA+ EPFOD

The continued applicability of AREVA methods to MELLLA+ EPFOD operation is addressed for BSEP in ANP-3108P (Reference 60). This evaluation concludes that the NRC approved AREVA methodology remains within its approval basis and continues to meet all applicable SER Limitations and Conditions for the expanded operating domain.

There are no generic restrictions or SER Limitations and Conditions applicable to AREVA methodology used at BSEP that are specific to MELLLA+ EPFOD operation.

Channel Bow Model, Fluence Gradient Range of Applicability

During the addition of the SAFLIM3D safety limit methodology (Reference 65) to Section 5.6.5.b of the BSEP TS, the following additional condition was added to the BSEP operating license (Amendment 262 for Unit 1 and Amendment 290 for Unit 2).

> The fuel channel bow standard deviation component of the channel bow model uncertainty used by ANP-10307PA, AREVA MCPR Safety Limit Methodology for Boiling Water Reactors (i.e., TS 5.6.5.b.11) to determine the Safety Limit Minimum

Critical Power Ratio shall be increased by the ratio of channel fluence gradient to the nearest channel fluence gradient bound of the channel measurement database, when applied to channels with fluence gradients outside the bounds of the measurement database from which the model uncertainty is determined.

This license condition addresses a NRC concern that a few channels may exhibit fluence gradients exceeding the measurement database used to develop the fluence based channel bow model. {{

}}

Fuel Cladding Peak Oxide Thickness

During the addition of RODEX4 thermal-mechanical methodology (Reference 67) to Section 5.6.5.b of the BSEP TS, the following regulatory commitment was made (SER Section 4.0 of Reference 61).

When using AREVA topical report, BAW-10247PA, "Realistic Thermal-Mechanical Fuel Rod Methodology for Boiling Water Reactors," Revision 0, April 2008 to determine core operating limits, the fuel cladding peak oxide thickness calculated by the RODEX4 corrosion model will be limited to less than the proprietary value defined in Section 2.2 of AREVA report, ANP-2992P, Revision 0, "AREVA Response to Additional RAI on the Brunswick RODEX4 LAR."

{{

}}

Table 2-1 Peak Nodal Exposures

Plant	Cycle	Peak Nodal Exposure
A	17	46.121 GWd/ST (50.840 GWd/MTU)
B (BWR-6)	13	53.628 GWd/ST (59.115 GWd/MTU)
B (BWR-6)	14	56.937 GWd/ST (62.761 GWd/MTU)
C (BWR-6)	12	52.696 GWd/ST (58.086 GWd/MTU)
D	12	53.786 GWd/ST (59.288 GWd/MTU)
BSEP MELLLA	19 - 120% OLTP	52.337 GWd/ST (57.691 GWd/MTU)
BSEP MELLLA+ (Reference Cycle)	19 - 120% OLTP	52.341 GWd/ST (57.696 GWd/MTU)
BSEP M+SAR (BWR/4 MELLLA+)	Equilibrium - 120% OLTP	58.378 GWd/ST (64.350 GWd/MTU)

Table 2-2 Steady State Bypass Voiding

Statepoint on Power/Flow Map	Core Power (% of Rated)	Core Flow (% of Rated)	Hot Channel Void Fraction in Bypass Region at Instrumentation D Level (MICROBURN-B2)
“E”	100	100	{{
“D”	100	98.9	
“N”	100	85	}}

Table 2-3 Not used

Table 2-4 [[ ]]

[[	
	]]
MCPR Margin[1]	[[ ]] ≥ 0.107

Note:

1. [[ ]]

Table 2-5 [[ ]]

[[	
	]]
MCPR Margin[1]	[[ ]] ≥ 0.153

Note:

1. [[ ]]

Table 2-6 [[

]]

[[			
			]]

Note:

1. [[

]]

Figure 2-1 Peak Bundle Power Versus Cycle Exposure For Multiple Plants

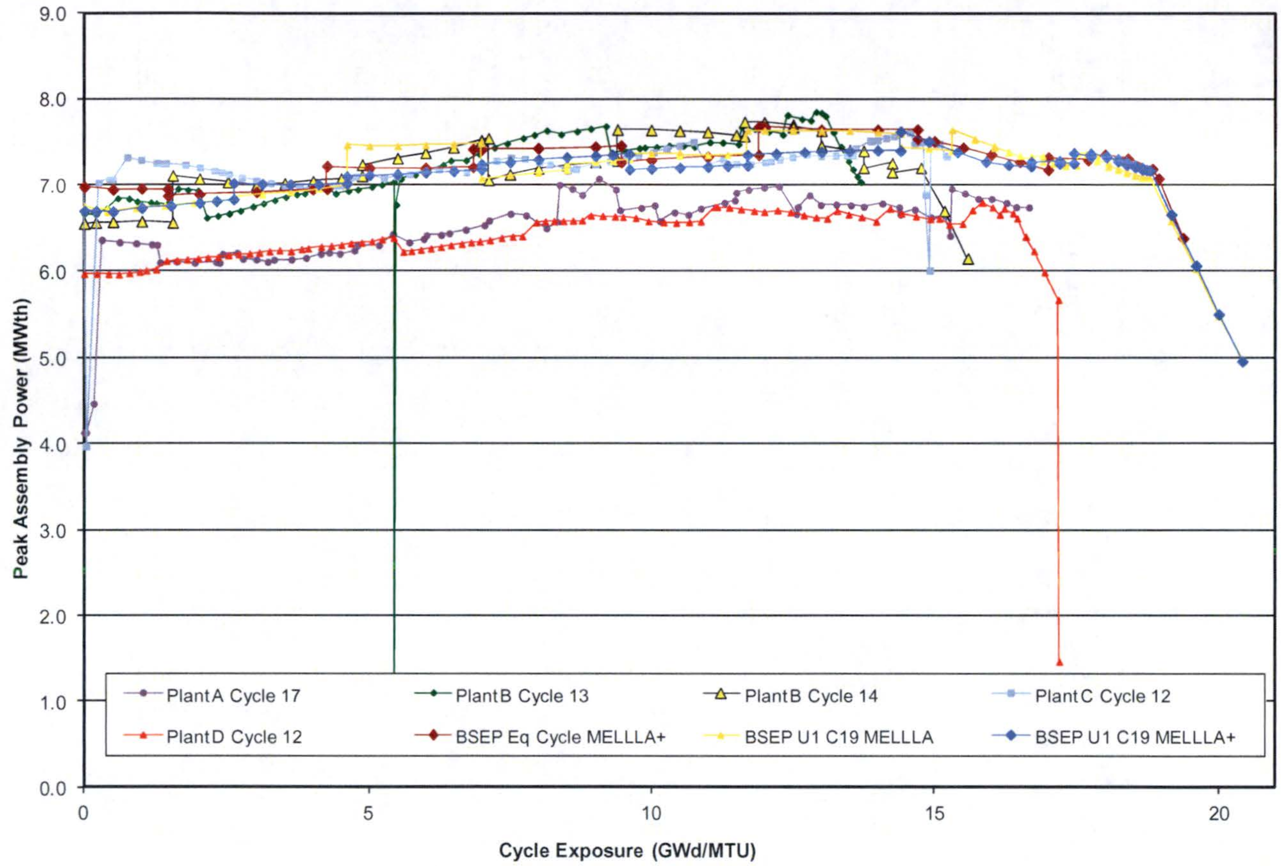


Figure 2-2 Peak Bundle Flow Versus Cycle Exposure for Multiple Plants

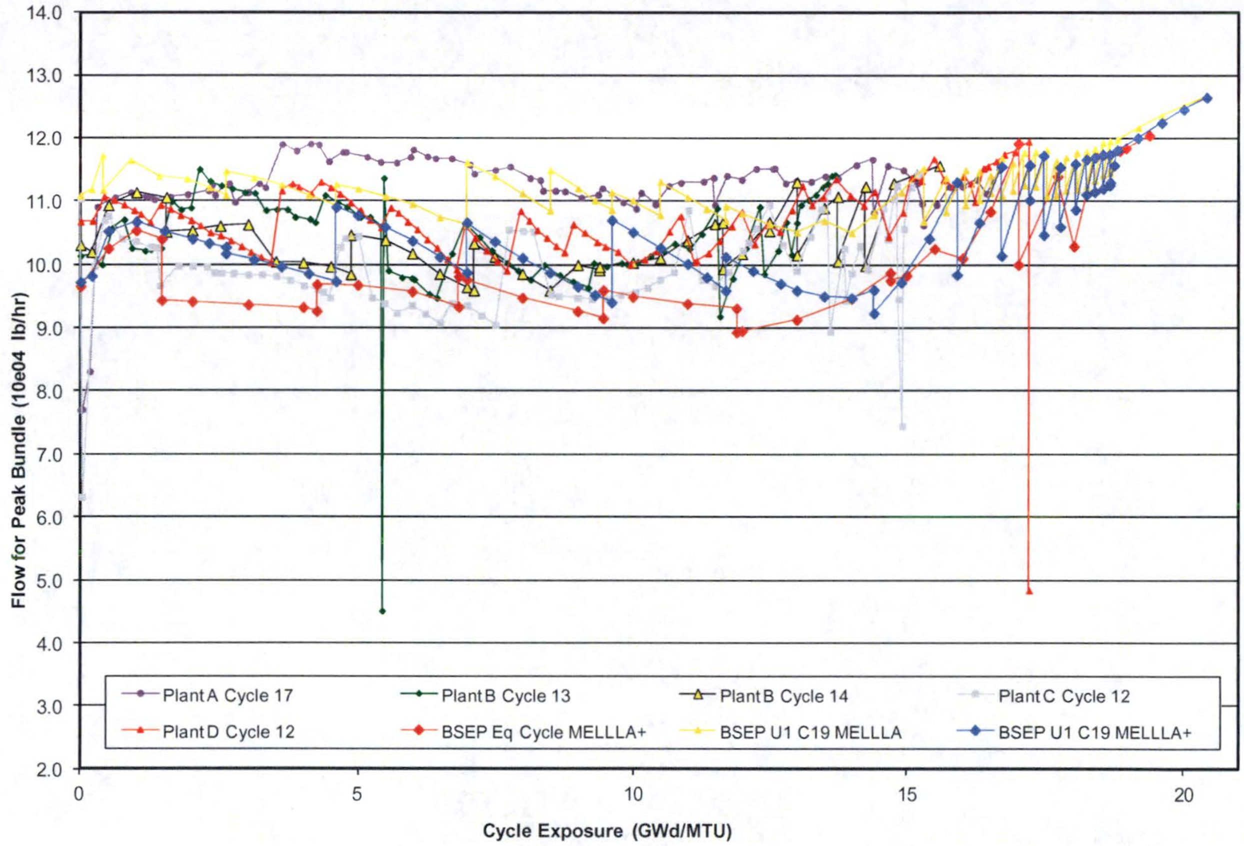


Figure 2-3 Exit Void Fraction For Peak Bundle Power Versus Cycle Exposure For Multiple Plants

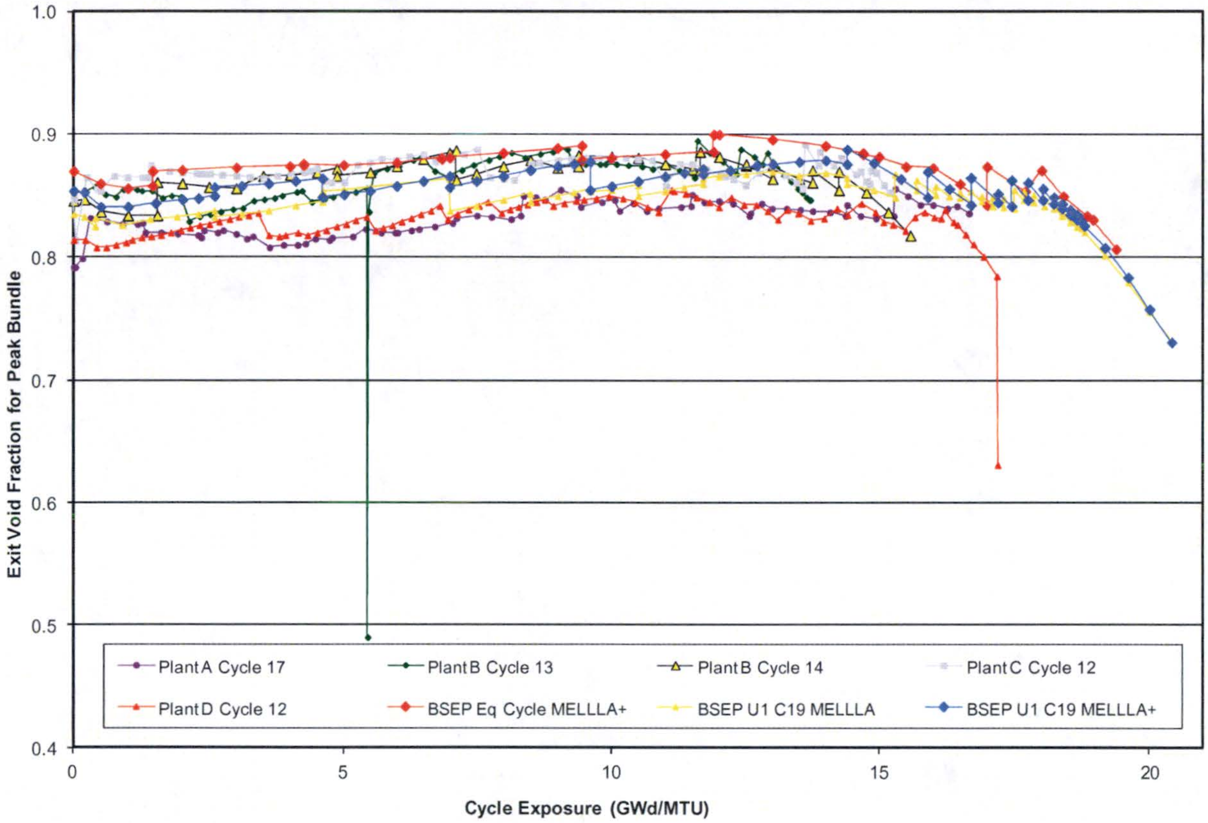


Figure 2-4 Maximum Channel Exit Void Fraction Versus Cycle Exposure For Multiple Plants

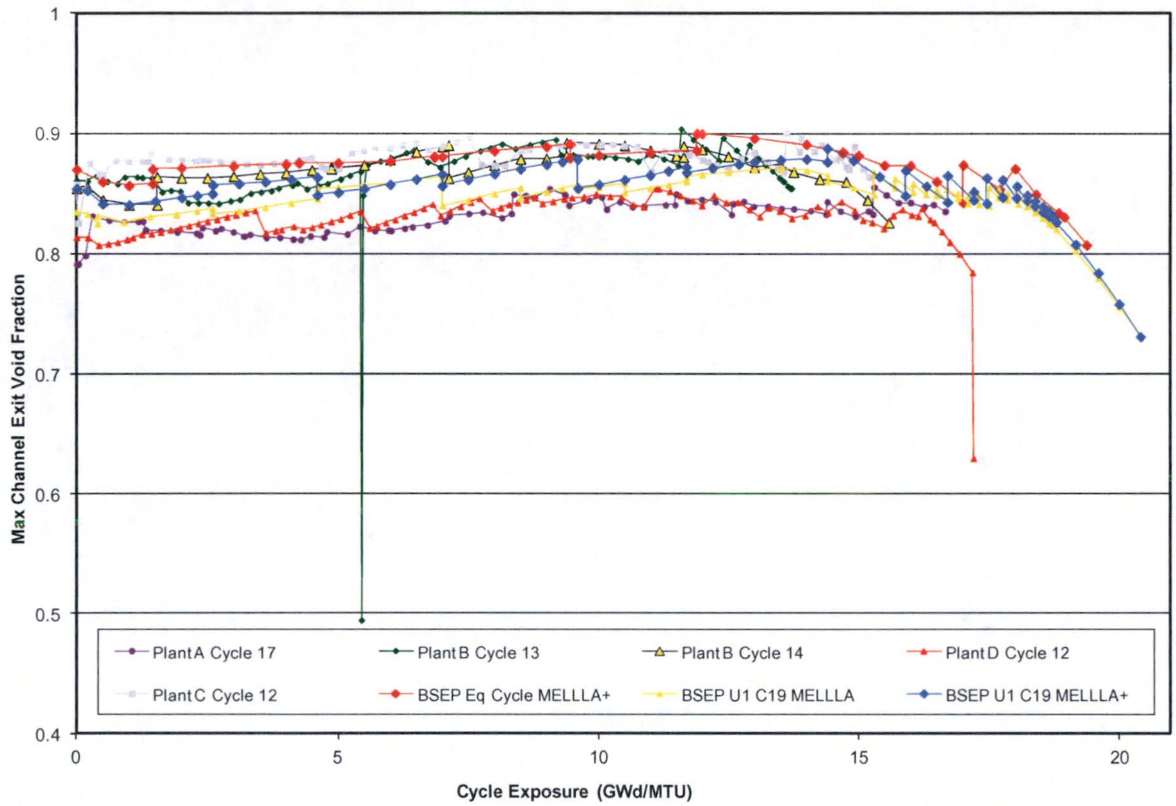


Figure 2-5 Core Average Exit Void Fraction Versus Cycle Exposure For Multiple Plants

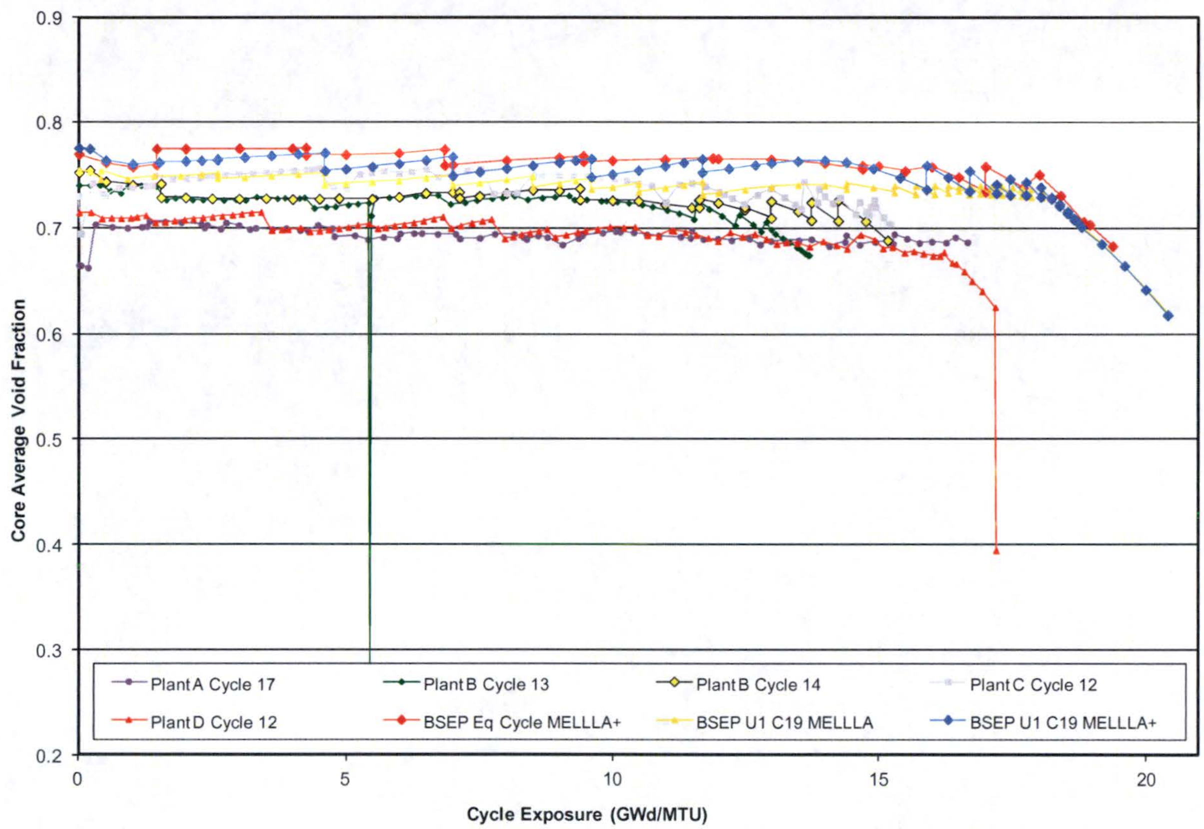


Figure 2-6 Peak LHGR Versus Cycle Exposure For Multiple Plants

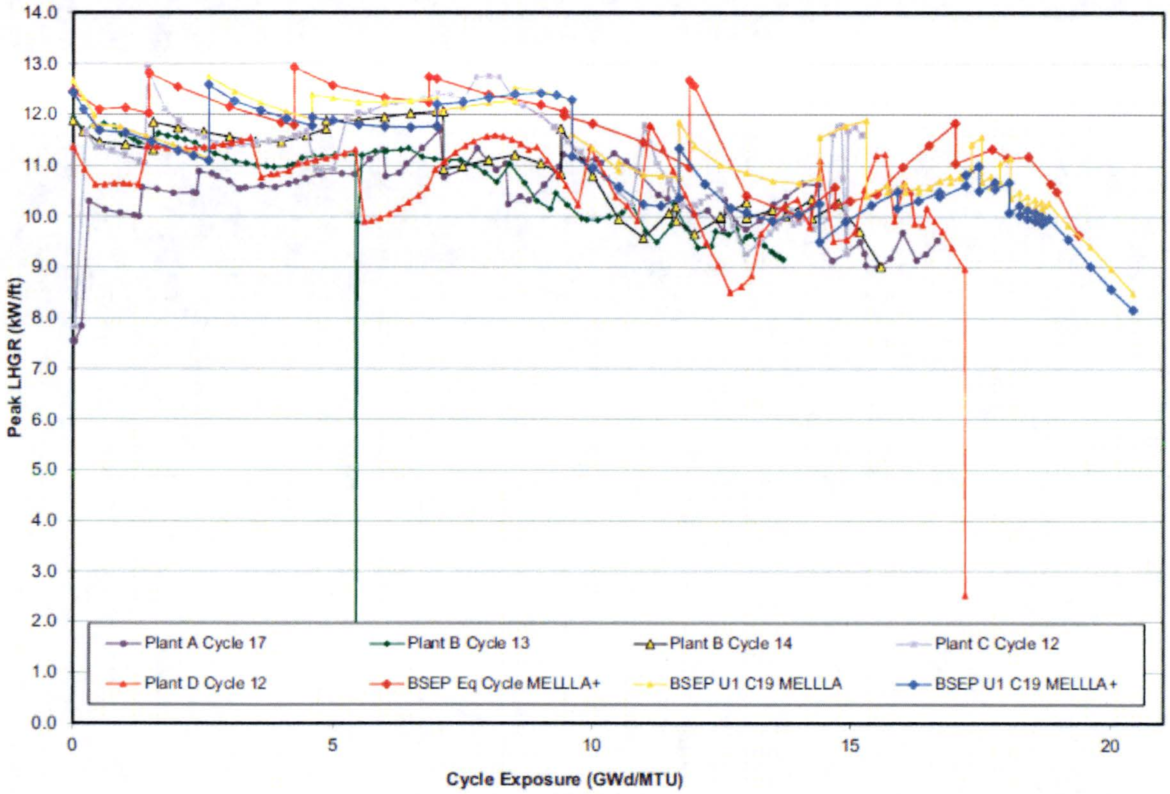


Figure 2-7 Nominal Bundle Power Map At BOC (0 MWd/MTU)

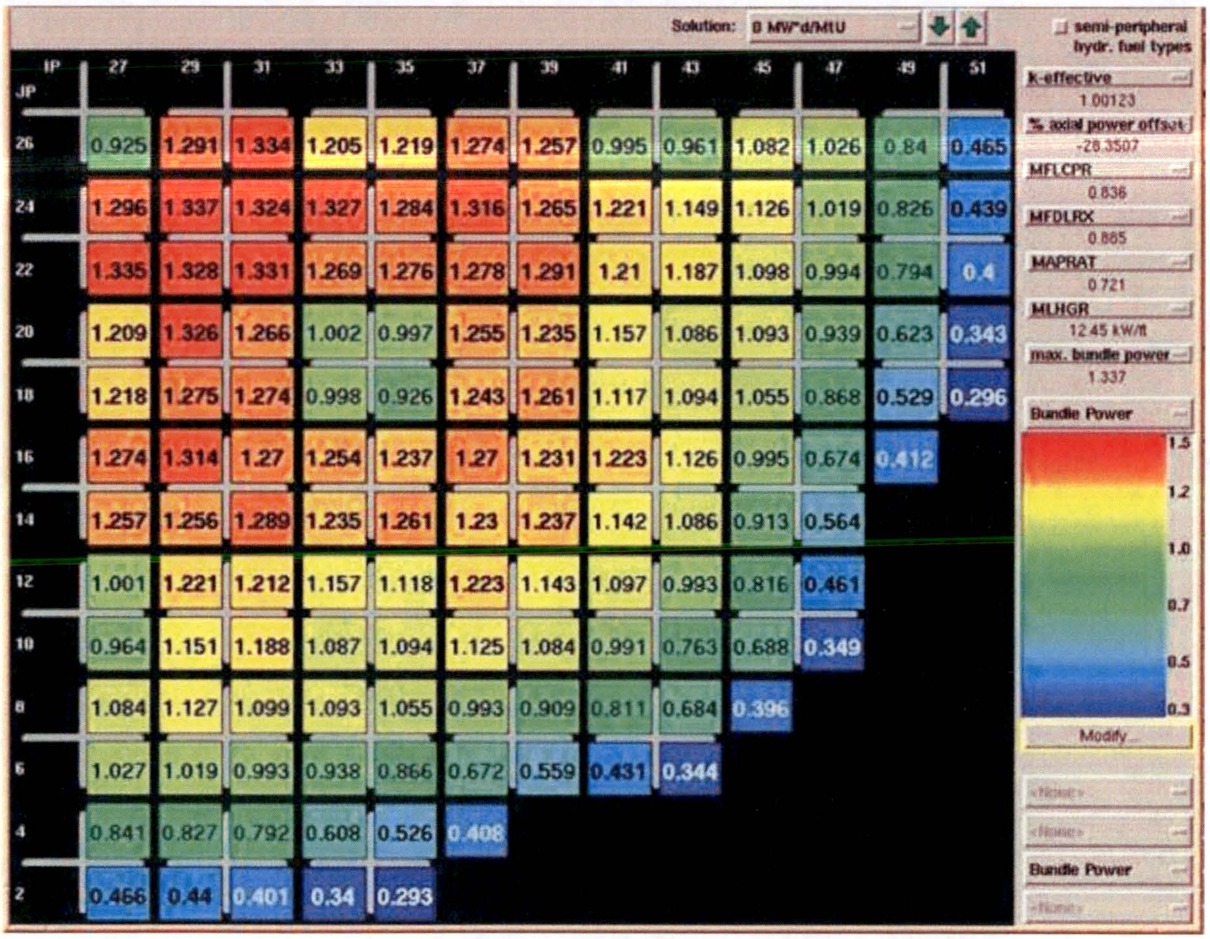


Figure 2-8 Nominal Bundle Power Map At MOC (9,000 MWd/MTU)

Figure 2-9 Nominal Bundle Power Map At EOR (End of Rated, 18,831.2 MWd/MTU)

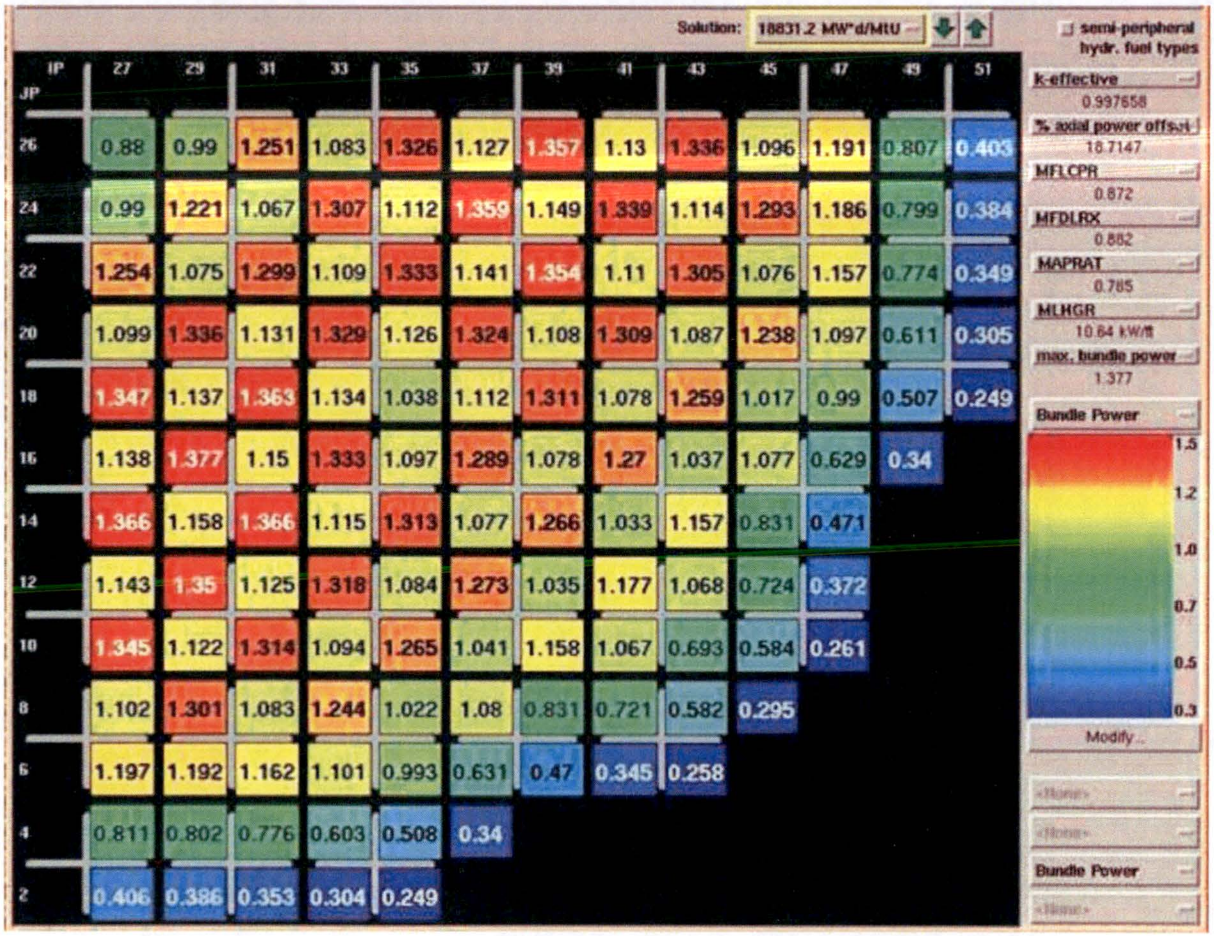


Figure 2-10 Maximum LHGR (kW/ft) Map At BOC (0 MWd/MTU)

Figure 2-11 Maximum LHGR (kW/ft) Map At MOC (9,000 MWd/MTU)

Figure 2-12 Maximum LHGR (kW/ft) Map At EOR (End of Rated, 18,831.2 MWd/MTU)

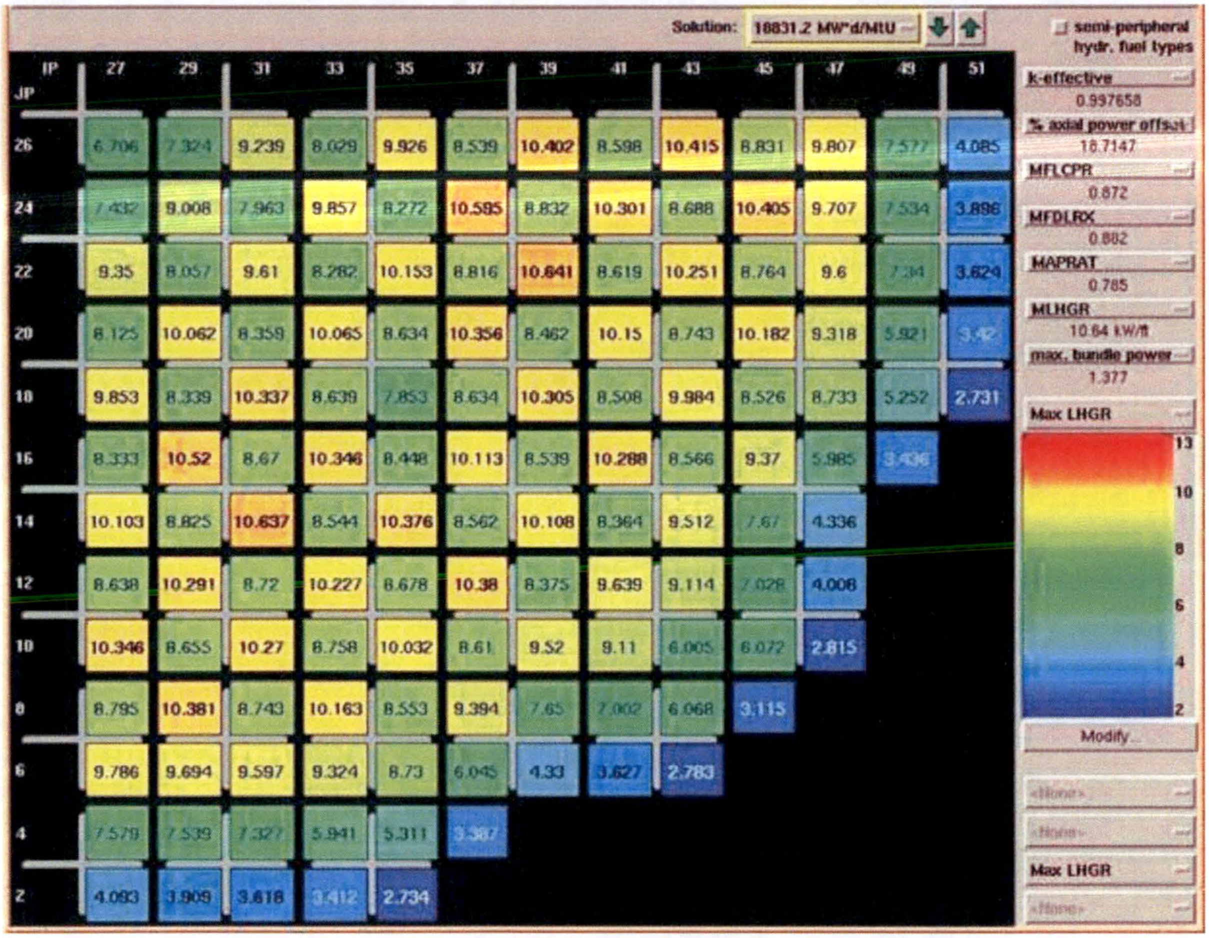


Figure 2-13 MCPR Map At BOC (0 MWd/MTU)

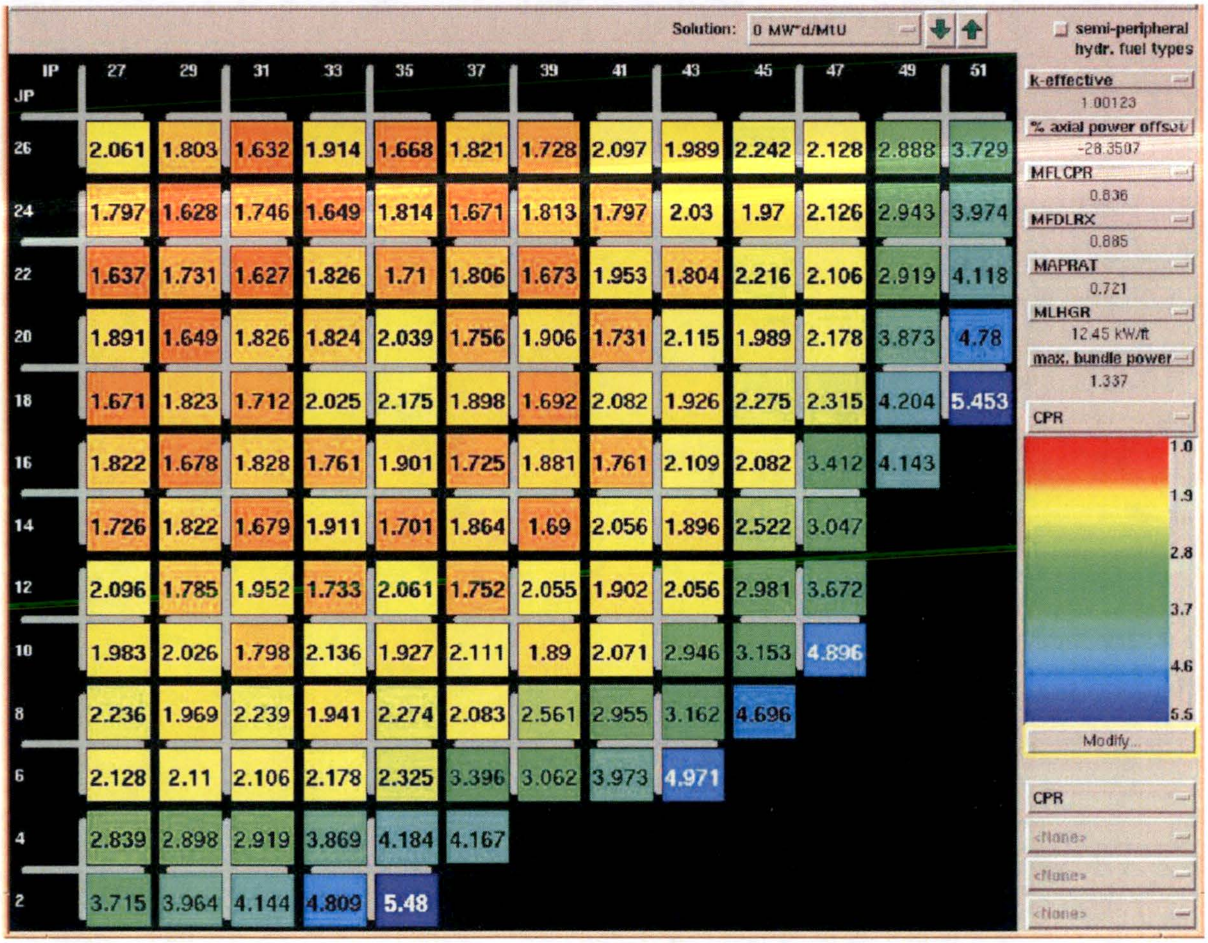


Figure 2-14 MCPR Map At MOC (9,000 MWd/MTU)

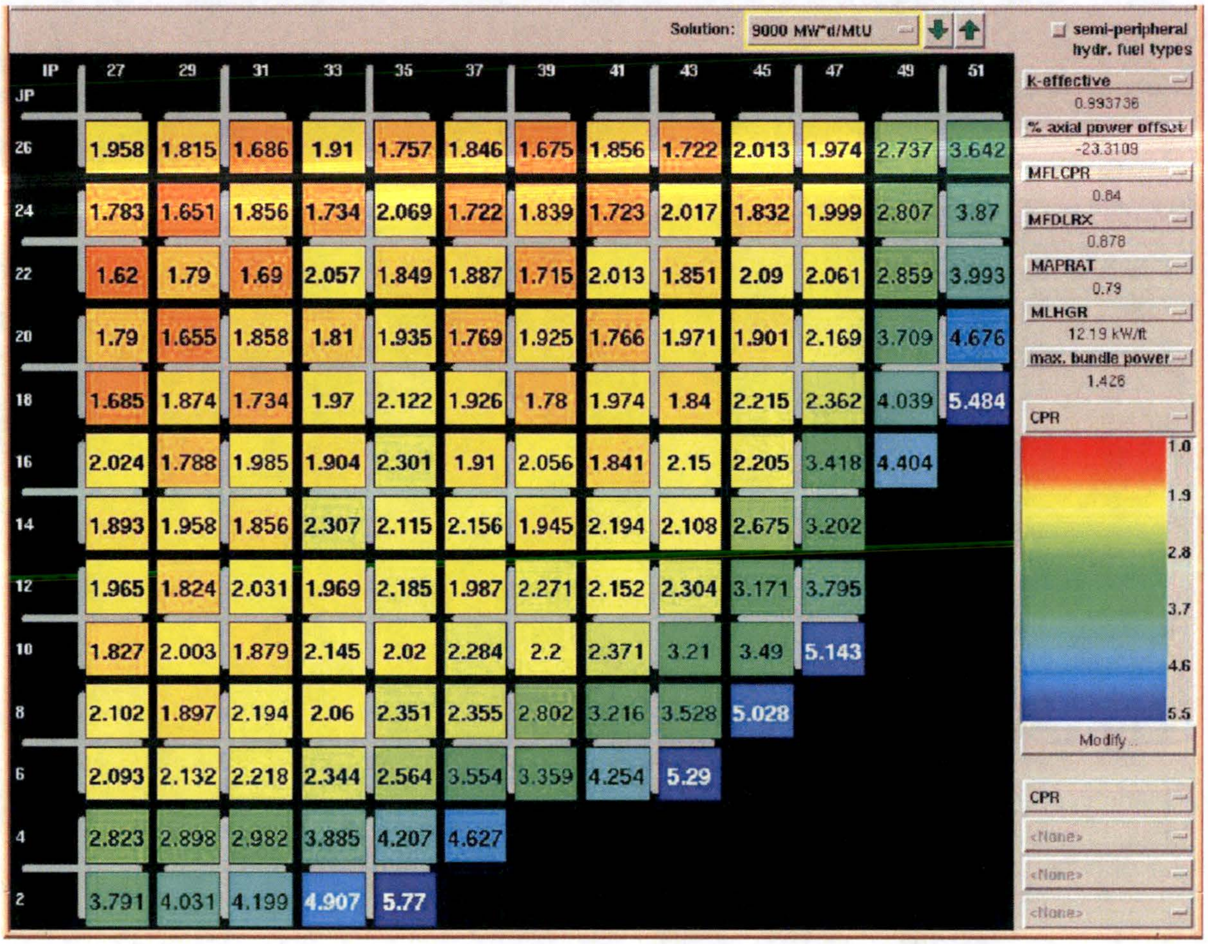


Figure 2-15 MCPR Map At EOR (End of Rated, 18,831.2 MWd/MTU)

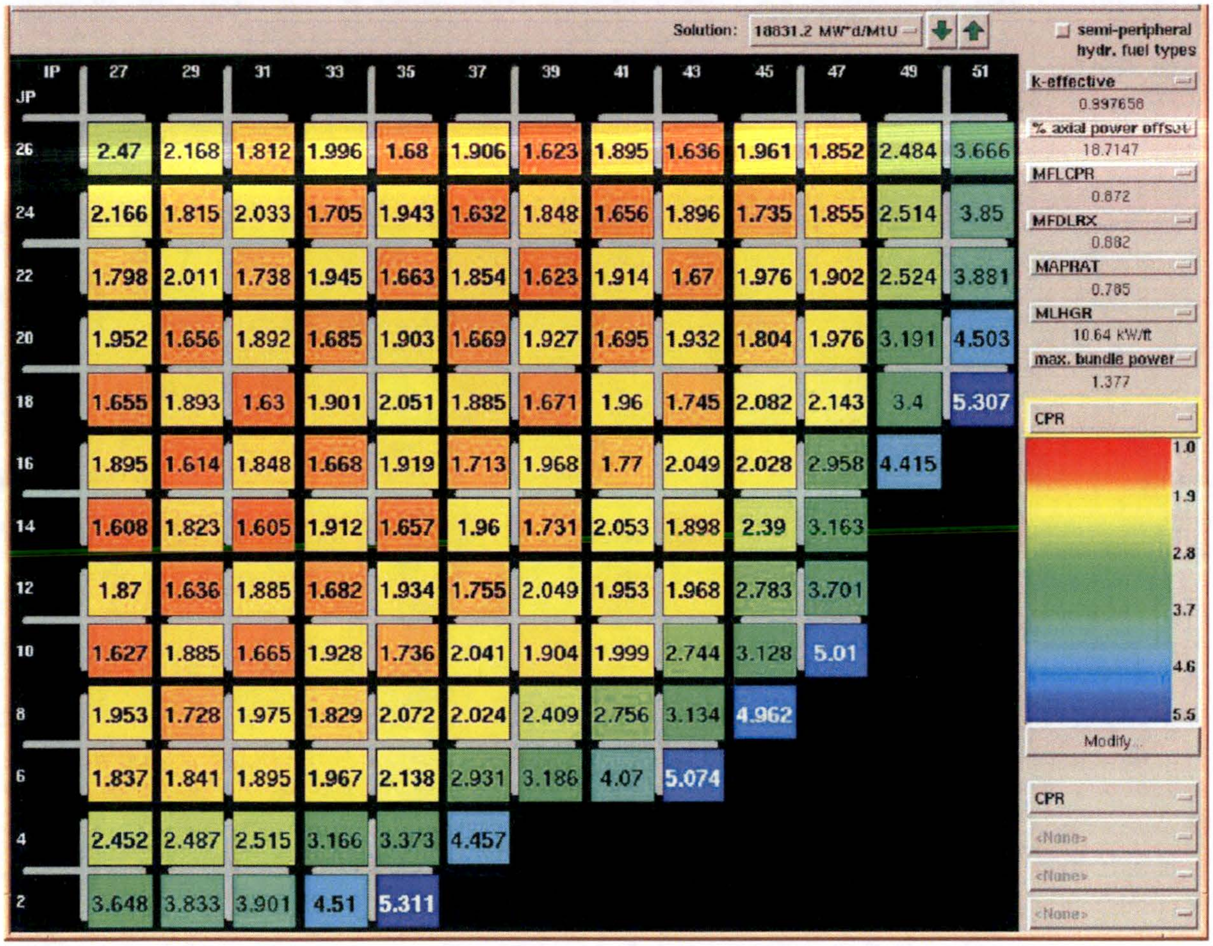
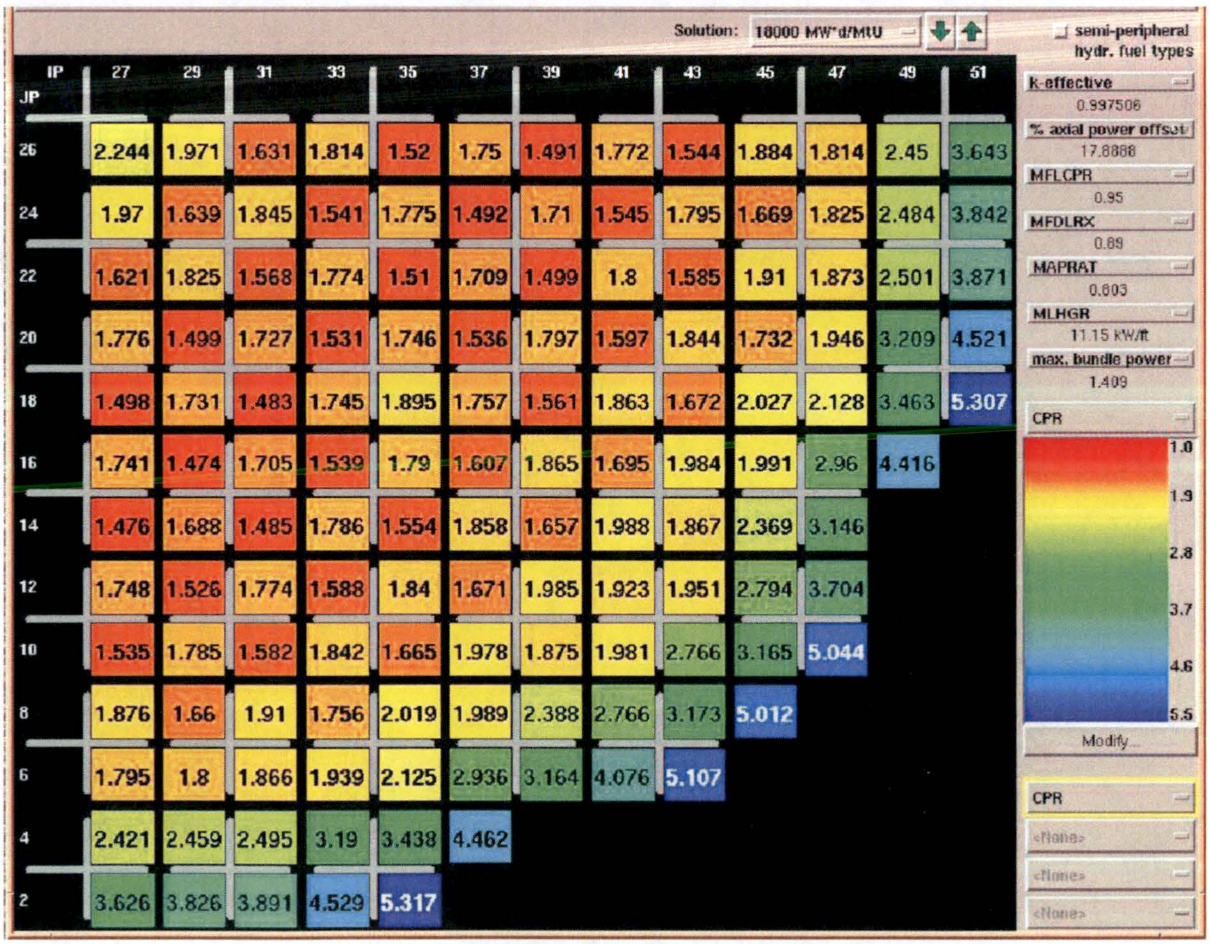


Figure 2-16 Maximum LHGR (kW/ft) Map at Exposure Where Peak Cycle FDLRX (or MFLPD) Occurs (17,000 MWd/MTU)

Figure 2-17 MCPR Map At Exposure Where Peak Cycle MFLCPR Occurs (18,000 MWd/MTU)



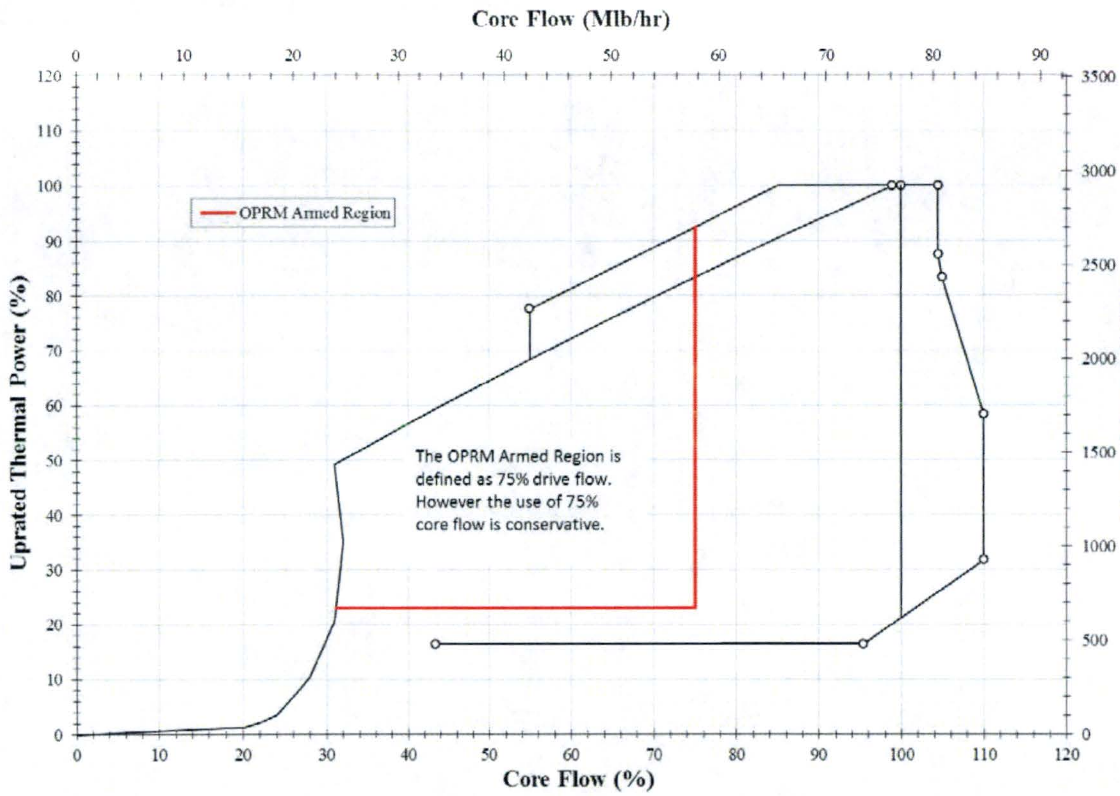


Figure 2-18 Required OPRM Armed Region

3.0 REACTOR COOLANT AND CONNECTED SYSTEMS

This section addresses the evaluations that are applicable to MELLLA+.

3.1 NUCLEAR SYSTEM PRESSURE RELIEF AND OVERPRESSURE PROTECTION

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Flow-Induced Vibration	Generic	Confirmed
Overpressure Relief Capacity	Plant Specific	Acceptable

3.1.1 Flow-Induced Vibration

The generic disposition of the Flow-Induced Vibration (FIV) topic in the M+LTR describes that because there is no increase in the maximum main steam (MS) line flow for the MELLLA+ operating domain expansion, there is no effect on the FIV of the piping and SRVs during normal operation. [[
]]

Consistent with the generic disposition discussed above, for BSEP, maximum MS line flow in the MELLLA+ operating domain does not increase. The numerical values showing no increase in maximum steam flow rate are presented in Table 1-2. MELLLA+ does not result in any increase to the BSEP maximum MS line flow, and there is no effect on the FIV experienced by the SRVs or piping during normal operation. [[
]]

The assessment of FIVs for BSEP is confirmed to be consistent with the generic disposition provided in the M+LTR, and thus no further evaluation is needed.

3.1.2 Overpressure Relief Capacity

The pressure relief system prevents overpressurization of the nuclear system during AOOs, the plant ASME upset overpressure protection event, and postulated ATWS events. The SRVs along with other functions provide this protection. For BSEP, the limiting overpressure event is the Main Steam Isolation Valve Closure with Scram on High Flux (MSIVF). The peak RPV bottom head pressure is unchanged and remains less than the ASME limit of 1,375 psig. The peak RPV dome pressure is unchanged and remains less than the ASME limit of 1,325 psig.

The SRV setpoint tolerance is independent of the MELLLA+ operating domain expansion. The AOO, ASME overpressure, and ATWS response reload licensing evaluations for MELLLA+ are performed using existing BSEP SRV setpoint tolerances of ±3%. The SRV setpoint tolerances are monitored at BSEP for compliance to the TS requirements.

[[
]] There are no changes made to the BSEP licensing basis for the ASME overpressure event.

The ASME overpressure analysis for BSEP was performed at the 102% power and 104.5% ICF core flow state point, and at the 102% power and 85% minimum core flow state point using an ATRIUM 10XM MELLLA+ representative core. The plant configuration analyzed assumed that one of the lowest setpoint SRVs was inoperable.

Results of the limiting ASME overpressure event for BSEP are presented in Reference 78 and demonstrate that the acceptance criteria are met. Therefore, no change in overpressure relief capacity is required to support MELLLA+ operation. The ATWS analysis discussed in Section 9.3.1 concludes that no increase in the number of SRVs credited in the analysis is required to demonstrate acceptable results. The ASME overpressure event continues to be analyzed each reload analysis and is reported in the RSAR. This process is unchanged by MELLLA+.

[[

]] In support of the introduction of MELLLA+ operation, the ASME and ATWS overpressure analyses were also performed with SRV setpoints based on a degradation scheme using a 95% probability/95% confidence approach with actual plant performance data. This is consistent with the discussion in Section 3.1.1 of the M+ LTR SER. The ASME and ATWS overpressurization analysis results using the alternate SRV setpoint tolerance approach are also presented in Reference 78. The results demonstrate that the respective overpressure acceptance criteria are met.

3.2 REACTOR VESSEL

The RPV structure and support components form a pressure boundary to contain reactor coolant and form a boundary against leakage of radioactive materials into the drywell. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Fracture Toughness	Plant Specific	Acceptable
Reactor Vessel Structural Evaluation	Generic	Confirmed

3.2.1 Fracture Toughness

The M+LTR, Section 3.2.1 describes the RPV fracture toughness evaluation process. RPV embrittlement is caused by neutron exposure of the wall adjacent to the core including the regions above and below the core that experience fluence $\geq$ 1.0E+17 n/cm^2. This region is defined as the "beltline" region. Operation at MELLLA+ conditions considering a new fluence calculation results in a lower neutron flux, which decreases the integrated fluence over the period of plant life.

The MELLLA+ (2,923 MWt) fluence value for the 60-year license (54 effective full power years (EFPY)) is 3.27E+18 n/cm^2 for BSEP Unit 1. The MELLLA+ (2,923 MWt) fluence value for the 60-year license (54 EFPY) is 3.33E+18 n/cm^2 for BSEP Unit 2. These values were obtained from a fluence calculation (References 14 and 15) performed in accordance with Regulatory Guide (RG) 1.190 (Reference 16), and are used to evaluate the vessel against the requirements of

10 CFR 50, Appendix G, as defined in Reference 17. The application of the RG 1.190 methodology satisfies the requirements of RG 1.99. The results of these evaluations indicate that:

a) The BSEP RPV materials do not have sufficient unirradiated upper shelf energy (USE) data. Therefore, Equivalent Margin Analyses were performed for the limiting beltline plate and weld materials to assure qualification. These values are provided in Tables 3-1a to 3-1d. The margin requirements of Boiling Water Reactor Vessel and Internals Project (BWRVIP-74-A, Reference 18) are maintained. The BSEP instrumentation nozzle is qualified by use of a RG 1.161 evaluation as approved by SER (Reference 19). The results for MELLLA+ are shown in Table 3-2.

b) The beltline material reference temperature of the nil-ductility transition (RT_{NDT}) remains below the 200°F screening criteria as defined in Reference 20. These values are provided in Tables 3-3a and 3-3b.

c) The CLTP pressure-temperature (P-T) curves remain bounding for MELLLA+ conditions. The CLTP adjusted reference temperature (ART) values for the beltline plates, welds, and the instrumentation nozzle remain bounding for MELLLA+.

d) The reactor vessel material surveillance program consists of three capsules for each unit. Two capsules remain in standby in the RPV for Unit 1 and one capsule remains in standby in the RPV for Unit 2. These capsules have been in the reactor vessel since plant startup.

e) One capsule containing Charpy specimens was removed from Unit 1 after 8.67 EFPY and from Unit 2 after 10.9 EFPY of operation. A second capsule was removed from Unit 2 after 17.4 EFPY and is currently stored in the spent fuel pool with no plans for testing. BSEP is participating in the BWRVIP Integrated Surveillance Program (ISP) (Reference 21) and will comply with the requirements of that program. MELLLA+ has no effect on the existing surveillance schedule.

f) The 60-year license (54 EFPY) beltline circumferential weld material RT_{NDT} values remain bounded by the requirements of Generic Letter (GL) 98-05 (Reference 22) and the values provided in NRC's SE of BWRVIP-05 (References 23 and 24). This comparison is provided in Table 3-4b.

g) The 60-year license (54 EFPY) beltline axial weld failure probability values remain bounded by the values provided in the NRC's SE of BWRVIP-05 (Reference 24). This comparison is provided in Table 3-4a.

h) The BSEP RPV materials reach upper shelf fracture toughness at the temperature of 235.1°F for Unit 1 and 227.5°F for Unit 2 during a reflood thermal shock event; these temperatures are well below the 400°F upper bound established in Reference 25, exhibiting sufficient margin for 60 years.

The maximum normal operating dome pressure for MELLLA+ is unchanged from that for CLTP power operation. Therefore, the hydrostatic and leakage test pressures and associated temperatures are acceptable for operation at MELLLA+ conditions. Because the vessel is still in compliance with the regulatory requirements, operation with MELLLA+ does not have an adverse effect (i.e., does not exceed regulatory requirements) on the reactor vessel fracture toughness. These analyses show compliance with the M+LTR SER Limitation and Condition 12.8.

3.2.2 Reactor Vessel Structural Evaluation

The generic disposition of the Reactor Vessel Structural Evaluation topic in the M+LTR describes that there are no changes in the reactor operating pressure, FW flow rate or steam flow rates for the MELLLA+ operating domain expansion. Other applicable mechanical loads do not increase for the MELLLA+ operating domain expansion. Therefore, the generic disposition in the M+LTR concludes that there is no change in the stress or fatigue for the reactor vessel components as a result of MELLLA+, and no further evaluation is required.

Consistent with the generic disposition discussed above, for BSEP, there are no increases in the reactor operating pressure, or maximum steam or FW flow rates for the MELLLA+ operating domain expansion. The numerical values showing no increases in reactor operating pressure, or maximum steam or FW flow rates are presented in Table 1-2. Other BSEP mechanical loads do not increase as a result of the MELLLA+ operating domain expansion. Therefore, there is no change in the stress and fatigue for the BSEP reactor vessel components and no further evaluation of BSEP reactor vessel structural integrity is required.

The reactor vessel structural evaluation for BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

3.3 REACTOR INTERNALS

3.3.1 Reactor Internal Pressure Differences

The reactor internals include core support structure and non-core support structure components. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Fuel Assembly Lift Forces	Generic	Confirmed
Reactor Internals Pressure Differences for Normal, Upset, Emergency and Faulted Conditions	Generic	Confirmed
Reactor Internals Pressure Differences (Acoustic and Flow-Induced Loads) for Faulted Conditions	Plant Specific	Acceptable
Reactor Internals Structural Evaluation for Normal, Upset, Emergency, and Faulted Conditions	Plant Specific	Acceptable
Steam Separator and Dryer Performance	Plant Specific	Acceptable

3.3.1.1 Fuel Assembly Lift Forces

The generic disposition of the Fuel Assembly Lift Forces topic in the M+LTR describes that fuel assembly lift forces are calculated for normal, upset, emergency, and faulted conditions consistent with the existing plant design basis. There are no increases in the core exit steam flow, reactor operating pressure, FW or steam flow rates for the MELLLA+ operating domain expansion. Because none of the preceding values change, the only remaining variable affecting the forces on the fuel assemblies for the normal, upset, emergency and faulted conditions in the MELLLA+ operating domain is the CF. Maximum CF is reduced in the MELLLA+ operating domain. [[

]] Therefore, no further evaluation of fuel assembly lift forces is required.

Consistent with the generic disposition discussed above, for BSEP, the difference between the 100% CLTP / 104.5% of RCF ICF operation point core exit steam flow and the 100% CLTP / 85% of RCF MELLLA+ operation point core exit steam flow is less than a 0.2% increase. The differences between the vessel steam flow and FW flow rates for the two power-flow points are both less than a 0.2% decrease. The dome pressures for the two power-flow points are identical. The small differences between the core exit steam flows, vessel steam flows and FW flow rates will have a negligible effect on the fuel assembly lift forces calculated for normal, upset, emergency and faulted conditions. Therefore, because the BSEP CF at the MELLLA+ state point at 85% of RCF is less than the current licensed operating domain state point at 104.5% of RCF, the normal, upset, emergency and faulted fuel assembly lift forces for the MELLLA+ operating domain [[

]] and no further evaluation of these forces is required.

The fuel assembly lift forces for BSEP are confirmed to be consistent with the generic disposition in the M+LTR.

3.3.1.2 Reactor Internal Pressure Differences for Normal, Upset, Emergency and Faulted Conditions

The generic disposition of the RIPDs for Normal, Upset, Emergency and Faulted Conditions topic in the M+LTR describes that RIPDs (pressure differentials across the components) are calculated for normal, upset, emergency and faulted conditions consistent with the existing plant design basis. There are no changes in the core exit steam flow, reactor operating pressure, FW or steam flow rates for the MELLLA+ operating domain expansion. Because none of the preceding values change, the only remaining variable affecting the RIPDs for the normal, upset, emergency and faulted conditions in the MELLLA+ operating domain is the CF. Maximum CF is reduced in the MELLLA+ operating domain. [[

]] Therefore, no further evaluation of RIPDs for normal, upset, emergency and faulted conditions is required.

Consistent with the generic disposition discussed above, for BSEP, the difference between the 100% CLTP / 104.5% of RCF ICF operation point core exit steam flow and the 100% CLTP / 85% of RCF MELLLA+ operation point core exit steam flow is less than a 0.2% increase. The differences between the vessel steam flow and FW flow rates for the two power-flow points are both less than a 0.2% decrease. The dome pressures for the two power-flow points are identical. The small differences between the core exit steam flows, vessel steam flows and FW flow rates will have a negligible effect on the RIPDs for normal, upset, emergency and faulted conditions. Therefore, because the BSEP CF at the MELLLA+ state point at 85% of RCF is less than the current licensed operating domain state point at 104.5% of RCF, the normal, upset, emergency and faulted condition RIPDs for MELLLA+ operating domain [[
]] which includes ICF up to 104.5% of RCF.
[[
]] and no further evaluation of these pressure differentials is required for normal, upset, emergency and faulted conditions.

The normal, upset, emergency and faulted RIPDs for BSEP are confirmed to be consistent with the generic disposition in the M+LTR.

3.3.1.3 Reactor Internals Pressure Differences (Acoustic and Flow-Induced Loads) for Faulted Conditions

As part of RIPDs, the faulted acoustic and flow-induced loads in the RPV annulus on jet pump, core shroud and core shroud support resulting from the recirculation line break LOCA have been considered in the BSEP evaluation. [[

]] and BSEP RIPDs for faulted conditions continue to be acceptable.

The BSEP-specific evaluation concludes that the RIPDs for faulted conditions are acceptable.

3.3.2 Reactor Internals Structural Evaluation

Structural integrity evaluations for MELLLA+ operating domain expansion are performed consistent with the existing design basis of the components. [[

]] Therefore, no further structural evaluation of the reactor internals is required. An evaluation of the load categories applicable to the reactor internals under normal, upset, emergency, and faulted conditions is presented below:

Load Category	MELLLA+ Results for Normal, Upset, Emergency, and Faulted Conditions
Dead Weight	[[
Seismic	
RIPDs (including Acoustic and Flow-Induced Loads)	
Fuel Assembly Lift Forces	
Hydrodynamic Containment Dynamic Loads - (LOCA and SRV)	
Annulus Pressurization (AP)	
Jet Reaction	
Thermal Effects	

Flow	]]

Applicable loads, load combinations, and service conditions have been evaluated consistent with the plant design basis for each component. As shown in the above table, the load conditions do not increase due to MELLLA+, and no further evaluation is required.

The BSEP-specific evaluation is acceptable for the Reactor Internals Structural Evaluation for normal, upset, emergency, and faulted conditions.

3.3.3 Steam Separator and Dryer Performance

The performance of the BSEP steam separator-dryer has been evaluated to determine the moisture content of the steam leaving the RPV. Compared to the current licensed operating domain, 100% of RCF state point, the average separator inlet flow decreases and the average separator inlet quality increases at MELLLA+ conditions. These factors, in addition to the core radial power distribution, affect the steam separator-dryer performance. Steam separator-dryer performance was evaluated at equilibrium cycle limiting conditions of high radial power peaking and 85% of RCF to assess their capability to provide the quality of steam necessary to meet operational criteria at MELLLA+ operating conditions.

The evaluation of steam separator and dryer performance at MELLLA+ conditions indicates an increase in MCO of < 0.20 wt.% where the original MCO performance specification was 0.10 wt.%. Section 3.3.4 identifies a plant-specific moisture performance specification under MELLLA+ operating conditions.

3.3.4 Steam Line Moisture Performance Specification

The effect of increased MCO on plant operation has been analyzed to verify acceptable steam separator-dryer performance under MELLLA+ operating conditions for an allowed maximum moisture content of 0.20 wt.%. MCO is monitored during operation to ensure adequate operating limitations are implemented as required to maintain MCO within analyzed conditions. The amount of time BSEP is operated with higher than the original design moisture content (0.10 wt.%) is expected to be minimal given how the plant will be operated. MCO monitoring periodicity is based upon operating experience.

The ability of the steam dryer and separator to perform their design functions during MELLLA+ operation was evaluated. The plant-specific evaluation concluded that the performance of the steam dryer and separator remains acceptable and dryer skirt remains covered at L4, the low water level alarm in the MELLLA+ operating domain.

The performance of the steam separator/dryer system is affected by the core radial power distribution and CF rate. For a constant reactor thermal power, the reduction in CF in the MELLLA+ domain generates an increase in steam quality entering the separators, which can lead to an increase in separator carryover. The increase in separator carryover can, in turn, lead to localized flooding of the dryer vanes above the affected separators that may lead to elevated

MCO. The steam separator/dryer performance was evaluated on a plant-specific basis to determine the influence of MELLLA+ on the steam dryer and separator operating conditions: (1) the entrained steam (i.e., carryunder) in the water returning from the separators to the reactor annulus region; (2) the moisture content in the steam leaving the RPV into the MS lines; and (3) the margin to dryer skirt uncovery.

The moisture content of the steam leaving the RPV increases in the MELLLA+ operating domain. The effect of increasing steam moisture content has been analyzed in the tasks that use the MCO value from Sections 3.3.3 and 3.3.4. The effects of increased moisture are discussed in the following sections:

a. 3.4.1 FIV Influence on Piping - Safety Related

Because there are no safety-related MS line thermowells or sample probes, no safety-related FW line sample probes, and no safety-related RRS line sample probes, no FIV evaluations were performed for these components.

b. 3.5.1 Reactor Coolant Pressure Boundary Piping

The generic disposition in the M+LTR indicates in Section 3.3.3 that the MCO may increase during the cycle when a plant is operating at or near the MELLLA+ minimum CF rate.

Consistent with this generic disposition, the MCO may increase to a maximum of 0.20 wt.% during the cycle when BSEP is operating at or near the MELLLA+ minimum CF rate.

Plant-specific evaluations of reactor coolant pressure boundary (RCPB) components and operational considerations have determined the potential increase in MCO up to 0.20 wt.% is acceptable because it does not result in unacceptable design or operating margins, and the resulting increase in steam density and system pressure drop are considered to be negligible.

c. 5.2.4 Main Steam Flow - FW Flow Mismatch

Operation at the higher MCO performance specification is acceptable. With a dryer moisture performance specification of 0.20 wt.%, the additional coolant removed from the RPV must be returned to the reactor in order to maintain correct water level. The FW system will be required to provide a slightly higher flow rate. The effect of the increased MS line MCO is to cause a slight imbalance (approximately 0.4%) in the feedwater control system (FWCS) control point, which will not have a significant effect on the normal reactor water level.

d. 8.1 Liquid and Solid Waste Management

Although the volume of waste generated is not expected to increase, potentially higher MCO in the reactor steam could result in slightly higher loading on the condensate demineralizers. Because the higher moisture content will occur infrequently, the MELLLA+ operating domain expansion will not cause the condensate demineralizer or the reactor water cleanup (RWCU) filter demineralizer backwash frequency to be changed significantly.

e. 8.4.2 Fission and Activation Corrosion Products

Steam separator and dryer performance for MELLLA+ operation is discussed in Section 3.3.3. The moisture content of the MS leaving the vessel may increase up to 0.20 wt.% at times while operating near the minimum CF in the MELLLA+ operating domain. The distribution of the fission and activated corrosion product activity between the reactor water and steam is affected by the increased moisture content. With increased MCO, additional activity is carried over from the reactor water with the steam. The BSEP plant-specific results for the concentration of total fission products and total activated corrosion products in reactor water are bounded by the design basis concentrations.

f. 8.5 Radiation Levels

As discussed in Section 8.4, the moisture carry over (MCO) of the MS leaving the vessel may increase for brief periods while operating in the MELLLA+ operating domain near 100%P/85%F. However, the BSEP cycle average value will be monitored and controlled within the analytical assumption of 0.2 wt.% used in the determination of normal operation radiation levels. The overall radiological effect of the increased moisture content is a function of the plant water radiochemistry and the levels of activated corrosion products.

g. 10.7.2 Flow Accelerated Corrosion (FAC)

As discussed in Section 3.3.3, there is a small increase in average moisture content during short periods of the cycle. This small increase in moisture content has no significant effect on FAC parameters.

3.4 FLOW-INDUCED VIBRATION

The FIV evaluation addresses the influence of the MELLLA+ operating domain expansion on reactor coolant pressure boundary (RCPB) piping, RCPB piping components, and RPV internals. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Piping FIV Evaluation Recirculation Piping Main Steam Piping Feedwater Piping Safety Related Thermowells and Probes	Generic	Confirmed
RPV Internals FIV Evaluation	Generic	Confirmed

3.4.1 FIV Influence on Piping

The generic disposition of the FIV Influence on Piping topic in the M+LTR describes that [[ ]] Flow rates in the recirculation system piping, MS piping, and FW piping as well as associated MS and FW branch lines do not increase as a result of MELLLA+ operating domain expansion. [[ ]] and no further evaluation of FIV influence on recirculation, MS and FW piping is required.

Consistent with the generic disposition discussed above, [[ ]] For BSEP, there are no increases in the recirculation system, MS, or FW flow rates as a result of MELLLA+ operating domain expansion as compared to the current licensed operating domain. The numerical values showing no increases in recirculation system, MS, or FW flow rates are presented in Table 1-2. [[ ]] and no further evaluation of FIV influence on recirculation, MS and FW piping is required.

The generic disposition of the FIV Influence on Piping topic in the M+LTR also finds that [[ ]] Because the flow rates in these piping systems do not increase for MELLLA+, there is no increase in FIV for the safety-related thermowells and probes. [[ ]] and no further evaluation of FIV influence on safety-related thermowells and probes is required.

Also, consistent with the generic disposition discussed above, [[ ]] For BSEP, there is no increase in flow in these systems for MELLLA+. Therefore, there is no increase in FIV for the safety-related thermowells and probes. [[ ]] and no further evaluation of FIV influence on safety-related thermowells and probes is required.

The FIV evaluation for these piping systems, including safety-related thermowells and probes, for BSEP, is confirmed to be consistent with the generic disposition in the M+LTR.

3.4.2 FIV Influence on Reactor Internals

The generic disposition of the FIV Influence on Reactor Internals topic in the M+LTR describes that [[ ]] The generic disposition evaluates the effect of the MELLLA+ operating domain expansion on the following components: shroud, shroud head and steam separator-dryer, core spray (CS) line, low pressure coolant injection (LPCI) coupling, control rod guide tube (CRGT), in-core guide tubes, fuel channel, local power range monitor (LPRM) / intermediate range monitor (IRM) tubes, jet pumps, jet pump sensing lines (JPSLs) and FW sparger. The MELLLA+ operating domain expansion results in decreased core and recirculation flow as well as no increase in the MS and FW flow rates. The generic evaluation shows that [[

]]

Consistent with the generic disposition discussed above, the effect of the MELLLA+ operating domain expansion is presented for the following components:

Component(s)	MELLLA+ Results
Shroud Shroud Head and Separator Steam Dryer	[[
CS Line LPCI Coupling CRGT In-Core Guide Tubes	
Fuel Channel LPRM/IRM Tubes	
Jet Pumps	

Component(s)	MELLLA+ Results
JPSLs	
FW Sparger	]]

For BSEP, the MELLLA+ operating domain expansion results in decreased core and recirculation flow as well as no increase in the MS and FW flow rates. The numerical values showing a decrease in core and recirculation flow as well as no increase in maximum steam or FW flow rates are presented in Table 1-2. As presented in the table above, [[
]] The reduced CF and recirculation flow in the MELLLA+ operating domain [[
]] Therefore, no further evaluation of the FIV influence on reactor internals is required for the BSEP MELLLA+ operating domain expansion.

The FIV evaluation of the BSEP reactor internals is confirmed to be consistent with the generic disposition in the M+LTR.

3.5 PIPING EVALUATION

3.5.1 Reactor Coolant Pressure Boundary Piping

The RCPB piping systems evaluation consists of a number of safety-related piping subsystems that move fluid through the reactor and other safety systems. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Main Steam and Feedwater (Inside Containment)	Generic	Confirmed
Recirculation and Control Rod Drive	Generic	Confirmed
Reactor Core Isolation Cooling (RCIC) High Pressure Coolant Injection (HPCI) Reactor Water Cleanup Core Spray Line Standby Liquid Control (SLC) Residual Heat Removal (RHR) RPV Head Vent Line SRV Discharge Line (SRVDL) Safety Related Thermowells	Generic	Confirmed

The piping systems are required to comply with the structural requirements of the ASME Boiler and Pressure Vessel Code (or an equivalent code) applicable at the time of construction or the governing code used in the stress analysis for a modified component.

3.5.1.1 Main Steam and Feedwater Piping Inside Containment

The generic disposition of the RCPB Piping - MS and FW Inside Containment topic in the M+LTR describes that the system temperatures, pressure, and flows in the MELLLA+ operating domain are within the range of rated operating parameters for the MS and FW piping system (inside containment). [[

]] The generic disposition in the M+LTR concludes that provided the temperatures, pressures, and flows in MS and FW systems for MELLLA+ operation are within the range of rated operating parameters for those systems, no further evaluation is required related to RCPB piping for MS and FW piping inside containment.

Consistent with the generic disposition discussed above, for BSEP, the MS and connected branch piping (i.e., RCIC and HPCI steam lines) and FW temperatures, pressures and flow are within the rated operating parameters for the MS and FW systems. MS and FW temperatures, flows, and pressures at MELLLA+ conditions are bounded by the CLTP temperatures, flows, and pressures, and as such are within the design values used in the design of the piping and supports chosen for worst case conditions. BSEP MS and FW piping inside containment is designed in accordance with the codes identified in UFSAR Table 3-8. [[

]]

Consistent with the generic disposition in the M+LTR, the temperatures, pressures, and flows in BSEP MS and FW systems for MELLLA+ operation are within the range of rated operating parameters for those systems, and no further evaluation is required related to the BSEP RCPB piping for MS and FW systems inside containment.

The generic disposition in the M+LTR does recognize that as discussed in Section 3.3.4, the MCO may increase during the cycle when a plant is operating at or near the MELLLA+ minimum CF rate.

Consistent with this generic disposition, the MCO may increase to a maximum of 0.20 wt.% during the cycle when BSEP is operating at or near the MELLLA+ minimum CF rate.

The evaluation of the BSEP MS and connected branch piping (i.e., RCIC and HPCI steam lines) and FW piping inside containment is confirmed to be consistent with the generic disposition in the M+LTR.

3.5.1.2 Reactor Recirculation and Control Rod Drive Systems

The generic disposition of the RCPB Piping - Reactor Recirculation and CRD systems topic in the M+LTR describes that there is no change in the maximum operating system temperatures, pressures, and flows in the MELLLA+ operating domain for the recirculation piping system and attached RHR piping system. [[

]] Therefore, the generic disposition concludes that no further evaluation of the RCPB piping - reactor recirculation and CRD systems is required for MELLLA+ operating domain expansion.

Consistent with the generic disposition discussed above, for BSEP, the reactor recirculation and CRD system temperatures, flows, and pressures at MELLLA+ conditions are bounded by the CLTP temperatures, flows, and pressures, and as such are within the design values used in the design of the piping and supports chosen for worst case conditions.

The evaluation of the BSEP reactor recirculation and CRD systems is confirmed to be consistent with the generic disposition in the M+LTR.

3.5.1.3 Other RCPB Piping Systems

3.5.1.3.1 Other RCPB Piping Systems - CS and SLCS

The generic disposition of the RCPB Piping - Other RCPB Piping Systems (with no flow while on-line) topic in the M+LTR describes that [[

]]

Because the piping systems meeting the criteria listed in the generic disposition [[
]] their susceptibility to erosion/corrosion does not increase, and no further evaluation of these other RCPB piping systems is required.

Consistent with the generic disposition discussed above, MELLLA+ operating domain expansion for BSEP does not change the maximum operating temperature, pressure, or flow rate of any of the following systems: CS and SLCS.

CS and SLCS system temperatures, flows, and pressures at MELLLA+ conditions are bounded by the CLTP temperatures, flows, and pressures, and as such are within the design values used in the design of the piping and supports chosen for worst case conditions.

Each of these BSEP systems [[

]] Consistent with the generic disposition, CS and SLCS susceptibility to erosion/corrosion does not increase, and no further evaluation of these other RCPB piping systems is required for BSEP.

3.5.1.3.2 Other RCPB Piping Systems – RPV Head Vent Line and SRVDLs

[[

]] For the RPV head vent line and the SRVDL, there is no change in the temperature, pressure, or flows in these systems as a result of MELLLA+ operating domain expansion. Because the piping systems have no change in system temperature, pressure or flow as a result of MELLLA+ operating domain expansion, [[
]] Their susceptibility to erosion/corrosion does not increase, and no further evaluation of these other RCPB piping systems is required.

Consistent with the generic disposition discussed above, MELLLA+ operating domain expansion for BSEP does not change the maximum operating temperature, pressure, or flow rate of any of the following piping systems: RPV head vent line and SRVDL.

RPV head vent line and SRVDL temperatures, flows, and pressures at MELLLA+ conditions are bounded by the CLTP temperatures, flows, and pressures, and as such are within the design values used in the design of the piping and supports chosen for worst case conditions. Additionally, there is no flow through the SRVDL during normal operating conditions.

The RPV head vent line and the SRVDL are unaffected by MELLLA+ operating domain expansion. Consistent with the generic disposition, their susceptibility to erosion/corrosion does not increase, and no further evaluation of these other RCPB piping systems is required for BSEP.

3.5.1.3.3 Other RCPB Piping Systems – RWCU

[[

]] Because the RWCU system has no change in system temperature, pressure or flow as a result of MELLLA+ operating domain expansion, [[
]] RWCU system susceptibility to erosion/corrosion does not increase, and no further evaluation of the RWCU system is required.

Consistent with the generic disposition discussed above, MELLLA+ operating domain expansion for BSEP does not change the maximum operating temperature, pressure, or flow rate of the RWCU system. RWCU system temperatures, flows, and pressures at MELLLA+ conditions are bounded by the CLTP temperatures, flows, and pressures, and as such are within the design values used in the design of the piping and supports chosen for worst case conditions. The BSEP RWCU system is unaffected by MELLLA+ operating domain expansion. Consistent with the generic disposition, the RWCU system susceptibility to erosion/corrosion does not increase, and no further evaluation of the RWCU system is required.

3.5.1.3.4 Other RCPB Piping Systems – Safety Related Thermowells

The generic disposition in the M+LTR recognizes that [[
]] Because the RCPB piping systems evaluated for EPU do not experience any increase in pressure, temperature, or flow at MELLLA+, their susceptibility to erosion/corrosion does not increase and no further evaluation of safety-related thermowells is required for BSEP.

Consistent with the generic disposition described above, the BSEP safety-related thermowells are unaffected by MELLLA+ as the evaluations performed for the currently licensed operating domain are bounding for MELLLA+ conditions. [[
]] Their susceptibility to erosion/corrosion does not increase and no further evaluation of safety-related thermowells is required for BSEP.

The evaluation of BSEP other RCPB piping systems is confirmed to be consistent with the generic disposition in the M+LTR.

3.5.1.4 Other Than Category "A" RCPB Material

As required by M+LTR SER Limitation and Condition 12.9, the following discussion is presented regarding other than Category "A" materials that exist in the RCPB Piping.

Category "A" is assumed to mean intergranular stress corrosion cracking (IGSCC) Category "A" that is a resistant material to IGSCC for BWR piping weldments in accordance with NUREG-0313 (Reference 58). "Other than Category A" is assumed to mean non-resistant or cracked materials for IGSCC BWR weldments in accordance with NUREG-0313 (IGSCC Categories B through G).

The BSEP Stress Corrosion Cracking Program is addressed in UFSAR Section 18.1.4. The BSEP Stress Corrosion Cracking Program is an augmented Inservice Inspection (ISI) examination program in accordance with 1BNP-PM-001 for BSEP Unit 1 and 2BNP-PM-002 for Unit 2. Those components other than Category A (Category B, C, D, and E) are listed in the Augmented ISI section of the Brunswick fourth Ten-Year Inservice Inspection Plan.

The BSEP in-service inspection (ISI) program for RCPB piping is coupled with the augmented program for reactor coolant piping based on Generic Letter (GL) 88-01 (Reference 56), NUREG-0313 (Reference 58) and Boiling Water Reactor Vessel Internals Project BWRVIP-75-A (Reference 57).

The inspection techniques utilized are in full conformance with ASME Section XI, Subsection IWB, IWC and IWD Program for the detection and characterization of service-induced, surface-connected planar discontinuities, such as IGSCC.

Continued implementation of the current program ensures the identification of any degradation of RCPB components during refuel outage inspections that may have initiated during MELLLA+ operating conditions. The augmented inspection program is designed to detect potential degradation from IGSCC. For IGSCC to occur, three conditions must be present: (1) a susceptible material (2) the presence of residual or applied tensile stress (such as from welding); and (3) an oxidizing environment.

Several SCC mitigation processes have been applied to BSEP in the SCC program which includes: (1) component replacement and preventive measures to mitigate SCC, and (2) inspections to monitor SCC and its effects. Replacement methodologies include piping replacement with SCC-resistant stainless steel. Preventive measures include heat sink welding, induction heating, mechanical stress improvement, and water chemistry control in accordance with industry recognized guidelines. Category "A" IGSCC susceptible welds are subsumed into the Risk Informed ISI Program. The BWR Stress Corrosion Cracking Program is consistent with the corresponding program described in NUREG-1801. Stress improvement processes and original construction processes used for IGSCC resistance are not affected by MELLLA+. Also, BSEP has implemented HWC and On Line Noble Chem® (OLNC), which reduces the potential for IGSCC initiation and lower crack growth rates of existing unrepaired relevant indications of RCPB components.

The Augmented Inspection Program at BSEP is acceptable to address concerns related to other than Category "A" materials in the RCPB.

Therefore, BSEP meets all M+LTR dispositions for Other Than Category "A" materials in the RCPB.

3.5.2 Balance-of-Plant Piping

The BOP piping evaluation consists of a number of piping subsystems that move fluid through systems outside the RCPB. The topics considered in this section are:

Topic	M+LTR Disposition	BSEP Result
Main Steam and Feedwater (Outside Containment)	Generic	Confirmed
Reactor Core Isolation Cooling High Pressure Coolant Injection Core Spray Residual Heat Removal	Generic	Confirmed
Offgas System Containment Air Monitoring Neutron Monitoring System	Generic	Confirmed

3.5.2.1 Main Steam and Feedwater (Outside Containment)

The generic disposition of the MS and FW (Outside Containment) topic in the M+LTR states that for all MS and FW piping systems, including the associated branch piping, the temperature, pressure, flow, and mechanical loads do not increase due to the MELLLA+ operating domain expansion. [[ ]] As discussed in Section 3.5.1.1, the susceptibility of these piping systems to erosion/corrosion does not increase. The generic disposition in the M+LTR concludes that no further evaluation is required for BOP piping – MS and FW (outside containment).

Consistent with the generic disposition discussed above, MELLLA+ operating domain expansion for BSEP does not change (no increase) the maximum operating temperature, pressure, flow rate, or mechanical loads for the MS and FW piping outside containment. MS and FW system temperatures, flows, and pressures at MELLLA+ conditions are bounded by the CLTP temperatures, flows, and pressures, and as such are within the design values used in the design of the piping and supports chosen for worst case conditions. The BSEP MS and FW piping outside containment is unaffected by the MELLLA+ operating domain expansion. The BSEP BOP piping outside containment was typically designed in accordance with American National Standards Institute (ANSI) B31.1 (Reference 26) and as such there were no fatigue analyses required or performed. [[ ]] Consistent with the generic disposition, the MS and FW piping outside containment susceptibility to erosion/corrosion does not increase, and no further evaluation is required.

The evaluation of the BSEP MS and FW piping outside containment is confirmed to be consistent with the generic disposition in the M+LTR.

3.5.2.2 Other BOP Piping Systems

3.5.2.2.1 Other BOP Piping Systems - RCIC, HPCI, CS, and RHR

The generic disposition of the Other BOP Piping Systems - RCIC, HPCI, CS, and RHR topic in the M+LTR describes that the loads and temperatures used in the analyses depend on the containment hydrodynamic loads and temperature evaluation results (Section 4.1). [[

]] The design basis LOCA dynamic loads including the pool swell loads, vent thrust loads, condensation oscillation (CO) loads, and chugging loads have been defined and evaluated for the current licensed operating domain which includes consideration of FFWTR. The pool temperatures due to a design basis LOCA were also defined for the current licensed operating domain. The values for the MELLLA+ operating domain remain within these bounding values. [[

]] For these BOP piping systems, no further evaluation is required as a result of MELLLA+.

The MELLLA+ operating domain expansion for BSEP does not change the maximum operating temperature, pressure, or flow rate, or increase mechanical loads for any of the following systems: RCIC, HPCI, CS, and RHR.

RCIC, HPCI, CS, and RHR system temperatures, flows, and pressures at MELLLA+ conditions are bounded by the CLTP temperatures, flows, and pressures, and as such are within the design values used in the design of the piping and supports chosen for worst case conditions.

Consistent with the generic disposition, for each of the BSEP systems described above, the loads and temperatures used in the analyses continue to be bounded by the loads and temperatures used in the analyses performed for the current licensed operating domain. Section 4.1 shows that the BSEP LOCA dynamic loads including the pool swell loads, vent thrust loads, CO loads, and chugging loads have been evaluated and are bounded by the current design basis. The BSEP peak suppression pool temperatures due to a design basis LOCA are also bounded by the current design basis. [[

]] For these BOP piping systems, no further evaluation is required as a result of MELLLA+.

3.5.2.2.2 Other BOP Piping Systems – Offgas System, Containment Air Monitoring, and Neutron Monitoring System

The generic disposition of the Other BOP Piping Systems - Offgas System, Containment Air Monitoring, and Neutron Monitoring System topic in the M+LTR describes that [[

]] For these BOP piping systems, no further evaluation is required as a result of MELLLA+.

Consistent with the generic disposition discussed above, there is no change to the BSEP reactor operating pressure or power level as a result of MELLLA+ operating domain expansion. The numerical values showing no increases in reactor operating pressure are presented in Table 1-2. [[

]] For these BOP piping systems, no further evaluation is required as a result of MELLLA+.

Because all of the piping systems in Section 3.5.2.2 meet the criteria listed in the generic disposition, [[ ]] their susceptibility to erosion/corrosion does not increase, and no further evaluation of these other BOP piping systems is required.

The evaluation of the BSEP other BOP piping systems is confirmed to be consistent with the generic disposition in the M+LTR.

3.6 REACTOR RECIRCULATION SYSTEM

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
System Evaluation	Generic	Confirmed
Net Positive Suction Head (NPSH)	Generic	Confirmed
Single Loop Operation	Generic	Confirmed
Flow Mismatch	Addressed in Section 4.3.6	

3.6.1 System Evaluation

The generic disposition of the RRS Evaluation topic in the M+LTR describes that all of the RRS operating conditions for the MELLLA+ operating domain are within the operating conditions in the current licensed operating domain. SLO is not allowed in the MELLLA+ operating domain. [[
]] and no further evaluation of this topic is required.

Consistent with the generic disposition discussed above, the BSEP RRS operating conditions in the MELLLA+ operating domain are within the operating conditions in the current licensed operating domain. For BSEP, there are no increases in the RRS temperature, pressure, or flow rates as a result of MELLLA+ operating domain expansion as compared to the current licensed operating domain. RRS system temperature for the current licensed operating domain is ~534°F and in the MELLLA+ operating domain is ~530°F. RRS system pressure for the current licensed operating domain and in the MELLLA+ operating domain is 1,045 psia. The numerical values showing no increases in RRS system flow rates are presented in Table 1-2. For BSEP, SLO is not allowed in the MELLLA+ operating domain. Therefore, consistent with the generic disposition, [[
]] and no further evaluation of this topic is required.

The evaluation of the BSEP RRS system evaluation is confirmed to be consistent with the generic disposition in the M+LTR.

3.6.2 Net Positive Suction Head

The generic disposition of the RRS-NPSH topic in the M+LTR describes that [[

]] Therefore, no further evaluation of the RRS NPSH topic is required.

Consistent with the generic disposition discussed above, [[

]] flow rate and FW temperature and as described above, they are not changed by MELLLA+. [[

]]

The numerical values showing no significant changes in FW temperature and flow are presented in Table 1-2. Therefore, no further evaluation of the RRS NPSH topic is required.

The evaluation of the BSEP RRS NPSH is confirmed to be consistent with the generic disposition in the M+LTR.

3.6.3 Single Loop Operation

The generic disposition of the RRS-SLO topic in the M+LTR states that SLO is not allowed in the MELLLA+ operating domain.

Consistent with the generic disposition, SLO operation is not allowed in the MELLLA+ operating domain. BSEP SLO operational limitations are identified in TS 3.4.1, with reference to the power/flow map located in the COLR. Section 1.2.1 confirms that this operating region does not change for MELLLA+. Therefore, SLO is not allowed in the MELLLA+ operating range and is not affected by the MELLLA+ operating domain expansion.

The evaluation of the BSEP RRS SLO is confirmed to be consistent with the generic disposition in the M+LTR.

As required by M+LTR SER Limitation and Condition 12.5.a, BSEP will modify TS 3.4.1 to recognize that SLO operation is prohibited in the MELLLA+ operating domain. This information is presented in the Duke Energy MELLLA+ LAR package. As required by M+LTR SER Limitation and Condition 12.5.c, BSEP currently includes the power/flow map in its COLR and will continue to include the power/flow map in the COLR after the MELLLA+ operating domain expansion is approved.

3.6.4 Flow Mismatch

Flow mismatch is discussed in Section 4.3.6.

3.7 MAIN STEAM LINE FLOW RESTRICTORS

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Structural Integrity	Generic	Confirmed

The generic disposition of the MS Line Flow Restrictor Structural Integrity topic in the M+LTR states that there is no increase in MS flow as a result of the MELLLA+ operating domain expansion. [[ ]] and no further evaluation of this topic is required.

Consistent with the generic disposition, there is no increase in BSEP MS flow as a result of MELLLA+ operating domain expansion. The numerical values showing that MS flow does not increase as a result of MELLLA+ are presented in Table 1-2. [[ ]] and no further evaluation of this topic is required.

The evaluation of the BSEP MS line flow restrictors is confirmed to be consistent with the generic disposition in the M+LTR.

3.8 MAIN STEAM ISOLATION VALVES

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Isolation Performance	Generic	Confirmed
Valve Pressure Drop	Generic	Confirmed

The generic disposition of the MSIV topic in the M+LTR states that there is no increase in MS pressure, flow, or pressure drop as a result of the MELLLA+ operating domain expansion. [[ ]] and no further evaluation of this topic is required.

Consistent with the generic disposition, there is no increase in BSEP MS pressure, flow, or pressure drop as a result of MELLLA+ operating domain expansion. The MS pressure for the current licensed operating domain and in the MELLLA+ operating domain is 1,045 psia. The numerical values showing that MS flow does not increase as a result of MELLLA+ are presented in Table 1-2. The pressure drop across the MSIVs is 9.5 psid for the current licensed operating domain and is expected to be slightly less for the MELLLA+ operating domain due to the slight decrease in steam flow. [[ ]] and no further evaluation of this topic is required.

The evaluation of the BSEP MSIVs structural and operational effects is confirmed to be consistent with the generic disposition in the M+LTR.

3.9 REACTOR CORE ISOLATION COOLING

The RCIC system provides inventory makeup to the reactor vessel when the vessel is isolated from the normal high-pressure makeup systems. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
System Hardware	Generic	Confirmed
System Initiation	Generic	Confirmed

Net Positive Suction Head	Generic	Confirmed
Inventory Makeup Level Margin to Top of Active Fuel (TAF)	Addressed in Section 9.1.3	

3.9.1 System Hardware

The generic disposition of the RCIC System Hardware topic in the M+LTR states that there are no changes to the RCIC system hardware as a result of MELLLA+ operating domain expansion.

Consistent with the generic disposition, there are no changes to the BSEP RCIC system hardware as a result of MELLLA+.

The evaluation of the BSEP RCIC system hardware is confirmed to be consistent with the generic disposition in the M+LTR.

3.9.2 System Initiation

The generic disposition of the RCIC System Initiation topic in the M+LTR states that there are no changes to the normal reactor operating pressure, decay heat or SRV setpoints as a result of MELLLA+ operating domain expansion. As a result, the generic disposition in the M+LTR concludes [[

]] Provided the conditions of the generic disposition are met, no further evaluation of this topic is required.

Consistent with the generic disposition, there are no changes to the normal reactor operating pressure, decay heat or SRV setpoints as a result of MELLLA+ operating domain expansion. The BSEP reactor operating pressure for the current licensed operating domain and in the MELLLA+ operating domain remains unchanged. The numerical values showing that reactor operating pressure does not increase as a result of MELLLA+ are presented in Table 1-2. As described in Section 1.2.3, the generic disposition in the M+LTR concludes that there is no increase in decay heat as a result of MELLLA+ operating domain expansion. As discussed in Section 3.1.2, SRV setpoints are unchanged by MELLLA+ operating domain expansion. Therefore, for BSEP, [[

]] BSEP meets the conditions of the generic disposition. No further evaluation of this topic is required.

The evaluation of the BSEP RCIC system initiation is confirmed to be consistent with the generic disposition in the M+LTR.

3.9.3 Net Positive Suction Head

The generic disposition of the RCIC NPSH topic in the M+LTR states that the NPSH available for the RCIC pump [[

]] For ATWS (Section 9.3) and Fire Protection (Section 6.7), operation of the RCIC system at suppression pool temperatures greater than the operational limit may be accomplished by using the CST volume as the source of water. Therefore, the specified operational temperature limit for the process water does not change with MELLLA+. The NPSH required by the RCIC pump [[ ]] Therefore, no further evaluation is required for this topic.

Consistent with the generic disposition, for BSEP, there are no physical changes to the pump suction configuration. The BSEP RCIC flow rate for the current licensed operating domain and in the MELLLA+ operating domain is 400 gpm. Minimum atmospheric pressure in the suppression chamber and the CST for the current licensed operating domain and in the MELLLA+ operating domain is 14.7 psia. The RCIC system has the capability of using the CST or the suppression pool as a suction source at CLTP and MELLLA+ conditions. The CST provides additional head over that provided by the suppression pool for the RCIC pump, and the CST is not subject to the heat addition from reactor blowdown, which reduces suction head. Consequently, suppression pool suction is more limiting for RCIC NPSH.

The design basis function of the RCIC system is to provide coolant to the reactor vessel so that the core is not uncovered as a result of loss of off-site alternating current (AC) power or for a loss of FW (LOFW) event. Because MELLLA+ does not increase core power and therefore decay heat, the EPU evaluation is not affected and remains bounding for the MELLLA+ operating domain expansion.

The NPSH required by the BSEP RCIC pump [[ ]] Therefore, no further evaluation is required for this topic.

The evaluation of the BSEP RCIC NPSH is confirmed to be consistent with the generic disposition in the M+LTR.

3.9.4 Inventory Makeup Level Margin to TAF

The makeup capacity of RCIC is evaluated in Section 9.1.3.

The RCIC system maintains sufficient water inventory in the reactor to permit adequate core cooling following a reactor vessel isolation event accompanied by loss of coolant flow from the FW system. The system design injection rate is sufficient for compliance with the system limiting criteria to maintain the reactor water level above TAF at MELLLA+ conditions. The RCIC system is designed to pump water into the reactor vessel over a wide range of operating pressures.

For many plants, including BSEP, that elected to elevate the nominal low water level, LL3/L1, setpoint to compensate for postulated instrument level inaccuracies due to reference leg heating effects during LOCAs, compliance with the operational criteria for LL3/L1 setpoint margin is not achieved either for EPU or MELLLA+ conditions. The minimum sensed water level outside the shroud decreased with EPU, and the resultant level was not high enough to ensure avoidance of the LL3/Ll instrument setpoint for ADS timer initiation and MSIV closure activation.

Operator action to inhibit ADS actuation following transient events will preclude reactor depressurization, thus allowing the RCIC system to perform its design basis function. There is no change in these actions resulting from MELLLA+.

3.10 RESIDUAL HEAT REMOVAL SYSTEM

The RHR system is designed to restore and maintain the reactor coolant inventory following a LOCA and remove reactor decay heat following reactor shutdown for normal, transient, and accident conditions. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Low Pressure Coolant Injection Mode	Addressed in Section 4.2.4	
Suppression Pool and Containment Spray Cooling (CSC) Modes	Generic	Confirmed
Shutdown Cooling (SDC) Mode	Generic	Confirmed
Steam Condensing Mode	Not Applicable to BSEP	
Fuel Pool Cooling Assist	Addressed in Section 6.3.1	

The primary design parameters for the RHR system are the decay heat in the core and the amount of reactor heat discharged into the containment during a LOCA. The RHR system operates in various modes, depending on plant conditions. [[

]]

3.10.1 LPCI Mode

The LPCI mode, as it supports the LOCA response, is discussed in Section 4.2.4, Low Pressure Coolant Injection.

3.10.2 Suppression Pool and Containment Spray Cooling Modes

The generic disposition of the RHR-Suppression Pool and CSC Modes topic in the M+LTR describes that the SPC mode is manually initiated to maintain the containment pressure and suppression pool temperature within design limits following isolation transients (loss of off-site power (LOOP), MSIVC, ATWS, National Fire Protection Association (NFPA) 805, station blackout (SBO)) or a postulated LOCA. The CSC mode reduces the containment pressure and suppression pool water temperature following an accident where steam bypass of the preferred flow path to the suppression pool occurs. [[

]] The pool temperatures are decreased for the ATWS event as a result of the increase in the SLC System boron-10 enrichment to 92 atom % (Section 9.3.1).

Consistent with the generic disposition, [[
]] Therefore, no further evaluation is required for this topic.

The evaluation of the BSEP RHR-suppression pool and CSC modes is confirmed to be consistent with the generic disposition in the M+LTR.

3.10.3 Shutdown Cooling Mode

The generic disposition of the RHR-SDC Mode topic in the M+LTR describes that the SDC mode is designed to remove the sensible and decay heat from the reactor primary system during a normal reactor shutdown. This non safety-related mode allows the reactor to be cooled down within a certain time, so that the SDC mode of operation does not become a critical path during refueling operations. [[
]]

Consistent with the generic disposition, [[
]] Therefore, no further evaluation is required for this topic.

The evaluation of the BSEP RHR-SDC mode is confirmed to be consistent with the generic disposition in the M+LTR.

3.10.4 Steam Condensing Mode

The steam condensing mode is not applicable for BSEP.

3.10.5 Fuel Pool Cooling Assist Mode

The fuel pool cooling assist mode, using existing RHR heat removal capacity, provides supplemental fuel pool cooling in the event that the fuel pool heat load exceeds the capability of the fuel pool cooling and cleanup system. [[
]] Therefore, there is no effect on the fuel pool cooling assist mode.

3.11 REACTOR WATER CLEANUP SYSTEM

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
System Performance	Generic	Confirmed
Containment Isolation	Generic	Confirmed

3.11.1 System Performance

The generic disposition of the RWCU System Performance topic in the M+LTR describes that the MELLLA+ operating domain expansion does not change the pressure or fluid thermal conditions experienced by the RWCU system. Operation in the MELLLA+ operating domain does not increase the quantity of fission products, corrosion products, and other soluble and insoluble impurities in the reactor water. Reactor water chemistry is within fuel warranty and TS limits on effluent conductivity and particulate concentration, and thus, no changes will be made in water quality requirements.

Consistent with the generic disposition discussed above, for BSEP, there is no significant increase in the quantity of fission products, corrosion products, and other soluble and insoluble impurities in the reactor water (see Section 8.4). Consistent with the generic disposition discussed above, for BSEP, there is no significant change in the FW line temperature, pressure, or flow rate. FW line temperature for the current licensed operating domain and in the MELLLA+ operating domain is 431°F (upstream of the RWCU return). As shown in Table 1-2, the FW flow rate in the MELLLA+ operating domain decreases slightly from the flow rate in the current licensed operating domain. As discussed in Section 1.2, reactor pressure for the current licensed operating domain and in the MELLLA+ operating domain does not change. Therefore, FW system resistance and operating conditions do not change and the pressure at the RWCU/FW system interface does not change. As discussed in Sections 1.2 and 3.6, reactor and recirculation system parameters are bounded by or unchanged from CLTP conditions. Therefore there is no effect on RWCU inlet conditions due to MELLLA+. Because there is no change to the pressure or fluid thermal conditions experienced by the RWCU system, and because there is no significant increase in the quantity of fission products, corrosion products, and other soluble and insoluble impurities in the reactor water, the BSEP RWCU system performance is confirmed to be consistent with the generic disposition in the M+LTR. Therefore, no further evaluation of this topic is required.

The evaluation of the BSEP RWCU system performance is confirmed to be consistent with the generic disposition in the M+LTR.

3.11.2 Containment Isolation

The generic disposition of the RWCU Containment Isolation topic in the M+LTR describes that the RWCU system is a normally operating system with no safety-related functions other than containment isolation. [[

]] because there is no change in the FW line pressure, temperature, or flow rate.

Consistent with the generic disposition discussed above, for BSEP, there is no significant change in the FW line temperature, pressure, or flow rate. FW line temperature for the current licensed operating domain and in the MELLLA+ operating domain is 431°F (upstream of the RWCU return). As shown in Table 1-2, the maximum FW flow rate in the MELLLA+ operating domain decreases slightly from the maximum flow rate in the current licensed operating domain. As such, the FW flow rates in the MELLLA+ operating domain remain within the FW flow rates in the current licensed operating domain. As discussed in Section 1.2, reactor pressure for the current licensed operating domain and in the MELLLA+ operating domain does not change. Therefore, FW system resistance and operating conditions do not change and the pressure at the RWCU/FW system interface does not change for RWCU return lines. As discussed in Section 3.11.1 above, there is no change to RWCU inlet conditions. [[

]]

The evaluation of the BSEP RWCU containment isolation is confirmed to be consistent with the generic disposition in the M+LTR.

Table 3-1a BSEP Unit 1 Equivalent Margin Analysis – Plate Material

Equivalent Margin Analysis Plant Applicability Verification Form for BSEP Unit 1 60-Year License (54 EFPY)			
BWR/3-6 Plate			
Surveillance Plate USE (Heat C4487-1):			
%Cu	=	0.12	
Unirradiated USE	=	N/A	
1st Capsule Measured USE	=	N/A	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	9.5	(RG 1.99, Revision 2, Figure 2)
Limiting Beltline Plate USE (Heat B8496-1):			
%Cu	=	0.19	
54 EFPY 1/4T Fluence	=	2.35E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	20.5	(RG 1.99, Revision 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Revision 2, Position 2.2)
		20.5% ≤	[[ ]]
Therefore, the vessel plates are bounded by the BWRVIP-74-A Equivalent Margin Analysis			

Table 3-1b BSEP Unit 1 Equivalent Margin Analysis – Weld Material

Equivalent Margin Analysis Plant Applicability Verification Form for BSEP Unit 1 60-Year License (54 EFPY)			
BWR/2-6 Weld			
Surveillance Weld USE (Heat S3986):			
%Cu	=	0.055	
Unirradiated USE	=	N/A	
1st Capsule Measured USE	=	N/A	
1st Capsule Fluence	=	3.2E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	8.6	(RG 1.99, Revision 2, Figure 2)
Limiting Beltline Weld USE (Heat 1P4218):			
%Cu	=	0.06	
54 EFPY 1/4T Fluence	=	2.03E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	14.0	(RG 1.99, Revision 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Revision 2, Position 2.2)
		14.0% ≤	[[ ]]
Therefore, the vessel welds are bounded by the BWRVIP-74-A Equivalent Margin Analysis			

Table 3-1c BSEP Unit 2 Equivalent Margin Analysis – Plate Material

Equivalent Margin Analysis Plant Applicability Verification Form for BSEP Unit 2 60-Year License (54 EFPY)			
BWR/3-6 Plate			
Surveillance Plate USE (Heat C4489-1):			
%Cu	=	0.12	
Unirradiated USE	=	N/A	
1st Capsule Measured USE	=	N/A	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	10.0	(RG 1.99, Revision 2, Figure 2)
Limiting Beltline Plate USE (Heat C4500-2):			
%Cu	=	0.15	
54 EFPY 1/4T Fluence	=	1.89E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	16.5	(RG 1.99, Revision 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Revision 2, Position 2.2)
		16.5% ≤	[[ ]]
Therefore, the vessel plates are bounded by the BWRVIP-74-A Equivalent Margin Analysis			

Table 3-1d BSEP Unit 2 Equivalent Margin Analysis – Weld Material

Equivalent Margin Analysis Plant Applicability Verification Form for BSEP Unit 2 60-Year License (54 EFPY)			
BWR/2-6 Weld			
Surveillance Weld USE (Heat Unknown):			
%Cu	=	0.183	
Unirradiated USE	=	N/A	
1st Capsule Measured USE	=	N/A	
1st Capsule Fluence	=	4.06E+17 n/cm^2	
1st Capsule Measured % Decrease	=	N/A	(Charpy Curves)
1st Capsule RG 1.99 Predicted % Decrease	=	15.5	(RG 1.99, Revision 2, Figure 2)
Limiting Beltline Weld USE (Heat S3986):			
%Cu	=	[[ ]]	
54 EFPY 1/4T Fluence	=	1.56E+18 n/cm^2	
RG 1.99 Predicted % Decrease	=	13.0	(RG 1.99, Revision 2, Figure 2)
Adjusted % Decrease	=	N/A	(RG 1.99, Revision 2, Position 2.2)
		13.0% ≤	[[ ]]
Therefore, the vessel welds are bounded by the BWRVIP-74-A Equivalent Margin Analysis			

Table 3-2 BSEP USE – Nozzle Forging (54 EFPY)

Unit 1

Location	Heat	Initial Unirradiated USE (ft-lbs)	%Cu	54 EFPY 1/4T Fluence (n/cm^2)	% Decrease USE	54 EFPY USE (ft-lbs)
N16	[[				]]	59.5

Unit 2

Location	Heat	Initial Unirradiated USE (ft-lbs)	%Cu	54 EFPY 1/4T Fluence (n/cm^2)	% Decrease USE	54 EFPY USE (ft-lbs)
N16	[[				]]	59.5

Table 3-3a BSEP Unit 1 ART (54 EFPY) [3]

Component	Heat	% Cu	% Ni	CF	Initial RT_{NDT} °F	54 EFPY Peak Fluence n/cm^2	54 EFPY 1/4T Fluence n/cm^2	54 EFPY ΔRT_{NDT} °F	σ_I	σ_Δ	Margin °F	54 EFPY Shift °F	54 EFPY ART °F
PLANT-SPECIFIC CHEMISTRIES													
Plates:													
Lower Shell	C4535-2	0.12	0.58	83	34	2.59E+18	1.86E+18	45.9	0	17.0	34.0	79.9	113.9
	C4550-1	0.11	0.60	74	10	2.59E+18	1.86E+18	40.9	0	17.0	34.0	74.9	84.9
Lower-Intermediate Shell	C4487-1	0.12	0.56	82	10	3.27E+18	2.35E+18	49.9	0	17.0	34.0	83.9	93.9
	B8496-1	0.19	0.58	140	10	3.27E+18	2.35E+18	85.2	0	17.0	34.0	119.2	129.2
Upper-Intermediate Shell [1]	C4510-2	0.35	0.58	209.5	22	1.71E+17	1.23E+17	26.4	0	13.2	26.4	52.8	74.8
	C4515-2	0.35	0.53	203	10	1.71E+17	1.23E+17	25.6	0	12.8	25.6	51.2	61.2
Axial Welds:													
G1, G2	S3986	0.05	0.96	68	10	1.67E+18	1.20E+18	30.9	0	15.5	30.9	61.8	71.8
F1, F2	S3986	0.05	0.96	68	10	2.20E+18	1.58E+18	35.0	0	17.5	35.0	70.0	80.0
E1, E2	S3986	0.05	0.96	68	10	1.71E+17	1.23E+17	8.6	0	4.3	8.6	17.1	27.1
Circumferential Welds:													
EF	S3986	0.05	0.96	68	10	1.71E+17	1.23E+17	8.6	0	4.3	8.6	17.1	27.1
FG	1P4218	0.06	0.87	82	-50	2.82E+18	2.03E+18	47.0	0	23.5	47.0	93.9	43.9
Nozzles:													
N16A, N16B	[[												130.9
N16 Welds													-17.4
N16 Welds												]]	-17.4
BEST ESTIMATE CHEMISTRIES FROM BWRVIP-135 R3 (Reference 27)													
Weld	S3986	[[		79	10	2.20E+18	1.58E+18	40.7	0	20.3	40.7	81.3	91.3
Weld	1P4218		]]	79	-50	2.82E+18	2.03E+18	45.2	0	22.6	45.2	90.5	40.5
Integrated Surveillance Program from BWRVIP-135 R3 (Reference 27)													
Plate [2]	B0673-1												
Weld [2]	5P6756												

Notes:

[1] Copper content was not available; a conservative value was used.

[2] As defined in BWRVIP-135 R3, the plate and weld materials identified in the ISP as representative for BSEP are not contained in the BSEP vessel. Therefore, no calculation is required or provided.

[3] These calculations are based upon a vessel thickness of 5.496 inches.

Table 3-3b BSEP Unit 2 ART (54 EFPY) [3]

Component	Heat	% Cu	% Ni	CF	Initial RT_{NDT} °F	54 EFPY Peak Fluence n/cm^2	54 EFPY 1/4T Fluence n/cm^2	54 EFPY ΔRT_{NDT} °F	σ_I	σ_Δ	Margin °F	54 EFPY Shift °F	54 EFPY ART °F
PLANT-SPECIFIC CHEMISTRIES													
Plates:													
Lower Shell	C4500-2	0.15	0.54	107	10	2.63E+18	1.89E+18	59.6	0	17.0	34.0	93.6	103.6
	C4550-2	0.11	0.60	74	10	2.63E+18	1.89E+18	41.2	0	17.0	34.0	75.2	85.2
Lower-Intermediate Shell	C4489-1	0.12	0.60	83	10	3.33E+18	2.40E+18	50.9	0	17.0	34.0	84.9	94.9
	C4521-2	0.12	0.57	82	10	3.33E+18	2.40E+18	50.3	0	17.0	34.0	84.3	94.3
Upper-Intermediate Shell [1]	C4854-2	0.35	0.56	207	10	1.74E+17	1.25E+17	26.4	0	13.2	26.4	52.8	62.8
	C4862-2	0.35	0.58	209.5	10	1.74E+17	1.25E+17	26.7	0	13.4	26.7	53.5	63.5
Axial Welds:													
G1, G2	S3986	0.05	0.96	68	10	1.64E+18	1.18E+18	30.7	0	15.3	30.7	61.3	71.3
F1, F2	S3986	0.05	0.96	68	10	2.16E+18	1.56E+18	34.8	0	17.4	34.8	69.5	79.5
E1, E2	S3986	0.05	0.96	68	10	1.74E+17	1.25E+17	8.7	0	4.3	8.7	17.3	27.3
Circumferential Welds:													
EF	S3986	0.05	0.96	68	10	1.74E+17	1.25E+17	8.7	0	4.3	8.7	17.3	27.3
FG	3P4000	0.02	0.90	27	-50	2.89E+18	2.08E+18	15.6	0	7.8	15.6	31.3	-18.7
Nozzles:													
N16A, N16B	[[												123.3
N16 Welds													-28.4
N16 Welds												]]	-17.1
BEST ESTIMATE CHEMISTRIES FROM BWRVIP-135 R3 (Reference 27)													
Weld	S3986	[[		79	10	2.16E+18	1.56E+18	40.4	0	20.2	40.4	80.7	90.7
Weld	3P4000		]]	27	-50	2.89E+18	2.08E+18	15.6	0	7.8	15.6	31.3	-18.7
Integrated Surveillance Program FROM BWRVIP-135 R3 (Reference 27):													
Plate [2]	B0673-1												
Weld [2]	5P6756												

Notes:

[1] Copper content was not available; a conservative value was used.

[2] As defined in BWRVIP-135 R3, the plate and weld materials identified in the ISP as representative for BSEP are not contained in the BSEP vessel. Therefore, no calculation is required or provided.

[3] These calculations are based upon a vessel thickness of 5.466 inches.

Table 3-4a BSEP Axial Weld Failure Probability (54 EFPY)

Value	NRC BWRVIP-05 Supplement of SER "Mod 2"	BSEP Unit 1 54 EFPY	BSEP Unit 2 54 EFPY
Cu %	0.219	[[	
Ni %	0.996		]]
CF	232	79	79
Fluence (f) at clad/weld interface (10^{19} n/cm^2)	0.148	0.220	0.216
$RT_{NDT(U)}$ (°F)	-2	10	10
ΔRT_{NDT} w/o margin (°F) (See Note 3)	116	46.8	46.4
Mean RT_{NDT} (°F)	114	56.8	56.4
Failure Frequency (NRC)	5.02×10^{-6}	Note 2	Note 2

Notes:

[1] Not Used.

[2] Although a failure frequency has not been calculated, the fact that the BSEP values at the end of license are less than the 64 EFPY value provided by the NRC leads to the conclusion that the BSEP RPV conditional failure probability is bounded by the NRC analysis, consistent with the requirements defined in GL 98-05.

[3] $\Delta RT_{NDT} = CF * f^{(0.28 - 0.10 \log f)}$; where CF is the chemistry factor per Reference 20.

Table 3-4b BSEP Circumferential Weld Inspection Relief (54 EFPY)

Parameter	NRC Staff Assessment for 64 EFPY (Circ. Welds)	BSEP Unit 1		BSEP Unit 2	
	(Chicago Bridge and Iron (CB&I) RPV)	1P4218 (CB&I Vessel)	S3986 (CB&I Vessel)	3P4000 (CB&I Vessel)	S3986 (CB&I Vessel)
Cu %	0.10	0.06	[[		
Ni %	0.99	0.87			]]
CF	134.9	82	79	27	79
Fluence at clad/weld interface (10^{19} n/cm^2)	1.02	0.282	0.0171	0.289	0.0174
$RT_{NDT(U)}$ (°F)	-65	-50	10	-50	10
ΔRT_{NDT} w/o margin (°F) (See Note 3)	135.6	53.7	12.3	17.8	12.5
Mean RT_{NDT} (°F)	70.6	3.7	22.3	-32.2	22.5
P (F|E) NRC (See Note 1)	1.78E-05	(Note 2)	(Note 2)	(Note 2)	(Note 2)

Notes:

[1] P (F|E) stands for "Conditional Probability of Failure".

[2] Although a conditional failure probability has not been calculated, the fact that the BSEP values at the end of license are less than the 64 EFPY value provided by the NRC leads to the conclusion that the BSEP RPV conditional failure probability is bounded by the NRC analysis, consistent with the requirements defined in GL 98-05.

[3] $\Delta RT_{NDT} = CF * f^{(0.28 - 0.10 \log f)}$; where CF is the chemistry factor per Reference 20.

[4] The BSEP RPV beltline region contains two (2) circumferential welds.

4.0 ENGINEERED SAFETY FEATURES

This section addresses the evaluations in RG 1.70, Chapter 6 that are applicable to MELLLA+.

4.1 CONTAINMENT SYSTEM PERFORMANCE

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Short-Term Pressure and Temperature Response	Plant Specific	Acceptable
Long-Term Suppression Pool Temperature Response	Generic	Confirmed
Containment Dynamic Loads		
Loss of Coolant Accident Loads	Plant Specific	Acceptable
Subcompartment Pressurization	Plant Specific	Acceptable
Safety Relief Valve Loads		
SRV Containment Dynamic Loads	Generic	Confirmed
Safety Relief Valve Piping Loads	Generic	Confirmed
Containment Isolation	Generic	Confirmed
Generic Letter 89-10	Generic	Confirmed
Generic Letter 89-16	Generic	Confirmed
Generic Letter 95-07	Generic	Confirmed
Generic Letter 96-06	Generic	Confirmed

4.1.1 Short-Term Pressure and Temperature Response

According to Section 4.1.1 of the M+LTR (Reference 1), operation in the MELLLA+ range may change the break energy for the DBA recirculation suction line break (RSLB). The break energy is derived from the break flow rate and enthalpy. [[

]]

The plant-specific BSEP short-term RSLB containment temperature and pressure responses are affected by the change in break fluid enthalpy as a result of MELLLA+ operating domain expansion. The short-term RSLB analyses cases at MELLLA+ demonstrate that peak drywell temperature (292.3°F) from the short-term RSLB for the MELLLA+ operating domain is bounded by the CLTP results (293.0°F) reported in Reference 28, which remains below the design limit of 340°F. The peak short-term RSLB pressure (45.8 psig) for the MELLLA+ operating domain is bounded by peak pressure (46.4 psig) obtained for the CLTP RSLB reported in Reference 28 and is below the design limit of 62 psig. [[

]]

The BSEP plant-specific evaluation concludes that [[

]]

4.1.2 Long-Term Suppression Pool Cooling Temperature Response

The generic disposition of the long-term SPC temperature response in Section 4.1 of the M+LTR in Reference 1 states that [[

]]

Therefore, no further evaluation of this topic is required.

Consistent with the generic disposition in the M+LTR, the sensible and decay heat do not change as a result of MELLLA+ operating domain expansion. [[
]] No further evaluation of this topic is required.

The evaluation of the BSEP long-term suppression pool temperature response is confirmed to be consistent with the generic disposition in the M+LTR.

4.1.3 Containment Dynamic Loads

4.1.3.1 Loss-of-Coolant Accident Loads

As described in the M+LTR, a plant-specific evaluation is performed to determine the effect of MELLLA+ on the LOCA containment dynamic loads. Results from [[
]]
are used to evaluate the effect of the MELLLA+ operating domain expansion on LOCA containment dynamic loads. The LOCA dynamic loads include vent thrust, pool swell, CO and chugging for a Mark I plant like BSEP (Reference 29).

The generic load definition in Reference 29 and the BSEP plant unique load definition (PULD) in Reference 30 form the basis for BSEP containment loads. Plant specific values for pool swell and vent thrust loads were defined during the Mark I containment long-term program and provided in Reference 30. The evaluation for pool swell and vent thrust loads confirmed that the current plant specific load definition in Reference 30 remains bounding. CO and chugging have been defined generically for Mark I plants as part of the Mark I containment program and are described in detail in the Mark I Containment Program Load Definition Report in Reference 29. The Load Definition Report was reviewed and approved by the NRC in NUREG-0661 and NUREG-0661 Supplement 1 (References 10 and 31). The containment response conditions with MELLLA+ were determined to be within the range of test conditions used to define the CO and chugging loads.

<u>Vent Thrust Load</u>

Vent thrust loads are calculated using the equations documented in the Load Definition Report (Reference 29) at MELLLA+ conditions, based on the DBA-LOCA results obtained with the GEH M3CPT code.

[[

]] Therefore the current vent thrust load definitions remains applicable at MELLLA+ conditions for BSEP.

Pool Swell Loads

Pool swell describes the initial containment response following a LOCA. The BSEP plant specific pool swell load is defined in Reference 30 based on the results of the Quarter Scale Test Facility (QSTF) plant unique tests (Reference 32). The DBA event for pool swell for the Mark I containment is [[ ]] The liquid mass flow, which initially flows from the break, flashes to steam and pressurizes the drywell.

[[

]] Therefore the current pool swell load definition remains applicable at MELLLA+ conditions for BSEP.

Condensation Oscillation Loads

CO loads result from oscillation of the steam-water interface that forms at the vent exit during the region of vent high steam mass flow rate. The CO loads occur after pool swell. The basis for the Mark I CO load definition is the Load Definition Report in Reference 29. The Mark I CO load definition was developed from test data from Full Scale Test Facility (FSTF) tests (Reference 33) to simulate LOCA thermal-hydraulic conditions (i.e., [[ ]]). The tests are bounding for all US Mark I plants, including the BSEP, considering MELLLA+ conditions. Therefore, the current CO load definitions for the BSEP remain applicable at MELLLA+ conditions.

Chugging Loads

Chugging occurs subsequent to CO. [[

]] The design loads for the BSEP are in accordance with the Load Definition Report load definition (Reference 29) and are also based on the Reference 33 test data. The range of conditions used in the FSTF tests in Reference 33 was established to bound all Mark I plants for the submerged structure and pool boundary chugging loads. The chugging load definition thus represents an envelope of the data from the tests. The thermal-hydraulic conditions for these tests [[ ]] were selected to produce the maximum chugging amplitudes possible with a Mark I containment geometry. Therefore, the current chugging load definitions remain applicable at MELLLA+ conditions for BSEP.

The results of the plant-specific LOCA containment dynamic loads evaluation demonstrate that existing vent thrust, pool swell, CO and chugging load definitions remain bounding for operation in the MELLLA+ operating domain. Therefore, the LOCA containment dynamic loads defined for BSEP are not affected by the MELLLA+ operating domain expansion.

4.1.3.2 Subcompartment (Annulus) Pressurization

The MELLLA+ Annulus Pressurization loads are bounded by the MELLLA condition with Feedwater Temperature Reduction and its supporting evaluations. For the purpose of Annulus Pressurization Loads evaluation, Brunswick is considered an "Old Loads" plant, with limited plant specific commitments to evaluate two breaks per the original design basis and to install guard pipes. In 1980 Recirculation Guard Pipes were installed on the recirculation suction piping which forced the released mass and energy directly into the drywell. With this modification, all safety related components of the RPV, RPV supports, and reactor internals were evaluated to withstand a combination of Design Basis Earthquake (DBE) and Annulus Pressurization events (either recirculation or feed water piping), and normal loads without exceeding allowable stresses. Subsequent plant changes including Feedwater Heaters Out-of-Service, the stretch uprate to 105%, and Extended Power Uprate confirmed acceptable loads for the two analyzed breaks per the original analysis basis.

No change in annulus pressurization due to the two analyzed breaks, Feedwater and Recirculation line breaks, will result from implementation of MELLLA+ because the maximum reactor operating pressure, steam flow, and feed water flow are not increased. Further, MELLLA+ annulus pressurization loads are bounded by previous evaluations for the MELLLA domain while in Reduced Feedwater Temperature. Reduced feedwater temperature increases the subcooling within the feedwater and recirculation lines which increases the break flow rates and resultant loading. The reduced feedwater temperature operational enhancement is not allowed while operating in the MELLLA+ operating domain. Therefore, the MELLLA+ Annulus Pressurization loads are bounded by the MELLLA condition with Feedwater Temperature Reduction and its supporting evaluations. Because the MELLLA+ operating domain annulus pressurization is bound by the current licensed MELLLA condition with FWTR, no further evaluation of this topic is required.

The evaluation of the BSEP subcompartment (annulus) pressurization is determined to be acceptable for MELLLA+.

4.1.3.3 SRV Piping – Containment Dynamic Loads

The generic disposition of the piping SRV Loads topic in the M+LTR describes that because the sensible and decay heat do not change in the MELLLA+ operating domain and because the SRV setpoints do not change, the SRV loads do not change. Therefore, no further evaluation of this topic is required.

Consistent with the generic disposition in the M+LTR, the sensible and decay heat do not change as a result of MELLLA+ operating domain expansion. This response is discussed in Section 1.2.3. Also, there is no change to the BSEP SRV setpoints as a result of MELLLA+

operating domain expansion. This topic is discussed in Section 3.1.2. Therefore, there is no change to the BSEP SRV loads. No further evaluation of this topic is required.

The evaluation of the BSEP piping SRV loads is confirmed to be consistent with the generic disposition in the M+LTR.

4.1.3.4 SRV Containment Dynamic Loads

The basis for the M+LTR (Reference 1) generic SRV containment load disposition was confirmed to be applicable to BSEP.

Section 4.1 of the M+LTR (Reference 1) provides the following generic disposition for the effect of MELLLA+ on long-term suppression pool temperature response and SRV loads;

[[

]]

For the BSEP MELLLA+ project, the M+LTR generic disposition is applicable because there are no changes to reactor power, dome pressure or SRV setpoints.

The MELLLA+ generic disposition is applicable to both first and second (or subsequent) SRV actuation loads.

[[

]] SRV first actuation loads are unaffected by MELLLA+ implementation, and remain bounded by the existing load definition.

[[

]]

loads due to second SRV actuations are not affected by MELLLA+ for BSEP.

4.1.4 Containment Isolation

The generic disposition of the Containment Isolation topic in the M+LTR concludes that [[

]] then a plant-specific evaluation is required to demonstrate the adequacy of the containment isolation system.

Consistent with the generic disposition discussed above, [[

]] Therefore, no containment isolation system evaluations are required for BSEP.

The evaluation of the BSEP containment isolation system is confirmed to be consistent with the generic disposition in the M+LTR.

4.1.5 Generic Letter 89-10

The generic disposition of the Generic Letter (GL) 89-10 topic in the M+LTR concludes that, [[

]] then no changes to the GL 89-10 motor-operated valve (MOV) program are required.

Consistent with the generic disposition discussed above, [[

]] Sections 6.6 and 10.1 confirm that other parameters with the potential to affect the capability of safety-related motor-operated valves (MOVs), such as the ambient temperature profile are unchanged. For each of the assessed parameters, the values in the MELLLA+ operating domain are bounded by those in the BSEP current licensed operating domain. Therefore, a GL 89-10 MOV program evaluation is not required.

The evaluation of the BSEP GL 89-10 MOV program input is confirmed to be consistent with the generic disposition in the M+LTR.

4.1.6 Generic Letter 89-16

In response to Generic Letter 89–16, some plants including BSEP have installed a hardened wetwell vent system. One of the design requirements for the hardened wetwell vent is the ability to exhaust energy equivalent to 1% CLTP. Safety Communication SC 09-03 was reviewed for the interaction of acoustic and Annulus Pressurization (AP) loads and determined to be acceptable based on the fact that BSEP is an "Old Loads" plant and is not licensed to AP loads. [[

]] and a revised hardened vent analysis is not required.

4.1.7 Generic Letter 95-07

The generic disposition of the GL 95-07 "Pressure Locking and Thermal Binding of Safety-Related Power-Operated gate Valves" topic in the M+LTR concludes that, [[

]] then no GL 95-07 evaluation is required.

Consistent with the generic disposition discussed above, [[

]] Therefore, no GL 95-07 evaluation is required.

The evaluation of the BSEP GL 95-07 program is confirmed to be consistent with the generic disposition in the M+LTR.

4.1.8 Generic Letter 96-06

The generic disposition of the GL 96-06 "Assurance of Equipment Operability and Containment Integrity During Design-Basis Accident Conditions" topic in the M+LTR concludes that [[

]]

then no GL 96-06 evaluation is required.

Consistent with the generic disposition discussed above, [[

]] Therefore, no GL 96-06 evaluation is required.

The evaluation of the BSEP GL 96-06 program is confirmed to be consistent with the generic disposition in the M+LTR.

4.2 EMERGENCY CORE COOLING SYSTEMS

The ECCS includes HPCI, the CS system, the LPCI mode of the RHR system, and the ADS. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
High Pressure Coolant Injection	Generic	Confirmed
High Pressure Core Spray	Not Applicable to BSEP	
Core Spray	Generic	Confirmed
Low Pressure Coolant Injection Mode of the RHR System	Generic	Confirmed
Automatic Depressurization System	Generic	Confirmed
ECCS Net Positive Suction Head	Generic	Confirmed

4.2.1 High Pressure Coolant Injection

The generic disposition of the HPCI system in the M+LTR describes that the HPCI system is designed to spray water into the reactor vessel over a wide range of operating pressures. In the event of a small break LOCA that does not immediately depressurize the reactor vessel, the HPCI system provides reactor vessel coolant inventory makeup to maintain reactor water level and help depressurize the reactor vessel. This system also provides spray cooling for long-term core cooling after a LOCA. In addition, the HPCI system serves as a backup to the RCIC system to provide makeup water in the event of a LOFW flow transient. For the MELLLA+ operating domain expansion, there is no change in the reactor operating pressure, decay heat, and the SRV setpoints. [[

]] the generic disposition finds that no further evaluation of the HPCI system is required.

Consistent with the generic disposition, there is no change to the reactor pressure as a result of MELLLA+ operating domain expansion. The numerical values showing no increases in reactor operating pressure are presented in Table 1-2. The sensible and decay heat do not change as a result of MELLLA+ operating domain expansion. This response is discussed in Section 1.2.3. Also, there is no change to the BSEP SRV setpoints as a result of MELLLA+ operating domain expansion. This topic is discussed in Section 3.1.2. [[

]] Therefore, all criteria related to the generic disposition of the HPCI system are met, and no further evaluation of the HPCI system is required.

The evaluation of the BSEP HPCI system is confirmed to be consistent with the generic disposition in the M+LTR.

4.2.2 High Pressure Core Spray

The high pressure core spray system is not applicable to BSEP.

4.2.3 Core Spray

The generic disposition of the CS system in the M+LTR describes that the CS system is automatically initiated in the event of a LOCA. The primary purpose of the CS system is to provide reactor coolant makeup for a large break LOCA and for any small break LOCA after the reactor vessel has depressurized. It also provides spray cooling for long-term core cooling in the event of a LOCA. [[

]] Provided the above criteria are met, the generic disposition requires no further evaluation of the CS system for MELLLA+.

Consistent with the generic disposition, there is no change to the reactor pressure as a result of MELLLA+ operating domain expansion. The numerical values showing no increases in reactor operating pressure are presented in Table 1-2. [[

]] Therefore, all criteria related to the generic disposition of the CS system are met, and no further evaluation of the CS system is required. In the event of a design basis NFPA 805 event discussed in Section 6.7, the CS system injects water into the reactor vessel to restore inventory and maintain core cooling following vessel depressurization.

The evaluation of the BSEP CS system is confirmed to be consistent with the generic disposition in the M+LTR.

4.2.4 Low Pressure Coolant Injection

The generic disposition of the LPCI system in the M+LTR describes that the LPCI mode of the RHR system is automatically initiated in the event of a LOCA. The primary purpose of the LPCI mode is to provide reactor coolant makeup for a large break LOCA and for any small break LOCA after the reactor vessel has depressurized. [[

]] the generic disposition requires no further evaluation of the LPCI system for MELLLA+.

Consistent with the generic disposition, there is no change to the reactor pressure as a result of MELLLA+ operating domain expansion. The numerical values showing no increases in reactor operating pressure are presented in Table 1-2. [[

]] Therefore, all criteria related to the generic disposition of the LPCI system are met, and no further evaluation of the LPCI system is required.

The evaluation of the BSEP LPCI system is confirmed to be consistent with the generic disposition in the M+LTR.

4.2.5 Automatic Depressurization System

The generic disposition of the ADS in the M+LTR describes that the ADS uses SRVs to reduce the reactor pressure following a small break LOCA, when it is assumed that the high pressure systems have failed. This allows the CS and LPCI systems to inject coolant into the reactor vessel. [[

]] the generic disposition finds that no further evaluation of the ADS system is required.

[[

]] Therefore, all criteria related to the generic disposition of the ADS system are met, and no further evaluation of the ADS system is required.

The evaluation of the BSEP ADS is confirmed to be consistent with the generic disposition in the M+LTR.

4.2.6 ECCS Net Positive Suction Head

The generic disposition of the ECCS-NPSH Topic in the M+LTR describes that the MELLLA+ operating domain expansion does not result in an increase in the heat addition to the suppression pool following a LOCA, Station Blackout, or NFPA-805 event. [[ ]] There are no physical changes in the piping or system arrangement. There is no change in the operator actions to throttle the RHR and CS pumps.

Consistent with the generic disposition, there is no increase in the heat addition to the suppression pool following a LOCA, Station Blackout, or NFPA-805 event [see Sections 4.1.2, 9.3.2 and 6.7, respectively]. There are also no changes in the BSEP ECCS piping or system arrangement. There is no change in the operator actions to throttle the RHR and CS pumps, or the containment overpressure that is credited to ensure adequate NPSH. Long term post-LOCA NPSH concerns are not applicable to the HPCI system. The available NPSH and required NPSH for the HPCI pump are not changed for MELLLA+. Therefore, all criteria related to the generic disposition of ECCS-NPSH are met, and no further evaluation is required.

Consistent with the M+LTR SER Limitation and Conditions 12.23.9 and 12.23.10, a BSEP plant-specific evaluation of ECCS pump NPSH for ATWS was performed. For ATWS, section 9.3.1 shows there is no loss of NPSH margin with the implementation of MELLLA+. The modification to increase SLCS B10 enrichment to 92 atom % increases the rate that the neutron absorber (B10) is added to the reactor and lengthens the time to reach HCTL during Long Term ATWS (relative to MELLLA with 47 atom % B10). Faster B10 injection allows the reactor to reach shutdown conditions earlier following an ATWS thereby reducing the heat load on the suppression pool. Therefore, MELLLA+ has no negative impact on ECCS NPSH.

The suppression pool temperature and associated containment pressure following an ATWS does not reduce the NPSH available for the ECCS pumps nor is safety grade equipment adversely impacted.

The evaluation of ECCS NPSH for BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

4.3 EMERGENCY CORE COOLING SYSTEM PERFORMANCE

The BSEP ECCS is designed to provide protection against postulated LOCAs caused by ruptures in the primary system piping. The ECCS performance characteristics do not change for the MELLLA+ operating domain expansion. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Break Spectrum Response and Limiting Single Failure	Plant Specific	Acceptable
Local Cladding Oxidation	Plant Specific	Acceptable
Core Wide Metal Water Reaction	Plant Specific	Acceptable
Coolable Geometry	Plant Specific	Acceptable
Long Term Cooling	Plant Specific	Acceptable
Flow Mismatch Limits	Plant Specific	Acceptable

4.3.1 Break Spectrum Response and Limiting Single Failure

The break spectrum analysis is performed to identify the characteristics of the break that result in the highest peak cladding temperature (PCT). The analysis examines variation in the following parameters: break location, break type, break size, limiting ECCS single failure and axial power shape. Split breaks from 0.05 ft2 up to the cross sectional area of the recirculation pipes, as well as double-ended guillotine (DEG) breaks with discharge coefficients ranging from 0.6 to 1.0, are evaluated. This ensures the analysis meets the M+LTR SER Limitation and Condition 12.13 and 12.14 which require that a sufficient number of small breaks sizes are analyzed at rated EPU power to ensure that the peak PCT break size is identified. Details of the Brunswick ATRIUM 10XM break spectrum analysis for MELLLA+ operation are presented in Reference 62. It should be noted that the PCT results from the break spectrum analysis are used to determine the characteristics of the limiting break and do not necessarily reflect the licensing PCT. Even though the characteristics of the limiting break will not change with exposure or nuclear fuel design, the value of PCT calculated for any given set of break characteristics is dependent on exposure and power peaking. As a result, heatup analyses are performed to determine the PCT versus exposure for each nuclear fuel design in the core using the boundary conditions determined for the limiting break. The maximum or licensing PCT is documented in the LOCA-ECCS MAPLHGR report (Reference 66).

The same LOCA analysis methodology (Reference 69) is used for all break sizes in the break spectrum analysis. As a result, sub-categories of small and large breaks are not used. {{

}}

The ATRIUM 10XM LOCA break spectrum analyses were performed for initial conditions of 102%P/ {{ }}, 102%P/85%F and {{ }}

{{

}} This is consistent with the discussion presented in the M+ LTR SER Section 4.3.1.3 and complies with the M+ LTR Limitation and Condition 12.10.a. {{

}} This meets the M+LTR SER Limitation and Condition 12.10.b. The off-rated set down is applied using the LHGRFACf multipliers which are included in the core monitoring system, thereby meeting the M+LTR SER Limitation and Condition 12.10.d requirements.

A summary of the two-loop operation (TLO) ATRIUM 10XM break spectrum analysis results is presented in Table 4-1. Based on the break spectrum results, the limiting break characteristics are identified below.

Limiting LOCA Break Characteristics	
Location	Recirculation discharge pipe
Type / size	Split / 3.6 ft^2
Single failure	Low-pressure coolant injection valve (SF-LPCI)
Axial power shape	Top-Peaked
Limiting power/flow state point	102%P/{{ }}

As described in Reference 62, the MAPLHGR multiplier for single-loop operation (SLO) is 0.80 for ATRIUM 10XM fuel. Applying this multiplier to the Reference 66 MAPLHGR limits ensures a LOCA from SLO is less limiting than the limiting LOCA event from two-loop operation. The extension of the power/flow map to MELLLA+ does not impact SLO, as SLO is not allowed in the MELLLA+ operating domain. The limiting break supports operating with all the operational enhancements described in Section 1.2.3.

Effect of MELLLA+ at Rated Power

The rated power PCT results presented in Table 4-1 show that decreasing the flow to the minimum core flow (85% of rated) results in a {{ }} While the lower core flow can result in earlier critical heat flux (CHF) and a higher PCT, {{ }}

Effect of MELLLA+ at Less Than Rated Power

The {{ }} results in Table 4-1 show that they are non-limiting; bound by the limiting results at {{ }}. While the lower core flow can result in earlier CHF and a higher PCT, {{ }}

Effect of Axial Power Shape

As required by M+LTR SER Limitation and Condition 12.11 and Methods LTR SER Limitation and Condition 9.7 (Reference 2), for MELLLA+ applications, the LOCA break spectrum analyses are required to include top-peaked and mid-peaked power shapes to establish the MAPLHGR limits and determine the PCT. Both top-peaked and mid-peaked axial power shapes were considered in the ATRIUM 10XM MELLLA+ LOCA break spectrum analyses for MELLLA+ operation. The boundary conditions from the limiting break were used in the follow-on LOCA-ECCS MAPLHGR analysis to determine the licensing PCT. A comparison of the more limiting top-peaked and mid-peak axial power shape results is presented in Table 4-1. More details are presented in Reference 62.

Reference 66 reports a licensing PCT of 1923°F for the ATRIUM 10XM fuel to support operation in the Brunswick power/flow operating domain – including MELLLA+ operation.

4.3.2 Local Cladding Oxidation

Reference 66 presents the results of the ATRIUM 10XM local cladding oxidation analysis. The maximum local cladding oxidation is 1.23%, much less than the 10 CFR 50.46 requirement of less than 17%.

4.3.3 Core Wide Metal Water Reaction

Reference 66 presents the results of the ATRIUM 10XM core wide metal water reaction analysis. The maximum core wide metal water reaction is less than 0.56% of the hypothetical amount that would be generated if all the metal in the cladding cylinders surrounding the fuel, except the cladding surrounding the plenum volume, were to react. The result is less than the 10 CFR 50.46 requirement of less than 1%.

4.3.4 Coolable Geometry

Demonstration that PCT, local cladding oxidation and core wide metal water reaction criteria are met ensures that a coolable geometry maintained.

4.3.5 Long-Term Cooling

Long-term coolability addresses the issue of reflooding the core and maintaining a water level adequate to cool the core and remove decay heat for an extended time period following a LOCA. For non-recirculation line breaks, the core can be reflooded to the top of the active fuel and be adequately cooled indefinitely. For recirculation line breaks, the core will initially remain covered following reflood due to the static head provided by the water filling the jet pumps to a level of approximately two-thirds core height. Eventually, the heat flux in the core will not be adequate to maintain a two-phase water level over the entire length of the core. Beyond this time, the upper third of the core will remain wetted and adequately cooled by core spray. Maintaining water level at two-thirds core height with one core spray system operating is sufficient to maintain long-term coolability. See Reference 62 for additional details.

4.3.6 Flow Mismatch Limits

The Brunswick ATRIUM 10XM MELLLA+ break spectrum analyses {{

}}

4.3.7 Other Limitations Related to ECCS System Performance

Reference 69 presents the AREVA LOCA-ECCS methodology used in the Brunswick MELLLA+ LOCA analysis. ANP-3108P, "Applicability of AREVA BWR Methods to Brunswick Extended Power/Flow Operation Domain" (Reference 60) includes a review of the application of the AREVA LOCA-ECCS methodology to support MELLLA+ operation at BSEP. Appendix E of Reference 60 discusses some extensions to the Reference 69 methodology in three areas: radiation view factors, {{ }} and thermal conductivity degradation. The application of the LOCA-ECCS methodology for Brunswick MELLLA+ ATRIUM 10XM LOCA analysis included the application of the Reference 69 methodology as extended by the discussion in Reference 60.

4.4 MAIN CONTROL ROOM ATMOSPHERE CONTROL SYSTEM

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Iodine Intake	Generic	Confirmed

The generic disposition of the Iodine Intake topic in the M+LTR describes that the MELLLA+ operating domain expansion does not result in a change in the source terms or the release rates (Section 8.0). [[

]] Provided this criterion is met, no further evaluation of the main control room (MCR) atmosphere control system is required.

Consistent with the generic disposition presented above, there is no change in the BSEP source term or release rates as a result of MELLLA+ operating domain expansion. This topic is discussed in Section 8.0. [[

]] No further evaluation of the MCR atmosphere control system is required.

The evaluation of the MCR atmosphere control system at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

4.5 STANDBY GAS TREATMENT SYSTEM

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Flow Capacity	Generic	Confirmed
Iodine Removal Capability	Generic	Confirmed

4.5.1 Flow Capacity

The generic disposition of the SGTS Flow Capacity topic in the M+LTR describes that the SGTS is designed to maintain secondary containment at a negative pressure and to filter the exhaust air for removal of fission products potentially present during abnormal conditions. By limiting the release of airborne particulates and halogens, the SGTS limits off-site dose following a postulated DBA. [[

]] and no further evaluation of the SGTS flow is required.

Consistent with the generic disposition discussed above, the design flow capacity of the BSEP SGTS was selected to maintain the secondary containment at the required negative pressure to minimize the potential for exfiltration of air from the Reactor Building. [[

]] and no further evaluation is required.

The evaluation of the SGTS flow at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

4.5.2 Iodine Removal Capacity

The generic disposition of the SGTS Iodine Removal Capacity topic in the M+LTR describes that the SGTS is designed to maintain secondary containment at a negative pressure and to filter the exhaust air for removal of fission products potentially present during abnormal conditions. By limiting the release of airborne particulates and halogens, the SGTS limits off-site dose following a postulated DBA. [[

]]

Consistent with the generic disposition discussed above, the core fission product inventory is not changed by the MELLLA+ operating domain expansion (Section 8.3), and coolant activity levels are defined by TSs and do not change, so no change occurs in the SGTS adsorber iodine loading, decay heat rates, or iodine removal efficiency. [[ ]] No further evaluation of this topic is required.

The evaluation of the SGTS iodine removal capacity at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

4.6 MAIN STEAM ISOLATION VALVE LEAKAGE CONTROL SYSTEM

BSEP does not use a MSIV leakage control system.

4.7 POST-LOCA COMBUSTIBLE GAS CONTROL SYSTEM

The topics addressed in this evaluation are:

Topic	**M+LTR Disposition**	**BSEP Result**
Post-LOCA Combustible Gas Control	Generic	Plant Specific Evaluation Acceptable

10 CFR 50.44 was revised in September 2003 and no longer defines a design basis LOCA hydrogen release and eliminates the requirements for hydrogen control systems to mitigate such releases. BSEP License Amendment Numbers 234 and 261 for Units 1 and 2 respectively, issued in 2005 (Reference 34), eliminated the requirements for the hydrogen/oxygen monitors and BSEP License Amendment Numbers 252 and 280 for Units 1 and 2 respectively, issued in 2009 (Reference 35), eliminated the requirements for the containment atmospheric dilution system. Duke Energy made commitments to maintain the hydrogen and oxygen monitoring systems capable of diagnosing beyond DBA events.

However, as this system is no longer required to be maintained as a post-LOCA combustible gas control system, no further evaluation is necessary relative to the MELLLA+ operating domain expansion. The generic disposition of the system (under the M+LTR) is no longer applicable.

The BSEP-specific evaluation concludes that the post-LOCA combustible gas control system is acceptable.

Table 4-1 Summary of TLO Recirculation Line Break Results Highest PCT Cases

{{

}}

5.0 INSTRUMENTATION AND CONTROL

This section addresses the evaluations that are applicable to MELLLA+.

5.1 NSSS MONITORING AND CONTROL

Changes in process parameters resulting from the MELLLA+ operating domain expansion and their effects on instrument performance are evaluated in the following sections. The effect of the MELLLA+ operating domain expansion on the TSs is addressed in Section 11 and the effect on the allowable values (AVs) in Section 5.3. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Average Power Range, Intermediate Range, and Source Range Monitors	Generic	Confirmed
Local Power Range Monitors	Generic	Confirmed
Rod Block Monitor	Generic	Confirmed
Rod Worth Minimizer	Generic	Confirmed
Traversing Incore Probes	Plant Specific	Acceptable

5.1.1 Average Power Range, Intermediate Range, and Source Range Monitors

The generic disposition of Average Power Range Monitors (APRMs), IRMs, and Source Range Monitors (SRMs) topic in the M+LTR describes that the APRM output signals are calibrated to read 100% at the CLTP. [[

]] Using normal plant surveillance procedures, the IRMs may be adjusted to ensure adequate overlap with the SRMs and APRMs. Therefore, no further evaluation of the APRMs, IRMs, or SRMs is required for MELLLA+.

Consistent with the generic disposition discussed above, there is no change in BSEP core power as a result of MELLLA+ operating domain expansion. [[

]] The APRMs, IRMs, and SRMs are installed at BSEP in accordance with the requirements established by the GEH design specifications. BSEP uses normal plant procedures to adjust the IRMs to ensure adequate overlap with the SRMs and APRMs. Therefore, no further evaluation is required.

The evaluation of APRMs, IRMs, and SRMs at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

5.1.2 Local Power Range Monitors

The generic disposition of the LPRM topic in the M+LTR describes that there is no change in the neutron flux experienced by the LPRMs resulting from the MELLLA+ operating domain expansion. [[

]] No further evaluation of these topics is required for MELLLA+.

Consistent with the generic disposition discussed above, there is no change in the neutron flux experienced by the BSEP LPRMs resulting from the MELLLA+ operating domain expansion. The [[

]] The LPRMs are installed at BSEP in accordance with the requirements established by the GEH design specifications. No further evaluation of these topics is required for MELLLA+.

The evaluation of LPRMs at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

5.1.3 Rod Block Monitors

The generic disposition of the Rod Block Monitor (RBM) topic in the M+LTR describes that the RBM uses LPRM instrumentation inputs that are combined and referenced to an APRM channel. [[

]]

Consistent with the generic disposition discussed above, and as described in Sections 5.1.1 and 5.1.2, the [[

]] No further evaluation of these topics is required for MELLLA+.

Section 9.1.1 evaluates the adequacy of the generic RBM setpoints.

The evaluation of RBM at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

5.1.4 Rod Worth Minimizer

The generic disposition of the RWM Topic in the M+LTR describes that the function of the RWM is to support the operator by enforcing rod patterns until reactor power has reached appropriate levels. The RWM functions to limit the local power in the core to control the effects of the postulated Control Rod Drop Accident (CRDA) at low power. The RWM precludes continuous control rod withdrawal errors during reactor startup by providing appropriate rod block signals to the Reactor Manual Control System (RMCS) rod block circuitry when an out-of-sequence rod is selected for withdrawal. [[

]] Therefore, no further evaluation is required.

Consistent with the generic disposition discussed above, the BSEP RWM supports the operator by enforcing rod patterns until reactor power has reached appropriate levels. [[

]] Therefore, no further evaluation is required.

The evaluation of the RWM system at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

5.1.5 Traversing Incore Probes

The generic disposition of the Traversing Incore Probes (TIPs) topic in the M+LTR describes that there is no change in the neutron flux experienced by the TIPs resulting from the MELLLA+ operating domain expansion. [[ ]] No further evaluation of these topics is required for MELLLA+.

Consistent with the generic disposition discussed above, there is no change in the neutron flux experienced by the BSEP TIPs resulting from the MELLLA+ operating domain expansion. [[ ]] The TIPs are installed at BSEP in accordance with the requirements established by the GEH design specifications. No further evaluation of these topics is required for MELLLA+.

The evaluation of TIPs at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

In accordance with Methods LTR SER Limitation and Condition 9.17 and M+LTR SER Limitation and Condition 12.15, for BSEP, the predicted bypass void fraction at the D-Level LPRMs is less than the [[ ]] design requirement. The RSAR (SRLR equivalent) will validate that the power distribution in the core is achieved while maintaining individual fuel bundles within the allowable thermal limits as defined in the COLR. When moving down and left on the MELLLA+ upper boundary, the hot channel exit void in the bypass region increases. The hot channel exit void in the bypass region exceeds [[ ]] at the 77.6% of CLTP / 55.0% of flow point as shown below.

Statepoint on Power / Flow Map	Core Thermal Power (%CLTP)	Core Flow (%rated)	Hot Channel Void Fraction in Bypass Region at Core Exit (MICROBURN-B2)	Hot Channel Void Fraction in Bypass Region at TIP Exit (MICROBURN-B2)	Hot Channel Void Fraction in Bypass Region at Instrumentation D-Level [1] (MICROBURN-B2)
"D"	100.0	98.9	0.069	0.029	0.0033
"N"	100.0	85	0.071	0.023	0.0029
"M"	77.6	55	0.085	0.019	0.0028
"L"	68.4	55	0.067	0.015	0.0018

Note 1: There is no bypass voiding at LPRM levels A, B, or C.

Since BSEP utilizes gamma TIPS vs thermal TIPs, bypass voiding above the D-level LPRMs in excess of [[ ]] is not an issue because gamma TIPs are less sensitive to core voiding. In addition, it has been confirmed that for all instrument locations, the bypass void at axial node 24 and below is less than the limit specified in M+LTR SER Limitation and Condition 12.15 for BSEP. Therefore, operator actions and procedures that mitigate the effect of bypass voiding on the thermal TIPs and the core simulator used to monitor the fuel performance are not required.

5.2 BOP MONITORING AND CONTROL

Operation of the plant in the MELLLA+ operating domain has no effect on the BOP system instrumentation and control devices. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Pressure Control System	Generic	Confirmed
Turbine Steam Bypass System (Normal Operation)	Generic	Confirmed
Turbine Steam Bypass System (Safety Analysis)	Generic	Confirmed
Feedwater Control System (Normal Operation)	Generic	Confirmed
Feedwater Control System (Safety Analysis)	Generic	Confirmed
Leak Detection System	Generic	Confirmed

5.2.1 Pressure Control System

The generic disposition of the Pressure Control System topic in the M+LTR describes that [[

]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

Consistent with the generic disposition discussed above, for BSEP, there are no increases in reactor operating pressure or MS flow rate. The numerical values showing no increases in reactor operating pressure or MS flow rate are presented in Table 1-2. The system dynamic characteristics of the BSEP pressure control system are not changed. [[

]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

The evaluation of the BSEP pressure control system is confirmed to be consistent with the generic disposition in the M+LTR.

5.2.2 Turbine Steam Bypass System (Normal Operation)

The generic disposition of the Turbine Steam Bypass System (Normal Operation) topic in the M+LTR describes that [[

]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

Consistent with the generic disposition discussed above, for BSEP, there are no increases in reactor operating pressure or MS flow rates. The numerical values showing no increases in reactor operating pressure or MS flow rate are presented in Table 1-2. The system dynamic characteristics of the BSEP turbine steam bypass system under normal operation are not changed. [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

The evaluation of the BSEP turbine steam bypass system under normal operation is confirmed to be consistent with the generic disposition in the M+LTR.

5.2.3 Turbine Steam Bypass System (Safety Analysis)

The generic disposition of the Turbine Steam Bypass System (Safety Analysis) topic in the M+LTR describes that [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

Consistent with the generic disposition discussed above, for BSEP, there are no increases in reactor operating pressure or MS flow rate. The numerical values showing no increases in reactor operating pressure or MS flow rate are presented in Table 1-2. The system dynamic characteristics of the BSEP turbine steam bypass system in safety analysis conditions are not changed. [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

The evaluation of the BSEP turbine steam bypass system (safety analysis) is confirmed to be consistent with the generic disposition in the M+LTR.

5.2.4 Feedwater Control System (Normal Operation)

The generic disposition of the FWCS (Normal Operation) topic in the M+LTR describes that [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

Consistent with the generic disposition discussed above, for BSEP, there are no increases in reactor operating pressure, MS or FW flow rates. The numerical values showing no increases in reactor operating pressure, MS or FW flow rates are presented in Table 1-2. The system dynamic characteristics of the BSEP FWCS under normal operation are not changed. [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

The evaluation of the BSEP FWCS under normal operation is confirmed to be consistent with the generic disposition in the M+LTR.

5.2.5 Feedwater Control System (Safety Analysis)

The generic disposition of the FWCS (Safety Analysis) topic in the M+LTR describes that [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

Consistent with the generic disposition discussed above, for BSEP, there are no increases in reactor operating pressure, MS or FW flow rates. The numerical values showing no increases in reactor operating pressure, MS or FW flow rates are presented in Table 1-2. The system dynamic characteristics of the BSEP FWCS in safety analysis conditions are not changed. [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

The evaluation of the BSEP FWCS (safety analysis) is confirmed to be consistent with the generic disposition in the M+LTR.

5.2.6 Leak Detection System

The generic disposition of the Leak Detection System topic in the M+LTR describes that [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

Consistent with the generic disposition discussed above, for BSEP, there are no increases in reactor operating pressure, MS or FW flow rates. In addition, RWCU, RHR, HPCI and RCIC pressures, temperatures, and flows are also unchanged. The numerical values showing no increases in reactor operating pressure, MS or FW flow rates are presented in Table 1-2. Therefore, the system dynamic characteristics of the BSEP leak detection system are not changed. [[ ]] Therefore, no further evaluation of this system is required as a result of MELLLA+.

The evaluation of the BSEP leak detection system is confirmed to be consistent with the generic disposition in the M+LTR.

5.3 TECHNICAL SPECIFICATION INSTRUMENT SETPOINTS

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
APRM Flow-Biased Scram	Plant Specific	Acceptable
Rod Block Monitor	Generic	Confirmed

5.3.1 APRM Flow-Biased Scram

The MELLLA+ APRM simulated thermal power (STP) scram AL line (also referred to as the APRM flow-biased scram AL line) is established to [[

]]

The MELLLA+ APRM STP High TLO AL expression for the scram is:

$$AL_{M+SCRAM} = 0.61\ W_d + 66.6\%$$

SLO is not applicable to the MELLLA+ operating domain as discussed in Section 3.6.3. Therefore, the SLO setpoints are unchanged.

The evaluation of APRM STP scram setpoints is consistent with the methods described for plant-specific evaluations of this topic in the M+LTR. The ARPM STP scram setpoints for the BSEP plant-specific evaluation are therefore acceptable.

5.3.2 Rod Block Monitor

The generic disposition of the RBM topic in the M+LTR describes that the RBM setpoints are established to mitigate the rod withdrawal error (RWE) event during power operation.

For plants with APRM / RBM / TSs (ARTS) RBM systems, [[

]]

Therefore, no further evaluation of the RBM TS values is required as a result of MELLLA+.

Consistent with the generic disposition discussed above, for BSEP, there is no change in reactor power level as a result of MELLLA+ operating domain expansion. BSEP has an ARTS RBM system. [[

]] Therefore, no further evaluation of the RBM TS values is required as a result of MELLLA+.

The evaluation of the BSEP RBM TS setpoints is confirmed to be consistent with the generic disposition in the M+LTR.

6.0 ELECTRICAL POWER AND AUXILIARY SYSTEMS

This section addresses the evaluations that are applicable to MELLLA+. Because there is no change in power output, most of the topics in this section are unaffected by the MELLLA+ operating domain expansion.

Switchyard and transmission system hardware changes are not required to support MELLLA+ operating domain expansion.

6.1 AC Power

The alternating current (AC) power supply includes both off-site and on-site power. The on-site power distribution system consists of transformers, buses, and switchgear. AC power to the distribution system is provided from the transmission system or from on-site Diesel Generators. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
AC Power (Normal or Degraded Voltage)	Generic	Confirmed

The generic disposition of the AC Power (Normal or Degraded Voltage) topic in the M+LTR describes that there is no change in the thermal power from the reactor or the electrical output from the station that results from the MELLLA+ operating domain expansion. [[

]] No further evaluation of the AC Power system is required.

Consistent with the generic disposition presented above, there is no change in the BSEP reactor thermal power or the electrical output from the station that results from the MELLLA+ operating domain expansion. [[

]] No further evaluation of the AC Power system is required.

Diesel generator loading is unaffected by operating in the MELLLA+ operating domain. No further evaluation of the Diesel Generator system is required.

The evaluation of the AC Power system at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.2 Direct Current (DC) Power

The direct current (DC) power distribution system provides control and motive power for various systems/components within the plant. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
DC Power	Generic	Confirmed

The generic disposition of the DC Power topic in the M+LTR describes that the MELLLA+ operating domain expansion does not change system requirements for control or motive power loads. [[ ]] Therefore, no further evaluation of this topic is required.

Consistent with the generic disposition presented above, [[ ]] as a result of MELLLA+ operating domain expansion. The MELLLA+ operating domain expansion does not change system requirements for control or motive power loads. Therefore, no further evaluation of the DC Power system is required.

The evaluation of the DC Power system at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.3 FUEL POOL

The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Fuel Pool Cooling	Generic	Confirmed
Crud Activity and Corrosion Products	Generic	Confirmed
Radiation Levels	Generic	Confirmed
Fuel Racks	Generic	Confirmed

6.3.1 Fuel Pool Cooling

The generic disposition of the Fuel Pool Cooling topic in the M+LTR describes that the MELLLA+ operating domain expansion does not increase the core power level. [[ ]] No further evaluation of the fuel pool cooling systems are required for MELLLA+ operating domain expansion.

Consistent with the generic disposition presented above, BSEP reactor power level does not increase as a result of MELLLA+ operating domain expansion. [[ ]] No further evaluation of the BSEP fuel pool cooling systems are required for MELLLA+ operating domain expansion.

The evaluation of the fuel pool cooling systems at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.3.2 Crud Activity and Corrosion Products

The generic disposition of the Spent Fuel Pool Crud and Corrosion Products topic in the M+LTR describes that [[

]] No further evaluation of the crud and corrosion products in the spent fuel pools is required for MELLLA+ operating domain expansion.

Consistent with the generic disposition presented above, [[

]] Therefore, no further evaluation of the crud and corrosion products in the spent fuel pools is required for the BSEP MELLLA+ operating domain expansion.

The evaluation of the crud and corrosion products in the spent fuel pools at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.3.3 Radiation Levels

The generic disposition of the Spent Fuel Pool Radiation Levels topic in the M+LTR describes that [[

]] No further evaluation of the radiation levels in the spent fuel pools is required for MELLLA+ operating domain expansion.

Consistent with the generic disposition presented above, [[

]] Therefore, no further evaluation of the radiation levels in the spent fuel pools is required for the BSEP MELLLA+ operating domain expansion.

The evaluation of the radiation levels in the spent fuel pools at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.3.4 Fuel Racks

The generic disposition of the Fuel Rack topic in the M+LTR describes that the MELLLA+ operating domain expansion does not increase the core power level. [[

]] No further evaluation of the fuel racks is required for MELLLA+ operating domain expansion.

Consistent with the generic disposition presented above, the MELLLA+ operating domain expansion does not increase the BSEP core power level. [[

]] No further evaluation of the fuel racks is required for MELLLA+ operating domain expansion.

The evaluation of the fuel racks at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.3.4.1 New and Spent Fuel Storage Criticality Review

ATRIUM 10XM is the current fuel design and is the design that will continue to be loaded for future MELLLA+ EPFOD operation at BSEP. No changes are required to the fuel design for future operation in this expanded operating domain.

BSEP has a new fuel storage vault (NFSV) that can be used to store fresh fuel assemblies prior to in-reactor operation. A criticality safety analysis (CSA) is documented in ANP-2962P (Reference 71) that supports storage of the ATRIUM 10XM fuel design in the NFSV. ATRIUM 10XM fuel stored in the NFSV must meet the criticality storage requirements provided in Table

2.1 of ANP-2962P. MELLLA+ EPFOD operation does not impact this CSA since exposed fuel cannot be stored in the NFSV. Consequently, the ANP-2962P CSA remains applicable for future BSEP MELLLA+ EPFOD bundle designs.

The BSEP spent fuel storage pool (SFSP) CSA for ATRIUM 10XM fuel is documented in ANP-2955P (Reference 72). ATRIUM 10XM fuel stored in the SFSP must meet the criticality storage requirements provided in Table 2.1 of this report. The ATRIUM 10XM SFSP CSA documented in ANP-2955P follows the intent[4] of the NRC interim staff guidance document for SFSP criticality safety analyses, DSS-ISG-2010-01 Revision 0 (Reference 73). A number of sensitivities were performed and are documented in Section 6 of the ANP-2955P CSA that were used to ensure that the original CSA was based upon limiting lattice reactivity values for a range of operational conditions. These sensitivities include impact of power density, in-core depletion fuel temperature, controlled depletion, and void history.

The assumed void history represents the greatest potential change with implementation of the MELLLA+ EPFOD due to the higher core average void fraction when operating at the lower flow conditions. Figure 6.4 of ANP-2955P shows the results of a sensitivity evaluation with respect to in-core depletion void history and its effect on the in-rack lattice k-infinity. The maximum in-rack reactivity condition from this sensitivity was utilized in establishing the reference bounding lattices used in the CSA.

The control density assumed in the in-core depletion can also be potentially impacted with the implementation of MELLLA+ EPFOD. The increase in core average voids may make it necessary to operate with a lower control rod density in order to compensate for the reduction in reactivity due to the decrease in moderator. Table 6.7 of ANP-2955P provides the results of a sensitivity in which the in-rack reactivity is compared for cases assuming both controlled and uncontrolled in-core depletion. The uncontrolled depletion results were shown to result in the higher in-rack k-infinities. The CSA was consequently based upon uncontrolled in-core depletions which remain bounding for MELLLA+ EPFOD operation.

The core power density and assumed depletion fuel temperatures are dependent upon power level. The original SFSP CSA was performed to support BSEP operating at EPU conditions and there is no change in the power level with the implementation of the MELLLA+ EPFOD. The SFSP CSA sensitivities included the impact of variations in power density of ± 50% as well as sensitivity to variations in fuel temperature of ± 100°F. Furthermore, the original sensitivity analyses included the impact of variations in void history.

Based upon the above, the SFSP CSA documented in ANP-2955 remains valid to support the storage of fuel operated in the MELLLA+ EFPOD extension.

[4] The ANP-2955P SFSP CSA (Reference 72) was issued prior to the issuance of the final staff guidance document (Reference 73). However, this CSA followed the guidance available in pre-release draft versions of the staff guidance document such as Reference 74 and meets the intent of the issued final guidance document.

As noted above, the BSEP criticality storage constraints are identified in Tables 2.1 of the NFSV CSA (Reference 71) and the SFSP CSA (Reference 72) reports. Cycle-specific confirmation that both the NFSV and SFSP criticality storage constraints is performed during the bundle and core design phase.

Based upon the preceding evaluation, the criticality analyses supporting fuel storage at BSEP is not adversely impacted with the implementation of MELLLA+ EPFOD and will remain valid for future cycles using the ATRIUM 10XM fuel design.

6.4 WATER SYSTEMS

The water systems are designed to provide a reliable supply of cooling water for normal operation and design basis accident conditions. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Water Systems	Generic	Confirmed

The generic disposition of the Water Systems topic in the M+LTR describes that, the performance of the safety-related Service Water System during and following the most limiting design basis event, the LOCA, is not affected by the MELLLA+ operating domain expansion. [[

]] No further evaluation of water systems is required for MELLLA+.

Consistent with the BSEP generic disposition presented above, for BSEP the MELLLA+ operating domain expansion does not affect the performance of the safety-related Service Water System or the RHR Service Water System during and following the most limiting design basis event, the LOCA, as discussed in Section 4.3. [[

]] No further evaluation of the BSEP water systems is required for MELLLA+ operating domain expansion.

The evaluation of the water systems at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.5 STANDBY LIQUID CONTROL SYSTEM

The SLCS is a manually operated system that pumps a sodium pentaborate solution into the vessel to provide neutron absorption and achieve a subcritical reactor condition in the situation where none of the control rods can be inserted. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Shutdown Margin	Generic	Confirmed
System Hardware	Plant Specific	Acceptable
ATWS Requirements	Plant Specific	Acceptable

6.5.1 Shutdown Margin

The generic disposition of the Shutdown Margin topic in the M+LTR describes that [[

]] An increase in the reactor boron concentration may be achieved by increasing, either individually or collectively, (1) the minimum solution volume; (2) the minimum specified solution concentration; or (3) the isotopic enrichment of the boron-10 in the stored neutron absorber solution. In order to account for reactivity variations between cycles, the UFSAR Section 9.3.4 limit for reactor coolant boron concentration has sufficient margin to accommodate most core design variations.

Consistent with the generic disposition presented above, the SLCS shutdown margin for BSEP is calculated as a part of the standard reload process. Because no new fuel product line designs are introduced for MELLLA+ operating domain expansion, the UFSAR Section 9.3.4 limit for minimum reactor coolant boron of 720 ppm natural boron does not change as a result of MELLLA+ operating domain expansion. BSEP calculates SLCS shutdown margin as a part of the core reload analysis. Therefore, no further evaluation of SLCS shutdown margin is required for MELLLA+.

BSEP is increasing the boron-10 enrichment from 47 atom % to 92 atom % in order to improve system performance as described in Section 9.3.1.2.

The evaluation of the SLCS shutdown margin at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.5.2 System Hardware

The M+LTR describes that SLCS is typically designed for injection at a maximum reactor pressure equal to the upper analytical setpoint for the lowest group of SRVs operating in the relief mode. [[

]] therefore, the operation of the SLCS pump discharge relief valves is considered on a plant-specific basis as discussed in Section 6.5.3.

The BSEP reactor operating pressure is unchanged by MELLLA+ operating domain expansion. The numerical values showing no increases in reactor operating pressure are presented in Table 1-2. As discussed in Section 3.1.2, there are no changes to the BSEP SRV setpoints as a result of MELLLA+ operating domain expansion. Because the reactor dome pressure and SRV setpoints are unchanged for MELLLA+, the SLCS process parameters do not change. Therefore, the capability of the SLCS to perform its shutdown function is not affected by MELLLA+. This plant-specific evaluation confirms that for BSEP the reactor operating pressure and the SRV setpoints are unchanged. Therefore, the BSEP SLCS remains capable of performing its shutdown function.

The BSEP-specific SLCS system hardware evaluation results are acceptable.

6.5.3 ATWS Requirements

As described in the M+LTR, the SLCS ATWS performance is evaluated in Section 9.3.1 for a representative core design in the MELLLA+ operating domain. The representative MELLLA+ evaluation shows that the SLCS maintains the capability to mitigate an ATWS and that the current boron injection rate is sufficient relative to the peak suppression pool temperature.

The BSEP plant-specific ATWS analysis shows the maximum reactor lower plenum pressure following the limiting ATWS event reaches 1,241 psig during the time the SLCS is analyzed to be in operation. The pressure margin for the pump discharge relief valves remains above the minimum value needed to ensure that the SLCS relief valves remain closed during system injection. Consequently, the current BSEP SLCS process parameters associated with the minimum boron injection rate do not need to change. Therefore, SLCS operation during an ATWS is not affected by the MELLLA+ operating domain expansion.

The BSEP-specific SLCS ATWS requirements evaluation results are acceptable.

6.6 HEATING, VENTILATION AND AIR CONDITIONING

The Heating, Ventilation, and Air Conditioning (HVAC) systems consists mainly of heating, cooling supply, exhaust and recirculation units in the turbine building, reactor building, containment building and the drywell, auxiliary building, fuel handling building, control building, and the radwaste building. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Heating, Ventilation. and Air Conditioning	Generic	Confirmed

The generic disposition of the HVAC topic in the M+LTR describes that the heat load from elevated process fluid temperatures and the heat load from motors and cables do not change due to MELLLA+ operating domain expansion. [[

]] No further evaluations of the HVAC system are required for MELLLA+ operating domain expansion.

Consistent with the generic BSEP disposition presented above, for BSEP HVAC systems, the heat load from elevated process fluid temperatures and the heat load from motors and cables are bounded by the CLTP heat load from elevated process fluid temperatures and the heat loads and as such are within the design of the HVAC equipment chosen for worst case conditions. [[

]] No further evaluations of the BSEP HVAC systems are required for MELLLA+ operating domain expansion.

The evaluation of the HVAC systems at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.7 Fire Protection

This section addresses the fire protection program, fire suppression and detection systems, and safe shutdown system responses to postulated NFPA 805 fire events. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Fire Protection	Generic	Confirmed

The generic disposition of the Fire Protection topic in the M+LTR describes that because the decay heat does not change for the MELLLA+ operating domain expansion, there are no changes in vessel water level response, operator response time, PCT, and peak suppression pool temperature and containment pressure. Therefore, the MELLLA+ operating domain expansion does not affect any features of the fire protection design. Although fire responses, operator actions and safe shutdown systems are plant-specific, MELLLA+ does not change the design requirements of fire events or requirements for operator actions and safe shutdown systems. Provided the above criteria are met, no further evaluation of Fire Protection is required for MELLLA+ operating domain expansion.

Consistent with the generic disposition presented above, for BSEP, these parameters do not change as a result of MELLLA+ operating domain expansion. As discussed in Section 1.2.3, decay heat does not change as a result of MELLLA+ operating domain expansion. Reactor vessel water level response is unchanged by MELLLA+ operating domain expansion. Operator response times are not affected by MELLLA+ because: [[

]] The effect of MELLLA+ operating domain expansion on PCTs is evaluated to be acceptable in Section 4.3. The effect of MELLLA+ operating domain expansion on peak suppression pool temperatures and containment pressure response are evaluated to be acceptable in Section 4.1. [[

]] The criteria in the generic disposition are met, and no further evaluation of fire protection is required for MELLLA+ operating domain expansion.

The evaluation of fire protection at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

6.8 Other Systems Affected

The topics addressed in this evaluation are other systems that may be affected by the MELLLA+ operating domain expansion:

Topic	M+LTR Disposition	BSEP Result
Other Systems	Generic	Confirmed

The generic disposition of the Other Systems Affected topic in the M+LTR describes that the systems typically found in a BWR power plant have been evaluated to establish those systems that are affected by the MELLLA+ operating domain expansion. Those systems that are significantly affected by the MELLLA+ operating domain expansion are addressed in this report. Other systems not addressed by this report are not significantly affected by the MELLLA+ operating domain expansion.

Consistent with the generic disposition presented above, the BSEP systems evaluated [[ ]] were reviewed for MELLLA+ operating domain expansion to ensure that all significantly affected systems were addressed. This topic confirms that those systems that are significantly affected by the MELLLA+ operating domain expansion are addressed in this report. Other systems not addressed by this report are not significantly affected by the MELLLA+ operating domain expansion.

The evaluation of the other systems at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

7.0 POWER CONVERSION SYSTEMS

This section addresses the evaluations that are applicable to MELLLA+. Because the reactor operating pressure, steam and FW flow rates, and FW fluid temperature ranges are unchanged by the operating domain expansion, the power conversion systems are unaffected.

7.1 TURBINE-GENERATOR

The turbine-generator converts the thermal energy in the steam into electrical energy. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Turbine-Generator	Generic	Confirmed

The generic disposition of the Turbine-Generator topic in the M+LTR describes that the MELLLA+ operating domain expansion does not change the pressure, thermal energy, and steam flow from the reactor. Likewise, there is no change in the electrical output of the generator. Therefore, there is no change in the previous missile avoidance and protection analysis. No further evaluation of this topic is required.

Consistent with the generic disposition presented above, there is no change in the reactor power level as a result of MELLLA+ operating domain expansion. For BSEP, there are no increases in reactor operating pressure or MS flow rate. The numerical values showing no increases in reactor operating pressure and MS flow rate are presented in Table 1-2. The electrical output in the current licensed operating domain and in the MELLLA+ operating domain is approximately 1,007 MWe. Therefore, there is no change to the BSEP missile avoidance and protection analysis for the current licensed operating domain. No further evaluation of this topic is required.

The evaluation of the turbine-generator at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

7.2 CONDENSER AND STEAM JET AIR EJECTORS

The condenser removes heat from the steam discharged from the turbine and provides liquid for the condensate and FW systems. The steam jet air ejectors remove non-condensable gases from the condenser to improve thermal performance. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Condenser And Steam Jet Air Ejectors	Generic	Confirmed

The generic disposition of the Condenser and Steam Jet Air Ejectors topic in the M+LTR describes that the MELLLA+ operating domain expansion does not change the steam flow rate or power level. [[

]] MELLLA+ operating domain expansion does not affect the condenser and steam jet air ejectors, and no further evaluation is required.

Consistent with the generic BSEP disposition presented above, there is no change in the reactor power level as a result of MELLLA+ operating domain expansion. For BSEP there are no increases in reactor operating pressure or MS flow rates. The numerical values showing no increases in reactor operating pressure and MS flow rates are presented in Table 1-2. [[

]] MELLLA+ operating domain expansion does not affect the BSEP condenser and steam jet air ejectors, and no further evaluation is required.

Evaluation of the BSEP condenser and steam jet air ejectors is confirmed to be consistent with the generic disposition in the M+LTR.

7.3 TURBINE STEAM BYPASS

The turbine steam bypass system provides a means of accommodating excess steam generated during normal plant maneuvers and transients. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Turbine Steam Bypass	Generic	Confirmed

The generic disposition of the Turbine Steam Bypass topic in the M+LTR describes that there is no change in the power level, pressure or steam flow for the MELLLA+ operating domain expansion. Therefore, MELLLA+ operating domain expansion does not affect the turbine steam bypass system, and no further evaluation is required.

Consistent with the generic disposition presented above, there is no change in the reactor power level as a result of the MELLLA+ operating domain expansion. For BSEP, there are no increases in the reactor operating pressure or MS flow rate. The numerical values showing no increases in the reactor operating pressure and MS flow rate are presented in Table 1-2. Therefore, MELLLA+ operating domain expansion does not affect the BSEP turbine steam bypass system, and no further evaluation is required.

The evaluation of the BSEP turbine steam bypass system is confirmed to be consistent with the generic disposition in the M+LTR.

7.4 FEEDWATER AND CONDENSATE SYSTEMS

The Feedwater and Condensate systems provide the source of makeup water to the reactor to support normal plant operation. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Feedwater And Condensate Systems	Generic	Confirmed

The generic disposition of the FW and Condensate Systems topic in the M+LTR describes that there is no change in the FW pressure, temperature, or flow for the MELLLA+ operating domain expansion. MCO for MELLLA+ conditions increases from 0.10 to 0.20 wt.%. Impact of higher moisture content is negligible on the Reactor Feed Pump Turbines and casing drains. The performance requirements for the FW and condensate systems are not changed by MELLLA+ operating domain expansion, and no further evaluation is required.

Consistent with the generic disposition presented above there is no change in the BSEP FW pressure, temperature, and flow rates. Because FW flow is unchanged in the MELLLA+ domain, system resistance and therefore operating pressures in the MELLLA+ operating domain are not changed. The numerical values showing no increases in FW temperature and flow rates are presented in Table 1-2. Therefore, MELLLA+ operating domain expansion does not affect the BSEP FW and condensate systems, and no further evaluation is required.

When in the MELLLA+ operating domain expansion, the Feedwater Heater Out-of-Service EOOS is not allowed. Typically this EOOS has been used to increase reactor power near end of cycle operations. Since core flow rates remain near maximum in this case, the plant would not be in the MELLLA+ operating domain expansion.

Evaluation of the BSEP FW and condensate systems is confirmed to be consistent with the generic disposition in the M+LTR.

8.0 RADWASTE SYSTEMS AND RADIATION SOURCES

This section addresses the evaluations that are applicable to MELLLA+.

8.1 LIQUID AND SOLID WASTE MANAGEMENT

The liquid radwaste system collects, monitors, processes, stores and returns processed radioactive waste to the plant for reuse or discharge. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Coolant Fission and Corrosion Product Levels	Addressed in Section 8.4	
Waste Volumes	Generic	Confirmed

8.1.1 Coolant Fission and Corrosion Product Levels

A discussion of the coolant activation products as well as fission and activated corrosion product levels in the coolant is presented in Section 8.4.

8.1.2 Waste Volumes

The generic disposition of the Waste Volumes topic in the M+LTR describes that because the power level, FW flow, and steam flow do not change for the MELLLA+ operating domain expansion, the volume of liquid radwaste and the coolant concentrations of fission and corrosion products will be unchanged. The largest source of liquid and wet solid waste is from the backwash of the condensate demineralizers. Although the volume of waste generated is not expected to increase, potentially higher MCO in the reactor steam could result in slightly higher loading on the condensate demineralizers. Because the higher moisture content will occur infrequently, the MELLLA+ operating domain expansion will not cause the condensate demineralizer or the RWCU filter demineralizer backwash frequency to be changed significantly. Therefore, the waste volumes will not be affected by the MELLLA+ operating domain expansion, and no further evaluation of this topic is required.

Consistent with the generic disposition presented above, there is no change in the reactor power level as a result of MELLLA+ operating domain expansion. For BSEP, there are no increases in the MS or FW flow rates. The numerical values showing no increases in MS and FW flow rates are presented in Table 1-2. The EPU evaluation was not limited by MCO, but is based on an increase in backwash frequency proportional to FW flow. The increase in FW flow due to EPU resulted in an increase in liquid waste processing of approximately 1% of liquid waste volume.

The evaluation of the BSEP waste volumes is confirmed to be consistent with the generic disposition in the M+LTR.

8.2 GASEOUS WASTE MANAGEMENT

The primary function of the gaseous waste management (offgas) system is to process and control the release of gaseous radioactive effluents to the site environs so that the total radiation exposure of persons in off-site areas is as low as reasonably achievable (ALARA) and does not exceed applicable guidelines. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Off-Site Release Rate	Generic	Confirmed
Recombiner Performance	Generic	Confirmed

8.2.1 Off-Site Release Rate

The generic disposition of the Off-Site Release Rate topic in the M+LTR describes that the radiological release rate is administratively controlled to remain within existing limits and is a function of fuel cladding performance, main condenser air inleakage, charcoal adsorber inlet dew point, and charcoal adsorber temperature. [[

]] No further evaluation of this topic is required.

Consistent with the generic disposition presented above, the BSEP radiological release rate is administratively controlled to remain within existing release rate limits. In addition, none of the applicable identified parameters are affected by MELLLA+ operating domain expansion. [[

]], and no further evaluation is required.

The evaluation of the BSEP off-site release rate is confirmed to be consistent with the generic disposition in the M+LTR.

8.2.2 Recombiner Performance

The generic disposition of the Recombiner Performance topic in the M+LTR describes that [[

]] Therefore, recombiner performance is unaffected by the MELLLA+ operating domain expansion, and no further evaluation is required.

Consistent with the generic disposition presented above, the BSEP-specific value for radiolytic hydrogen gas flow rate is 24.4 lbm/hr, which does not change as a result of MELLLA+ operating domain expansion. Therefore, the BSEP recombiner performance is unaffected by the MELLLA+ operating domain expansion, and no further evaluation is required.

The evaluation of the BSEP recombiner performance is confirmed to be consistent with the generic disposition in the M+LTR.

The evaluation of the BSEP gaseous waste management system is confirmed to be consistent with the generic disposition in the M+LTR.

8.3 Radiation Sources in the Reactor Core

During power operation, the radiation sources in the core are directly related to the fission rate. These sources include radiation from the fission process, accumulated fission products, and neutron activation reactions. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Post Operational Radiation Sources for Radiological and Shielding Analysis	Generic	Confirmed

The generic disposition of the Post Operational Radiation Sources for Radiological and Shielding Analysis topic in the M+LTR describes that the post-operation radiation sources in the core are primarily the result of accumulated fission products. [[

]] Therefore, no further evaluation of radiation sources in the reactor core is required.

Consistent with the generic disposition presented above, the reactor power does not increase as a result of MELLLA+ operating domain expansion. BSEP core average exposure is [[

]] No further evaluation of radiation sources in the reactor core is required.

Evaluation of the BSEP radiation sources in the reactor core is confirmed to be consistent with the generic disposition in the M+LTR.

8.4 RADIATION SOURCES IN REACTOR COOLANT

Radiation sources in the reactor coolant include activation products, activation corrosion products, and fission products. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Coolant Activation Products	Generic	Confirmed
Fission and Activated Corrosion Products	Plant Specific	Acceptable

8.4.1 Coolant Activation Products

The generic disposition of the Coolant Activation Products topic in the M+LTR describes that during reactor operation, the coolant passing through the core region becomes radioactive as a result of nuclear reactions. The coolant activation process is the dominant source resulting in the production of short-lived radionuclides of N-16 and other activation products. These coolant activation products are the primary source of radiation in the turbines during operation. [[

]] therefore, no further evaluation of this topic is required.

Consistent with the generic disposition presented above, the reactor power does not increase as a result of MELLLA+ operating domain expansion. The BSEP steam flow rate has a negligible change as a result of MELLLA+ operating domain expansion. Numerical values demonstrating that the MS flow does not increase are provided in Table 1-2. [[

]] No further evaluation of this topic is required.

The evaluation of the BSEP coolant activation products in the reactor core is confirmed to be consistent with the generic disposition in the M+LTR.

8.4.2 Fission and Activation Corrosion Products

The reactor coolant contains fission products and activated corrosion products. For the MELLLA+ operating domain there is negligible change in the FW flow, steam flow, or power. However, [[

]]

For BSEP, reactor power and fuel thermal limits do not change as a result of the MELLLA+ operating domain expansion. The BSEP MS and FW flow rates have a negligible change as a result of the MELLLA+ operating domain expansion. Numerical values demonstrating that the MS and FW flow rates do not increase are provided in Table 1-2. However, the increased MCO results affect the steam fission production concentration in the MELLLA+ operating domain.

Steam separator and dryer performance for MELLLA+ operation is discussed in Section 3.3.3. The moisture content of the MS leaving the vessel may increase up to 0.2 wt.% at times while operating near the minimum CF in the MELLLA+ operating domain. The distribution of the fission and activated corrosion product activity between the reactor water and steam is affected by the increased moisture content. With increased MCO, additional activity is carried over from the reactor water with the steam. While the moisture content limit is 0.2 wt.%, [[

]] the fission and activated corrosion product levels in the plant are affected by operation in the MELLLA+ operating domain.

Based on the above evaluation, the BSEP plant-specific results for the concentration of total fission products and total activated corrosion products in reactor water are bounded by the design basis concentrations.

8.5 RADIATION LEVELS

Radiation levels during operation are derived from coolant sources. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Normal Operational Radiation Levels	Plant Specific	Acceptable
Post-Shutdown Radiation Levels	Plant Specific	Acceptable
Post-Accident Radiation Levels	Plant Specific	Acceptable

8.5.1 Normal Operational Radiation Levels

The M+LTR describes that plant radiation levels for normal and post-shutdown operation are directly dependent upon radiation levels and radionuclide species in the reactor coolant (steam and water) except where the core is directly involved. [[

]]

For BSEP reactor power does not change as a result of the MELLLA+ operating domain expansion. The BSEP MS flow rate does not change as a result of the MELLLA+ operating domain expansion. Numerical values demonstrating the MS flow rate does not increase are provided in Table 1-2. Because there is no change in power or steam flow rate for the MELLLA+ expanded operating domain, the radiation levels from the coolant activation products do not vary significantly. These radionuclide concentrations in the coolant do not vary significantly unless the MCO from the vessel increases, which affects the equilibrium concentrations in the coolant. As discussed in Section 8.4.2, the moisture content of the MS leaving the vessel may increase at certain times while operating in the MELLLA+ operating domain. However, the BSEP cycle average value will be monitored and controlled within the existing analytical assumption of 0.2 wt.% used in the determination of normal operation radiation levels. The overall radiological effect of the increased moisture content is a function of the plant water radiochemistry and the levels of activated corrosion products maintained. BSEP maintains appropriate health physics and ALARA controls to address any increase in the normal operation levels.

8.5.2 Post-Shutdown Radiation Levels

The M+LTR describes that plant radiation levels for normal and post-shutdown operation are directly dependent upon radiation levels and radionuclide species in the reactor coolant (steam and water) except where the core is directly involved. [[

]]

For BSEP, reactor power does not change as a result of the MELLLA+ operating domain expansion. The BSEP MS flow rate does not change as a result of the MELLLA+ operating domain expansion. Numerical values demonstrating the MS flow rate does not increase are provided in Table 1-2. The shutdown radiation levels are dominated by the accumulated contamination of some fission and activated corrosion products. These radionuclide concentrations in the coolant do not vary significantly unless the MCO from the vessel increases, which affects the equilibrium concentrations in the coolant. As discussed in Section 8.4, the moisture content of the MS leaving the vessel may increase at certain times while operating in the MELLLA+ operating domain. However, the BSEP cycle average value will be monitored and controlled within the existing analytical assumption of 0.2 wt.% used in the determination of post-shutdown radiation levels. The overall radiological effect of the increased moisture content is a function of the plant water radiochemistry and the levels of activated corrosion products maintained. BSEP maintains appropriate health physics and ALARA controls to address any increase in the shutdown radiation levels.

8.5.3 Post-Accident Radiation Levels

The M+LTR describes that the post-accident radiation levels depend primarily upon the core inventory of fission products and Technical Specification levels of radionuclides in the coolant. [[ ]] operation since power or burnup is not substantially changed. [[ ]] Section 9.2 discusses off-site doses for post-accident calculations.

8.6 NORMAL OPERATION OFF-SITE DOSES

The primary source of normal operation off-site doses is: (1) airborne releases from the Offgas System, and (2) gamma shine from the plant turbines. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Plant Gaseous Emissions	Generic	Confirmed
Gamma Shine from the Turbine	Generic	Confirmed

8.6.1 Plant Gaseous Emissions

The generic disposition of the Plant Gaseous Emissions topic in the M+LTR describes that for the MELLLA+ operating domain expansion, there is no change in the core power and the steam flow rate. [[ ]] No further evaluation of plant gaseous emissions is required.

Consistent with the generic disposition presented above, the reactor power does not change as a result of the MELLLA+ operating domain expansion. The BSEP steam flow rate does not change as a result of the MELLLA+ operating domain expansion. Numerical values demonstrating that the MS flow does not increase are provided in Table 1-2. [[ ]]

In the MELLLA+ operating domain, MCO in the MS can increase; therefore, an evaluation was performed for BSEP using a maximum of 0.20 wt.% for short periods of time during the operating cycle. The increase in MCO results in a negligible effect on plant gaseous emissions.

The evaluation of the BSEP gaseous emissions is confirmed to be consistent with the generic disposition in the M+LTR.

8.6.2 Gamma Shine from the Turbine

The generic disposition of the Gamma Shine from the Turbine topic in the M+LTR describes that for the MELLLA+ operating domain expansion, [[

]] For BSEP, the moisture content of the main steam leaving the reactor vessel may be as high as 0.20 wt.% while operating for short periods during a cycle in the MELLLA+ operating domain. The BSEP EPU evaluated MCO was 0.10 wt.%. An evaluation of gamma shine from the turbine was performed for operating in the MELLLA+ operating domain.

The evaluation determined, since normal radiation levels are dominated by the short-lived radionuclide N-16, the potentially higher fission products in the steam due to a higher moisture carryover are expected to have a negligible effect on normal radiation levels. The BSEP steam flow rate does not change as a result of the MELLLA+ operating domain expansion. Numerical values demonstrating the MS flow does not increase are provided in Table 1-2; therefore, the gamma dose from the turbine does not change. [[

]]

The evaluation of the BSEP gamma shine is confirmed to be consistent with the generic disposition in the M+LTR.

The evaluation of the BSEP normal operation off-site dose is confirmed to be consistent with the generic disposition in the M+LTR.

9.0 REACTOR SAFETY PERFORMANCE EVALUATIONS

This section addresses the evaluations that are applicable to MELLLA+.

9.1 ANTICIPATED OPERATIONAL OCCURRENCES

The BSEP UFSAR defines the licensing basis AOOs. Table 9-1 of the M+LTR provides an assessment of the effect of the MELLLA+ operating domain expansion on each of the Reference 4 limiting AOO events and key non-limiting events. Table 9-1 of the M+LTR includes fuel thermal margin, overpressure, and loss of water level events. The overpressure protection analysis events are addressed in Section 3.1. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Fuel Thermal Margins Events	Plant Specific	Acceptable
Power and Flow Dependent Limits	Plant Specific	Acceptable
Non-Limiting Events	Plant Specific	Acceptable

9.1.1 Fuel Thermal Margin Events

Operating limits are established to ensure the AOO and accident acceptance criteria are satisfied. A review of the licensing basis of the Brunswick plant was performed to identify the potentially limiting thermal margin events, i.e., those events which set the thermal limits. The potentially limiting thermal margin events include:

- Generator Load Rejection No Bypass (LRNB)
- Turbine Trip No Bypass (TTNB),
- Feedwater Controller Failure (Maximum Demand) (FWCF)
- Loss of Feedwater Heating (LFWH),
- Control Rod Withdrawal Error (CRWE),

While the fuel loading error is categorized as an Infrequent Event, it is often analyzed as an AOO. In this situation, the results of the fuel loading error are also considered in establishing the thermal limits.

The transient analysis codes presented in Table 1-1a are used to perform the AOO analyses. Analyses for a representative Brunswick MELLLA+ cycle (based on Brunswick Unit 1 Cycle 19) were performed at ICF and minimum flow conditions and are documented in Reference 78. The reload licensing report (RSAR) for the initial Brunswick MELLLA+ cycle will be submitted to the NRC for confirmation per the M+LTR SER Limitation and Condition 12.4. Table 9-1 provides a comparison of the rated power results with ICF and minimum core flow for the potentially limiting events.

The potentially limiting pressurization events (LRNB, TTNB and FWCF) are caused by a rapid closure of the turbine control valves or the turbine stop valves. In the case of the FWCF event, the rapid valve closure occurs after an overcooling phase as the water level increases due to a significant increase in feedwater flow. The rapid turbine valve closure causes a compression wave to travel through the steam lines into the vessel and create a rapid pressurization of the core. The increase in pressure causes a decrease in core voids, which in turn causes a rapid increase in power. The rapid closure of the turbine valves also causes a scram. The core power excursion is terminated primarily by the reactor scram and revoiding of the core. Results of pressurization events are presented in Table 9-1. The responses of various reactor and plant parameters during the LRNB and TTNB events for the rated power ICF and 85% core flow state points are presented in Figures 9-1 through 9-4. The results show that the ICF state point is the limiting flow condition at rated power.

The LFWH event was analyzed for the representative Brunswick MELLLA+ cycle and the results are presented in Table 9-1. The LFWH event analysis supports an assumed 100°F decrease in the feedwater temperature. This results in an increase in core inlet subcooling, thereby reducing voids, increasing power and causing a shift in the axial power distribution. As a result of the axial power shift and increased core power, voids begin to build up in the bottom region of the core, acting as negative feedback to the increased subcooling effect and moderating the core power increase.

The CRWE transient is an inadvertent reactor operator initiated withdrawal of a control rod. This withdrawal increases local power and core thermal power, lowering the core MCPR. The CRWE transient is typically terminated by control rod blocks initiated by the rod block monitor (RBM). The CRWE event is evaluated on a cycle-specific basis with results provided in the cycle-specific RSAR (and COLR). The CRWE event was analyzed for the representative Brunswick MELLLA+ cycle and the results are presented in Table 9-1. Analyses were performed for a range of potential BSEP RBM set points from 108% to 117%. The rated power results presented Table 9-1 are for a RBM high power set point of 108%.

There are two types of fuel loading errors possible in a BWR: the mislocation of a fuel assembly in a core position prescribed to be loaded with another fuel assembly; and the misorientation of a fuel assembly with respect to the control blade. The fuel loading errors are evaluated on a cycle-specific basis with results provided in the cycle-specific RSAR. The mislocation and misorientation analysis results for the representative Brunswick MELLLA+ cycle, show that the AOO acceptance criteria are met, and are not limiting.

9.1.2 Power and Flow Dependent Limits

As discussed in Section 2.2, MCPR and LHGR limits are established to ensure that the steady state and AOO acceptance criteria are met. These limits are modified by power- and flow-dependent limits or multipliers when the plant is operating at less than 100% power and/or 100% core flow.

The flow-dependent MCPR (MCPRf) limits and LHGR multipliers (LHGRFACf) are based on CPR and local power changes experienced by the fuel during postulated slow recirculation flow increase analyses. The analysis assumes a failure of the recirculation flow control system such that the core flow increases slowly to the maximum flow physically permitted by the equipment. An uncontrolled increase in flow creates the potential for a significant increase in core power and heat flux. The MCPRf limits are set such that the increase in core power, resulting from the maximum increase in core flow assures the SLMCPR is not violated. Table 9-2 summarizes the results of the slow recirculation flow increase analysis and compares them with the MCPRf limits. The LHGRFACf multipliers are established to provide protection against fuel centerline melt and overstraining of the cladding during a slow flow runup.

The power-dependent MCPR (MCPRp) limits are established or confirmed on a cycle-specific basis to ensure that less than 0.1% of the fuel rods in the core are expected to experience boiling transition during an AOO initiated from rated or off-rated conditions. The MCPRp limits are based on the sum of the ΔCPR for the limiting AOO at a given power level and the SLMCPR. These limits can be established as a function of exposure and/or scram speed.

The power-dependent LHGR multipliers (LHGRFACp) are established to protect against fuel melting and overstraining (i.e. thermal-mechanical response) of the cladding during an AOO. The LHGRFACp multipliers are determined using the RODEX4 (Reference 67) methodology and are applied to both the UO2 and GdO2 fuel rods thereby meeting the SER Limitation and Condition 9.9 discussed in Appendix A. Both the LHGRFACf and LHGRFACp multipliers are applied directly to the steady state LHGR limits. The lower value of LHGRFACf and LHGRFACp is used to determine the margin to limits for a given core state point.

The power and flow dependent limits are established or confirmed on a cycle-specific basis and are reported in the RSAR, thereby meeting SER Limitations and Conditions 9.9 and 9.10 discussed in Appendix A, and M+ LTR Limitation and Condition 12.4.

9.1.3 Non-Limiting Events

A disposition of events was performed to support the introduction of the ATRIUM 10XM fuel at BSEP for EPU and MELLLA+ operation. The results identify the events discussed in Section 9.1.1 as the potentially limiting AOOs. The other events are non-limiting. The results are consistent with the generic disposition of events presented in the M+LTR.

Event	Discussion
Fuel Thermal Margin Events:	
Inadvertent HPCI Start	{{
Fast Recirculation Increase	
MSIV Closure, All Valves	}}

MSIV Closure, One Valve	{{
Transient Overpressure Events:	
TTNB with Scram on High Flux (Failure of Direct Scram)	}}

The evaluation of the BSEP non-limiting events meets all M+LTR dispositions.

9.2 DESIGN BASIS ACCIDENTS AND EVENTS OF RADIOLOGICAL CONSEQUENCE

9.2.1 Design Basis Events

This section addresses the radiological consequences of a Design Basis Accident (DBA). The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Control Rod Drop Accident (CRDA)	Plant Specific	Acceptable
Instrument Line Break Accident (ILBA)	Not Applicable to BSEP	
Main Steam Line Break Accident (MSLBA) (Outside Containment)	Plant Specific	Acceptable
Loss of Coolant Accident (LOCA) (Inside Containment)	Plant Specific	Acceptable
Large Line Break (Feedwater or Reactor Water Cleanup)	Not Applicable to BSEP	
Liquid Radwaste Tank Failure	Not Applicable to BSEP	
Fuel Handling Accident (FHA)	Plant Specific	Acceptable
Offgas System Failure	Not Applicable to BSEP	
Cast Drop Accident	Not Applicable to BSEP	

9.2.1.1 Control Rod Drop Accident

The radiological consequences of this DBA are evaluated to determine off-site doses as well as control room operator doses. DBA calculations are generally based on core inventory sources or Technical Specification source terms, [[

]]

For BSEP, two postulated CRDA events govern the analysis of radiological consequences. For Event 1, the release path is via the mechanical vacuum pump at low power operation. For Event 2, the event occurs at normal power and the release path is via the condenser and the steam jet air ejectors. For Event 1, the plant is not operating in the MELLLA+ operating domain as shown by the Power/Flow map, and therefore there is no effect on the results. Because BSEP may operate with portions of the Offgas system bypassed, Event 2 represents the bounding radiological consequences.

The CRDA release is dependent on the source terms and maximum peaking factor. Operation in the MELLLA+ operating domain does not affect the Alternate Source Term (AST) CRDA source term and the peaking factor remains bounding. There are no changes to removal, transport, or dose conversion assumptions for this event. Therefore, the BSEP CRDA evaluation for the MELLLA+ operating domain is bounded by the analysis for the current licensed operating domain, and no further evaluation is required.

9.2.1.2 Instrument Line Break Accident

The ILBA is not applicable to BSEP.

9.2.1.3 Main Steam Line Break Accident (Outside Containment)

The generic disposition of the Main Steam Line Break Accident (MSLBA) (Outside Containment) topic in the M+LTR describes that the radiological consequences of this DBA are evaluated to determine off-site doses as well as control room operator doses. DBA calculations are generally based on core inventory sources or Technical Specification source terms, [[

]] Table 9-4 of the M+LTR provides a detailed evaluation of the MSLBA events. [[

]]

Consistent with the generic disposition presented above, and as presented in Table 9-4 of the M+LTR, for BSEP the source terms for the MSLBA are dependent on the relative amount of water and steam released. Radionuclide concentrations are set at conservative values for the coolant source terms and at Technical Specification limits, which remain bounding and unchanged. The MELLLA+ operating domain expansion results in more steam voids in the reactor vessel resulting in a larger fraction of steam release than in the current licensed operating domain. The fission product release is weighted by the water, because the concentration of iodine in water is 50 times that of steam (Reference 1). The increase in steam and decrease in water results in lower releases such that the current analysis is bounding. These results are equally applicable to the AST analysis used at BSEP. In addition, the analysis of record for the worst-case MSLBA radiological consequences is at hot standby conditions, which is outside of the MELLLA+ operating domain as shown by the Power/Flow map. Therefore the BSEP MSLBA evaluation is not affected by the MELLLA+ operating domain expansion and no further evaluation is required.

The evaluation of the BSEP MSLBA is confirmed to be consistent with the generic disposition in the M+LTR.

9.2.1.4 Loss-of-Coolant Accident (Inside Containment)

The generic disposition of the LOCA (Inside Containment) topic in the M+LTR describes that the radiological consequences of this DBA are evaluated to determine off-site doses as well as control room operator doses. DBA calculations are generally based on core inventory sources or Technical Specification source terms, [[

]]

The design input and assumptions for suppression pool pH were previously evaluated. The source term assumptions are not changing for MELLLA+. In addition, the acid production terms are not changing for MELLLA+ conditions. The use of Sodium Pentaborate as a buffer per UFSAR Section 15.6.4.3.1.1 continues to be appropriate.

Table 9-4 of the M+LTR provides a detailed evaluation of each of the above events. [[

]], then no further review is required.

Consistent with the generic disposition presented above, and [[

]] Therefore, the BSEP LOCA evaluation is not affected by the MELLLA+ operating domain expansion and no further evaluation is required.

The evaluation of the BSEP LOCA is confirmed to be consistent with the generic disposition in the M+LTR.

9.2.1.5 Large Line Break (Feedwater or Reactor Water Cleanup)

The large line break is not applicable to BSEP.

9.2.1.6 Liquid Radwaste Tank Failure

The liquid radwaste tank failure is not applicable to BSEP.

9.2.1.7 Fuel Handling Accident

The generic disposition of the Fuel Handling Accident (FHA) topic in the M+LTR describes that the radiological consequences of this DBA are evaluated to determine off-site doses as well as control room operator doses. DBA calculations are generally based on core inventory sources or Technical Specification source terms, [[

]] Table 9-4 of the M+LTR provides a detailed evaluation of each of the above events. [[

]]

Consistent with the generic disposition presented above, [[

]]
Therefore, the BSEP FHA evaluation for the MELLLA+ operating domain is bounded by the analysis for the current licensed operating domain, and no further evaluation is required.

The evaluation of the BSEP FHA is confirmed to be consistent with the generic disposition in the M+LTR.

9.2.1.8 Offgas System Failure

The offgas system failure is not applicable to BSEP.

9.2.1.9 Cask Drop

The cask drop accident is not applicable to BSEP.

9.3 Special Events

This section considers three special events: ATWS, station blackout (SBO), and ATWS with core instability. The operator actions required as a result of ATWS are reviewed and discussed as a part of Section 10.9. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
ATWS (Overpressure)	Plant Specific	Acceptable
ATWS (Suppression Pool Temperature and Containment Pressure)	Plant Specific	Acceptable
ATWS (Peak Cladding Temperature and Oxidation)	Plant Specific	Acceptable
Station Blackout	Generic	Confirmed
ATWS with Core Instability	Generic	Plant Specific Evaluation Acceptable

9.3.1 Anticipated Transients Without Scram

There is no change in core power, decay heat, pressure, or steam flow as a result of the MELLLA+ operating domain expansion. [[

]] The ATWS evaluation acceptance criteria are to:

- Maintain reactor vessel integrity (i.e., peak vessel bottom pressure less than the ASME Service Level C limit of 1,500 psig)
- Maintain containment integrity (i.e., maximum containment pressure lower than the design pressure of the containment structure and maximum suppression pool temperature lower than the pool temperature limit)
- Maintain coolable core geometry

Plant-specific ATWS analyses are performed to demonstrate that the ATWS acceptance criteria are met for operation in the MELLLA+ operating domain. BSEP meets the ATWS mitigation requirements in 10 CFR 50.62 for an alternate rod insertion (ARI) system, SLCS boron injection equivalent to 86 gpm, and automatic RPT logic (i.e., anticipated transient without scram - recirculation pump trip (ATWS-RPT)). The plant-specific ATWS analyses take credit for the ATWS-RPT and SLCS. However, ARI is not credited.

In accordance with M+LTR SER Limitations and Conditions 12.18.e and 12.18.f, the key input parameters to the plant-specific ATWS analyses are provided in Table 9-3. For key input parameters that are important to simulating the ATWS analysis and are specified in the TSs (e.g., SLCS parameters, ATWS-RPT), the calculation assumptions are consistent with the proposed BSEP TS values and plant configuration. Although conservative inputs consistent with the BSEP TS values were used, in some instances, nominal input parameters are used consistent with the approach in Reference 36. Reference 36 contained sensitivity studies on key parameters for information. However, there was no specific uncertainty treatment applied. In addition, the EOOS assumptions for ATWS are consistent with TS requirements. M+LTR SER Limitation and Condition 12.23.2 requires that the plant-specific automatic settings be modeled for ATWS. For BSEP, the plant automatic settings, which include the ATWS-RPT, low steam line pressure isolation, and SRV actuation, are modeled based on the input parameters in Table 9-3. As required by M+LTR SER Limitation and Condition 12.23.8, the plant-specific ATWS analyses account for plant- and fuel-design-specific features including debris filters.

9.3.1.1 Anticipated Transients Without Scram (Licensing Basis)

The plant-specific ATWS analysis is performed using the approved ODYN methodology documented in Section 5.3.4 of the LTR "Generic Guidelines for General Electric Boiling Water Reactor Extended Power Uprate" (ELTR1) (Reference 3). The ATWS analysis using the ODYN methodology is the plant's licensing basis for this application.

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A licensing basis ODYN ATWS analysis was performed to demonstrate the effect of MELLLA+ on the ATWS acceptance criteria. [[

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The results of the licensing basis ODYN ATWS analysis are provided in Tables 9-4 and 9-5. The tabulated peak value and time trace for reactor power, reactor dome pressure, PCT, and suppression pool temperature is provided in Table 9-5 for the limiting event in the ODYN ATWS analysis.

[[

]] The peak vessel bottom pressure response is dependent on several inputs, including the SRV upper tolerances assumed in the ATWS analysis. In accordance with M+LTR SER Limitation and Condition 12.23.3, [[

]] The SRV upper tolerances used in the ATWS analysis are consistent with the plant-specific performance.

[[

]]

The suppression pool temperature following an ATWS is bounded by EPU. [[

]]

M+LTR SER Limitation and Condition 12.23.11 requires that the use of suppression pool temperature limits higher than the heat capacity temperature limit (HCTL) for emergency depressurization must be justified. The containment design limit is the ATWS acceptance criteria. [[

]] Consistent with M+LTR SER Limitation and Condition 12.18.b, a best–estimate TRACG analysis was not needed. Section 9.3.1.2 provides the basis for not performing a best-estimate TRACG analysis.

The peak containment pressure is 8.4 psig, which is below the BSEP design limit of 62 psig.

A coolable core geometry is ensured by meeting the 2,200°F PCT and 17% local cladding oxidation acceptance criteria of 10 CFR 50.46. [[

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The results of the licensing basis ODYN ATWS analysis meet the ATWS acceptance criteria. The use of PRIME satisfies the Methods LTR SER Limitation and Condition 9.12. Therefore, the BSEP response to an ATWS event initiated in the MELLLA+ operating domain is acceptable.

9.3.1.2 Anticipated Transients Without Scram (Best-Estimate Calculation)

The HCTL is determined from BSEP EOPs. The HCTL is a function of operating reactor pressure and suppression pool water level. For a normal suppression pool water level, the HCTL is approximately 158°F near the SRV opening pressure. This pool temperature was applied as a conservative value for initiating operator action to start depressurization. Figure 9-5 shows the HCTL at various reactor pressures and suppression pool levels.

BSEP EOPs require depressurization during an ATWS event when the suppression pool temperature reaches the HCTL.

Consistent with M+LTR SER Limitation and Condition 12.18.b, a TRACG calculation is not required if the plant increases the boron-10 concentration/enrichment so that the integrated heat load to containment calculated by the licensing ODYN calculation does not change with respect to a reference OLTP/75 percent flow ODYN calculation. This assessment has been performed for BSEP using ODYN, and the heat load to the pool is reduced at EPU/85 percent flow conditions with increased enriched boron (92 atom % B-10) versus OLTP/75% flow conditions (19.8 atom % B-10). The peak pool temperature for EPU/85% flow is 174.0°F. The peak pool temperature for OLTP/75% flow is 189.4°F. Thus, no TRACG calculation is required for BSEP for MELLLA+ conditions.

9.3.2 Station Blackout

The generic disposition of the SBO topic in the M+LTR describes that there is no significant change in core power, decay heat, pressure, or steam flow as a result of the MELLLA+ operating domain expansion. [[

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Consistent with the generic disposition presented above, there is no change in the reactor power level as a result of the MELLLA+ operating domain expansion. As discussed in Section 1.2.3, there is no significant change in decay heat as a result of the MELLLA+ operating domain expansion. For BSEP, there are no increases in reactor operating pressure as result of MELLLA+ operating domain expansion. For BSEP, there are no significant changes in the MS flow rate. The numerical values showing no significant changes to reactor operating power and MS flow rate are presented in Table 1-2. [[

]] No further evaluation is required.

The evaluation of the BSEP SBO is confirmed to be consistent with the generic disposition in the M+LTR.

9.3.3 ATWS with Core Instability

The NRC has reviewed and accepted GEH's disposition of the effect of large coupled thermal-hydraulic/neutronic core oscillations during a postulated ATWS event, which is presented in NEDO-32047-A (Reference 37). The companion report, NEDO-32164 (Reference 38) was approved by the same NRC SER. The NRC review concluded that the GEH TRACG code is an adequate tool to estimate the behavior of operating reactors during transients that may result in large power oscillations. The review also concluded that the ATWS criteria listed below are met:

1. Radiological consequences must be maintained within 10 CFR 100 guidelines;
2. Primary system integrity to be maintained;
3. Fuel damage limited so as not to significantly distort the core, impede core cooling, or prevent safe shutdown;
4. Containment integrity to be maintained; and
5. Long-term shutdown and cooling capability to be maintained.

Furthermore, the NRC review concluded that the specified operator actions are sufficient to mitigate the consequences of an ATWS event with large core power oscillations. [[

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M+LTR SER Limitation and Condition 12.19 requires that a plant-specific ATWS instability calculation be performed to demonstrate that BSEP EOP actions, including boron injection and water level control strategy, effectively mitigate an ATWS event with large power oscillations in the MELLLA+ operating domain. The plant-specific ATWS instability calculation was: (1) based on the limiting exposure condition (BOC, peak reactivity, and EOC exposures were analyzed); (2) modeled the plant-specific configuration important to the ATWS instability response; and (3) used the limiting mode nodalization scheme (regional and core-wide modes were analyzed). M+LTR SER Limitation and Condition 12.23.5 requires that the power density be less than 52.5 MWt/Mlbm/hr at rated power. For BSEP, the plant-specific maximum power-to-flow ratio at rated power and minimum CF is 44.7 MWt/Mlbm/hr, which meets the requirement. The plant-specific TRACG calculation modeled in-channel water rod flow in accordance with M+LTR SER Limitation and Condition 12.24.1. The plant-specific ATWS instability calculation was performed using the latest NRC-approved neutronic and thermal-hydraulic codes TGBLA06/PANAC11 and TRACG04 (Reference 39).

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The results of the plant-specific TRACG ATWS instability calculation are provided in Table 9-6. Figures 9-10 and 9-11 show the mitigating effect of decreasing water level.

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The results of the plant-specific TRACG ATWS instability calculation meet the ATWS acceptance criteria. The use of PRIME satisfies the Methods LTR SER Limitation and Condition 9.12. Therefore, the BSEP response to an ATWS with core instability event initiated in the MELLLA+ operating domain is acceptable. BSEP EOP actions, including boron injection and water level control strategy, effectively mitigate an ATWS event with large power oscillations in the MELLLA+ operating domain.

Table 9-1 AOO Event Results Summary

Event	Parameter	Unit	CLTP ICF (104.5%) Rated Core Flow	CLTP 85% Rated Core Flow
TTNB	Peak Neutron Flux	% Initial	377	337
	Peak Heat Flux	% Initial	130	128
	Peak Vessel Pressure	psia	1302	1290
	ΔCPR (TSSS)	NA	0.33	0.30
LRNB	Peak Neutron Flux	% Initial	377	333
	Peak Heat Flux	% Initial	130	128
	Peak Vessel Pressure	psia	1300	1289
	ΔCPR (TSSS)	NA	0.33	0.30
FWCF	Peak Neutron Flux	% Initial	314	270
	Peak Heat Flux	% Initial	128	126
	Peak Vessel Pressure	psia	1274	1259
	ΔCPR (TSSS)	NA	0.30	0.27
LFWH	ΔCPR	NA	0.10*	--
CRWE	ΔCPR	NA	0.19*,†	--

* {{
}}

† Result presented is for a RBM setting of 108%

Table 9-2 Comparison Slow Recirculation Flow Increase Results and MCPR Flow Limit

Flow (%)	Slow Recirculation Flow Increase MCPR	MCPR Flow Limit
31	1.61	1.70
40	1.54	-----
50	1.51	-----
55	-----	1.60
60	1.46	-----
70	1.34	-----
80	1.29	-----
90	1.23	-----
100	1.16	1.18
107	1.09	1.18

Table 9-3 Key Input Parameters for ATWS Analyses

Parameter	MELLLA+	Basis
Reactor Power (MWt)	2,923	[[
Analyzed Power (MWt)	2,923	
Analyzed Core Flow (Mlbm/hr / % Rated)	65.45 / 85.0	
Reactor Dome Pressure (psia)	1,045	
MSIV Closure Time (sec)	4.0	
High Pressure ATWS-RPT Setpoint (psig)	1,147	
Low Pressure Isolation Setpoint (psig)	785	
RCIC Flow Rate (gpm)	500	
HPCI Flow Rate (gpm)	4,250	
Number of SRVs / SRVs OOS	11 / 1	
Each SRV Capacity at 1,080 psig (Mlbm/hr)	0.830	
SRV Analytical Opening Setpoints (psig)	1,174.2 – 1,220.4	
Turbine Bypass Capacity (% Rated Steam Flow)	15.5	
SLCS Injection Location	Lower Plenum	
SLCS Injection Rate (gpm)	86	
Boron-10 Enrichment (atom %)	92	
Sodium Pentaborate Concentration (% by weight)	8.5	
SLCS Liquid Transport Time (sec)	30	
SLCS Initiation Delay (sec)	0	
Initial Suppression Pool Liquid Volume (ft^3)	86,450	
Initial Suppression Pool Temperature (°F)	95	
Number of RHR SPC Loops	2	
RHR Heat Exchanger Effectiveness Per Loop (BTU/sec-°F)	235	
Number of RHR SPC Loops during LOOP Event	2	
RHR Heat Exchanger Effectiveness Per Loop during LOOP Event (BTU/sec-°F)	235	]]

Note:

1. [[
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Table 9-4 Key Results for Licensing Basis ODYN ATWS Analysis

ATWS Acceptance Criteria	MELLLA+	Design Limit
Peak Vessel Pressure (psig)	[[	1,500
Peak Suppression Pool Temperature (°F)		207.7
Peak Containment Pressure (psig)		62
Peak Cladding Temperature (°F)		2,200
Peak Local Cladding Oxidation (%) [1]	]]	17

Note:

1. [[

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Table 9-5 ODYN ATWS Analysis Limiting Event Results

Parameter	Limiting Event	Peak Value	Time Trace
Reactor Power (Heat Flux)	PRFO at EOC	154.1% Rated	Figure 9-6
Reactor Vessel Pressure	PRFO at BOC	1,496 psig	Figure 9-7
Suppression Pool Temperature	MSIVC at EOC	174.0°F	Figure 9-8
Peak Cladding Temperature	MSIVC at EOC	1,215°F	Figure 9-9

Table 9-6 Key Results for ATWS with Core Instability Analysis from MELLLA+ Operating Domain

ATWS Acceptance Criteria	MELLLA+	Design Limit
Peak Vessel Pressure (psig) [1]	[[	1,500
Peak Suppression Pool Temperature (°F) [1]		207.7
Peak Containment Pressure (psig)		62
Peak Cladding Temperature (°F)		2,200
Peak Local Cladding Oxidation (%) [2]	]]	17

Notes:

1. Peak vessel pressure and suppression pool temperature for ATWS/I are less than ODYN limiting event results shown in Table 9-5. Cladding oxidation was not calculated as part of the ODYN limiting event calculations in Table 9-5.
2. [[

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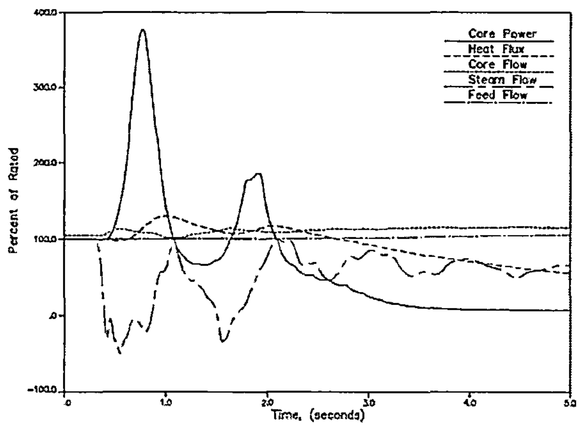
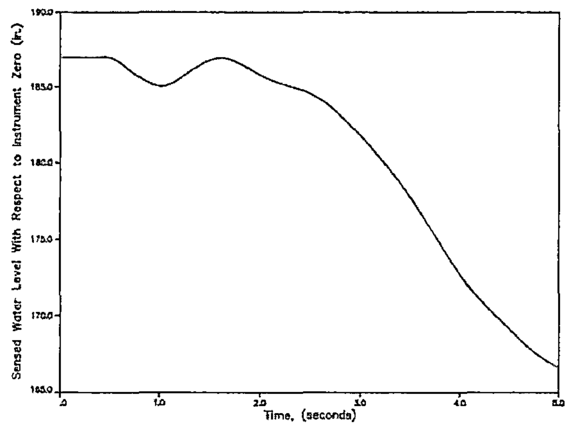
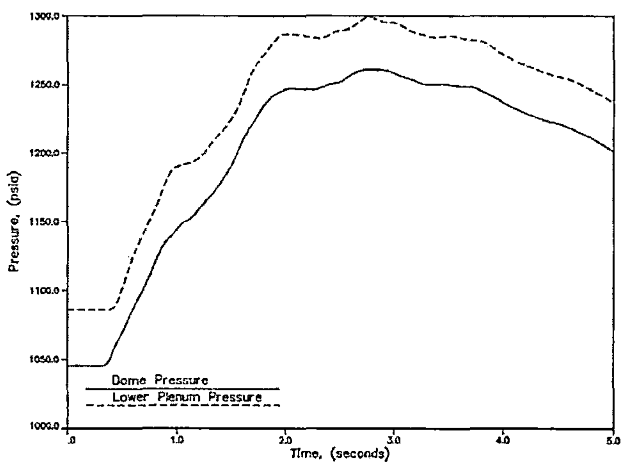


Key Parameters

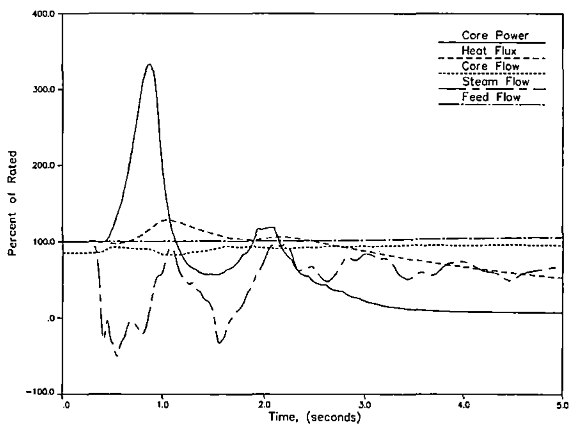


Sensed Water Level

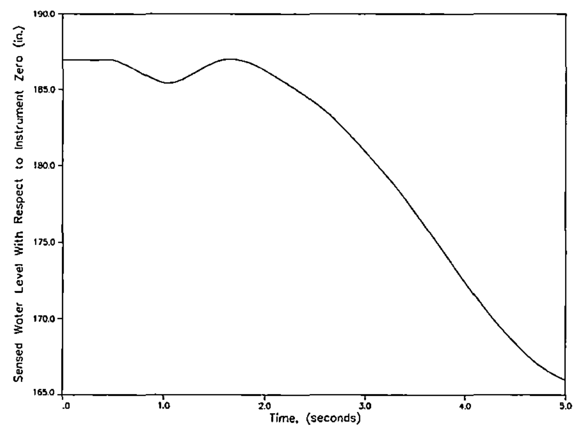


Vessel Pressures

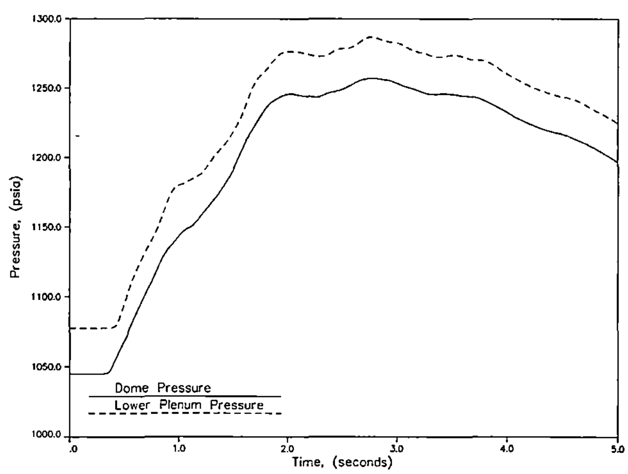
Figure 9-1 EOCLB LRNB at 100P/104.5F – TSSS



Key Parameters

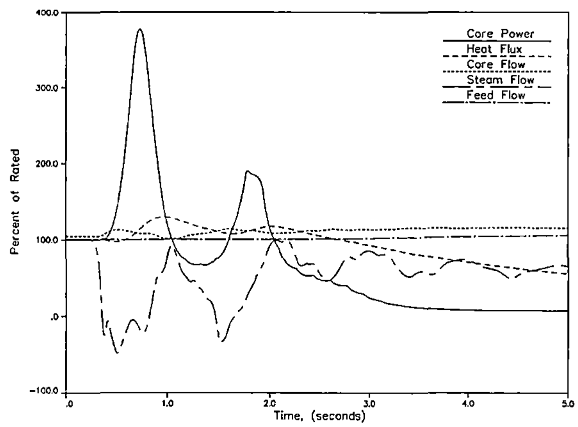


Sensed Water Level

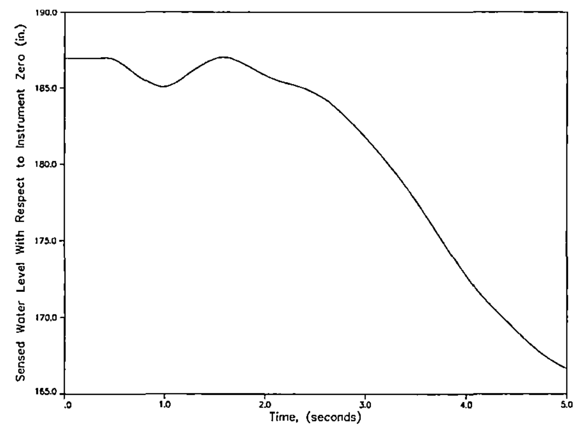


Vessel Pressures

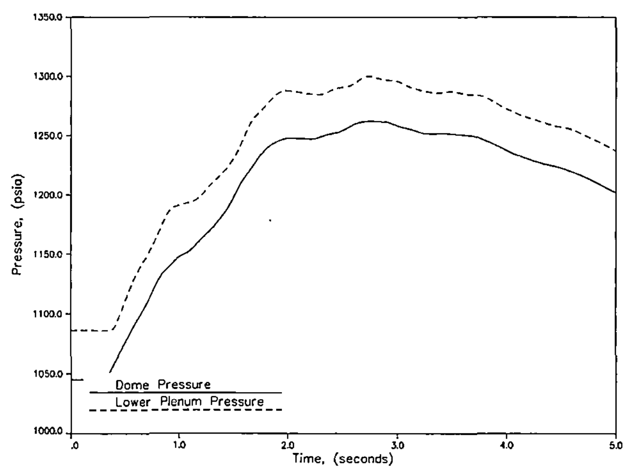
Figure 9-2 EOCLB LRNB at 100P/85F – TSSS



Key Parameters

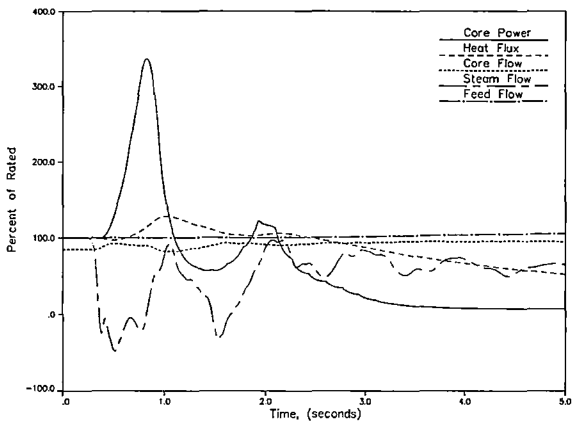


Sensed Water Level

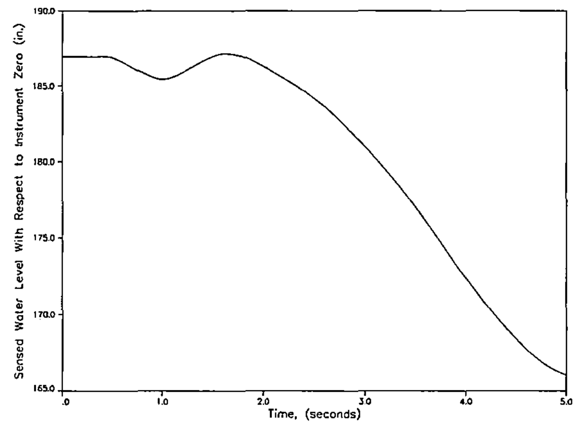


Vessel Pressures

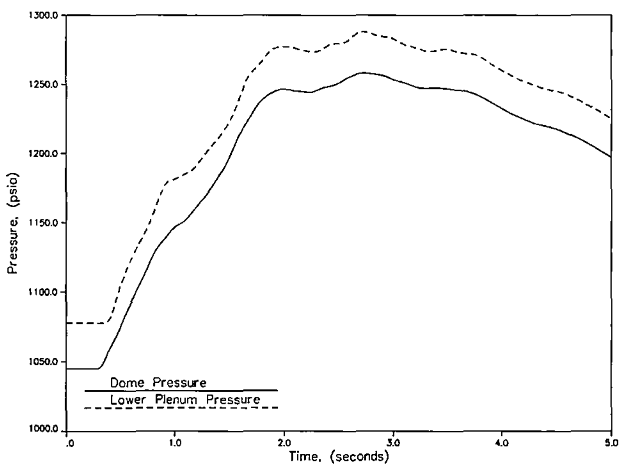
Figure 9-3 EOCLB TTNB at 100P/104.5F – TSSS



Key Parameters



Sensed Water Level



Vessel Pressures

Figure 9-4 EOCLB TTNB at 100P/85F – TSSS

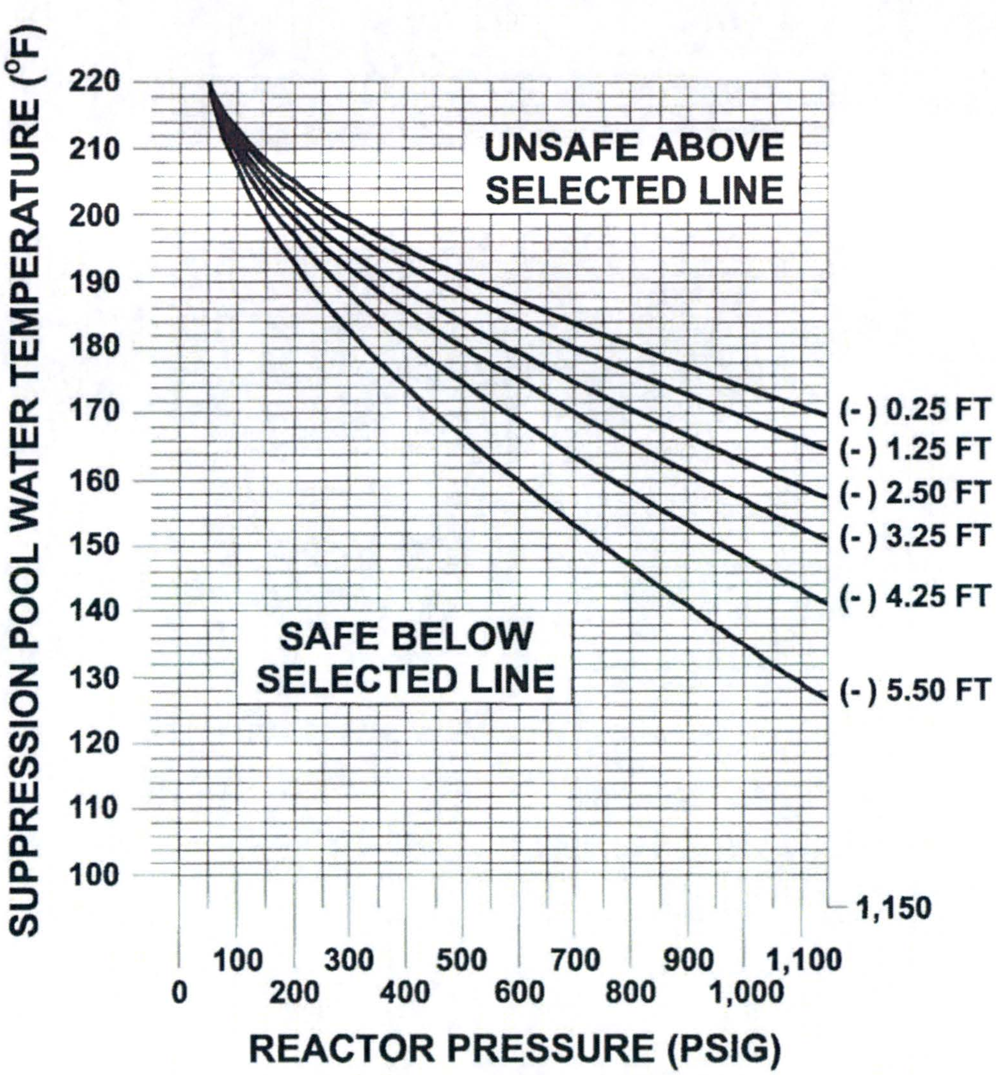


Figure 9-5 HCTL as a Function of Reactor Pressure

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Figure 9-6 ODYN ATWS Analysis – PRFO at EOC Reactor Power (Neutron Flux)

[[

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Figure 9-7 ODYN ATWS Analysis – PRFO at BOC Reactor Dome Pressure

[[

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Figure 9-8 ODYN ATWS Analysis – MSIVC at EOC Suppression Pool Temperature

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Figure 9-9 ODYN ATWS Analysis – MSIVC at EOC PCT

[[

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Note: [[

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Figure 9-10 Best-Estimate TRACG ATWS Analysis in MELLLA+ Operating Domain – TTWBP at 120% OLTP / 85% Core Flow Initial Condition – BOC With Regional Instability

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Figure 9-11 Best-Estimate TRACG ATWS Analysis in MELLLA+ Operating Domain – TTWBP at 120% OLTP / 85% Core Flow Initial Condition – BOC With Regional Instability

10.0 OTHER EVALUATIONS

This section addresses the evaluations in Section 10 of the M+LTR.

10.1 HIGH ENERGY LINE BREAK

HELBs are evaluated for their effects on equipment qualification. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Steam Lines	Generic	Confirmed
Balance-of-Plant Liquid Lines	Generic	Confirmed
Other Liquid Lines	Generic	Plant Specific Evaluation Acceptable

10.1.1 Steam Lines

The generic disposition of the HELB Steam Lines topic in the M+LTR describes that MELLLA+ operating domain expansion has no effect on the steam pressure or enthalpy at the postulated steam line break locations. Therefore, MELLLA+ has no effect on the mass and energy releases from an HELB in a steam line. Therefore, no plant-specific evaluation is required for steam line breaks.

Consistent with the generic disposition presented above, a review of the heat balances produced for BSEP MELLLA+ operating domain expansion confirms that there is no effect on the steam pressure or enthalpy at the postulated break locations (e.g., MS, HPCI, RCIC). Therefore, MELLLA+ has no effect on the mass and energy releases from an HELB in a steam line. Therefore, no plant-specific evaluation is required for steam line breaks.

The evaluation of the BSEP HELBs in steam lines is confirmed to be consistent with the generic disposition in the M+LTR.

10.1.2 Balance-of-Plant Liquid Lines

The generic disposition of the HELB BOP Liquid Lines topic in the M+LTR describes that MELLLA+ operating domain expansion has no effect on the steam pressure or enthalpy at the postulated FW line break locations. Therefore, MELLLA+ has no effect on the mass and energy releases from an HELB in a FW line. Therefore, no plant-specific evaluation is required for BOP liquid line breaks.

Consistent with the generic disposition presented above, a review of the heat balances produced for MELLLA+ confirms that there is no effect on the liquid line conditions at the postulated FW break locations. Therefore, MELLLA+ has no effect on the mass and energy releases from an HELB in a FW line. Therefore, no plant-specific evaluation is required for BOP liquid line breaks.

The evaluation of the BSEP HELB in BOP liquid lines is confirmed to be consistent with the generic disposition in the M+LTR.

10.1.3 Other Liquid Lines

The generic disposition of the HELB Other Liquid Lines topic in the M+LTR describes that [[

]] The scope of these evaluations includes MELLLA+ operating domain expansion effects on subcompartment pressures and temperatures, pipe whip, jet impingement, and flooding, consistent with the plant licensing basis.

A review of the heat balances produced for the BSEP MELLLA+ operating domain confirms that there is no effect on the liquid line conditions (excluding FW addressed in Section 10.1.2) at the postulated break locations. [[

]] The scope of these evaluations includes MELLLA+ operating domain expansion effects on subcompartment pressures and temperatures, pipe whip, jet impingement, and flooding, consistent with the plant licensing basis.

The BSEP-specific evaluation concludes that the HELB in other liquid lines is acceptable.

10.2 MODERATE ENERGY LINE BREAK

Moderate energy line breaks are not included in the BSEP Licensing Basis.

10.3 ENVIRONMENTAL QUALIFICATION

Safety-related components are required to be qualified for the environment in which they operate. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Electrical Equipment	Generic	Confirmed
Mechanical Equipment with Non-Metallic Components	Generic	Confirmed
Mechanical Component Design Qualification	Generic	Confirmed

10.3.1 Electrical Equipment

The generic disposition of the Electrical Equipment topic in the M+LTR describes that there is no change in core power, radiation levels, decay heat, pressure, steam flow, or FW flow as a result of the MELLLA+ operating domain expansion. [[

]] No further evaluation is required for environmental qualification of electrical equipment as a result of MELLLA+ operating domain expansion.

Consistent with the generic disposition presented above, the reactor power does not increase as a result of MELLLA+ operating domain expansion. There is no change in normal operation radiation levels (see Section 8.5). There is also no change in decay heat (see Section 1.2.3). For BSEP there are no increases in reactor operating pressure, MS or FW flow rates. The numerical values showing no increases in reactor operating pressure, MS or FW flow rates are presented in Table 1-2. [[

]] No further evaluation is required for environmental qualification of electrical equipment as a result of MELLLA+ operating domain expansion.

The evaluation of the BSEP environmental qualification of electrical equipment is confirmed to be consistent with the generic disposition in the M+LTR.

10.3.2 Mechanical Equipment With Non-Metallic Components

The generic disposition of the Mechanical Equipment with Non-Metallic Components topic in the M+LTR describes that operation in the MELLLA+ operating domain does not increase any of the normal process temperatures. [[

]] No further evaluation is required for environmental qualification of mechanical equipment with non-metallic components as a result of the MELLLA+ operating domain expansion.

Consistent with the generic disposition presented above, for BSEP, normal process temperatures are not affected by MELLLA+. There is no change in radiation levels in any of the plant areas where safety-related equipment is located (see Section 8.5). [[

]] No further evaluation is required for environmental qualification of mechanical equipment with non-metallic components equipment as a result of the MELLLA+ operating domain expansion.

The evaluation of the BSEP environmental qualification of mechanical equipment with non-metallic components is confirmed to be consistent with the generic disposition in the M+LTR.

10.3.3 Mechanical Component Design Qualification

The generic disposition of the Mechanical Component Design Qualification topic in the M+LTR describes that operation in the MELLLA+ operating domain does not change any of the normal process temperatures, pressures, or flow rates. [[

]] The change in fluid induced loads on safety-related components is discussed in Sections 3.2.2, 3.5 and 4.1.3. [[

]]

For BSEP normal process temperatures, pressures, and flow rates are not affected by MELLLA+. There is no change in radiation levels in any of the plant areas where safety-related equipment is located (see Section 8.5). [[

]]

The evaluation of the BSEP mechanical components design qualification is confirmed to be consistent with the generic disposition in the M+LTR.

10.4 TESTING

When the MELLLA+ operating domain expansion is implemented, testing is recommended to confirm operational performance and control aspects of the MELLLA+ changes. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Steam Separator-Dryer Performance	Plant Specific	Acceptable
APRM Calibration	Plant Specific	Acceptable
Core Performance	Plant Specific	Acceptable
Pressure Control	Plant Specific	Acceptable
Water Level Control	Plant Specific	Acceptable
Neutron Flux Noise Surveillance	Plant Specific	Acceptable

10.4.1 Steam Separator-Dryer Performance

The performance of the steam separator-dryer (i.e., MCO) is determined by a test similar to that performed in the original startup test program. Testing will be performed near the CLTP and the MELLLA+ minimum CF state point of 85% as well as other state points that may be deemed valuable for the purpose of defining the MCO magnitude and trend. This test does not involve safety-related considerations.

10.4.2 Average Power Range Monitor Calibration

The APRM system is calibrated and functionally tested. The APRM STP scram and rod block are calibrated with the MELLLA+ equations and the APRM trips and alarms tested. This test will confirm that the APRM trips, alarms, and rod blocks perform as intended in the MELLLA+ operating domain.

10.4.3 Core Performance

The core performance test will evaluate the core thermal power, fuel thermal margin, and CF performance to ensure a monitored approach to CLTP in the MELLLA+ operating domain. Measurements of reactor parameters are taken in the MELLLA+ operating domain. Core thermal power and fuel thermal margin are calculated using accepted methods. After steady-state conditions are established, measurements will be taken, core thermal power and fuel thermal margin calculated, and evaluated against projected values and operational limits.

10.4.4 Pressure Control

The pressure test will confirm that the pressure control system settings established for operation with the current power versus flow upper boundary at CLTP are adequate in the MELLLA+ operating domain. The pressure control system response to pressure changes is determined by making a reactor pressure change and monitoring the pressure control system response.

10.4.5 Water Level Control

The water level changes test verifies that the FWCS can provide acceptable reactor water level control in the MELLLA+ operating domain. Reactor water level changes are introduced, while the feedwater control system response is monitored.

10.4.6 Neutron Flux Noise Surveillance

The neutron flux noise surveillance test verifies that the neutron flux noise level in the reactor is within expectations in the MELLLA+ operating domain. The noise will be recorded by monitoring the LPRMs and APRMs at steady state conditions in the MELLLA+ operating domain.

10.5 INDIVIDUAL PLANT EXAMINATION

This section provides an assessment of the risk increase, including Core Damage Frequency (CDF) and Large Early Release Frequency (LERF), associated with operation in the MELLLA+ domain. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Initiating Event Categories and Frequency	Generic	Confirmed
Component Reliability	Generic	Confirmed
Operator Response	Generic	Confirmed
Success Criteria	Generic	Confirmed
External Events	Generic	Confirmed
Shutdown Risk	Generic	Confirmed
PRA Quality	Generic	Confirmed

In accordance with M+LTR SER Limitation and Condition 12.21, a plant-specific Probabilistic Risk Assessment (PRA) evaluation was performed (Reference 80), which included CDF and LERF impacts associated with operation in the MELLLA+ operating domain. The evaluation scope included all of the elements of Section 10.5, Individual Plant Examination, of the M+LTR (Reference 1).

The BSEP Full Power Internal Events (FPIE) and LERF current base CDF, change in CDF for MELLLA+ and MELLLA+ total CDF are shown in the tables below:

For FPIE

BSEP Unit	Base CDF (MELLLA)	Delta CDF	MELLLA+ CDF
1	7.87E-06	1.3E-07	8.0E-06
2	7.87E-06	1.17E-07	7.99E-06

For LERF

BSEP Unit	Base CDF (MELLLA)	Delta CDF	MELLLA+ CDF
1	5.67E-07	4.6E-08	6.13E-07
2	5.67E-07	4.56E-08	6.13E-07

Using the NRC guidelines established in Regulatory Guide 1.174 and the calculated results from the Level 1 and 2 PRA, the best estimate for the CDF risk increase (1.3E-07/yr) and the best estimate for the LERF increase (4.6E-08/yr) are both within Region III (i.e., changes that represent very small risk changes).

Based on the risk results from the plant-specific PRA evaluation, operation within the proposed BSEP MELLLA+ operating domain is acceptable on a risk basis.

10.5.1 Initiating Event Categories and Frequency

The MELLLA+ core operating domain expansion involves changes to the operating power/core flow map and a small number of setpoints and alarms. There is no change in the operating pressure, power, steam flow rate, and feedwater flow rate. MELLLA+ implementation does not include changes to plant hardware or operating procedures that would create additional event categories or have a significant effect on initiating event frequencies.

Typical internal initiating event categories were qualitatively assessed by reviewing the contributors to their occurrence and the effects of MELLLA+ on them. The contributors most likely to be affected by MELLLA+ are those associated with system and scram trip setpoints. The MELLLA+ operating domain expansion will require changes to some setpoints (e.g., flow-biased alarm and trip functions). The setpoints are established to ensure that adequate operational flexibility and necessary safety functions are maintained throughout the MELLLA+ operating domain (Section 5.3). Testing is recommended to confirm operational performance and control aspects of the MELLLA+ changes, including the setpoint changes (Section 10.4).

The MELLLA+ operating domain expansion does not significantly change the probability of an instability event. The probability of a two recirculation pump trip or a recirculation flow runback are unchanged.

The MELLLA+ operating domain expansion will not change the probability of an ATWS event. MELLLA+ implementation does not involve any changes to reactivity control systems and does not increase the scram demand frequency.

10.5.2 Component and System Reliability

The MELLLA+ operating domain expansion does not affect the system or component reliability (and thereby, there is no direct change to the core damage frequency (CDF) and large early release frequency (LERF) results). There is no change in the operating pressure, power, steam flow rate and FW flow rate. The MELLLA+ core operating domain expansion does not require major plant hardware modifications. No additional requirements will be imposed on any of the safety, balance-of-plant, electrical, or auxiliary systems. The environmental qualification envelope is not changed. The Technical Specifications (TS) ensure that plant and system performance parameters are maintained within the values assumed in the safety analyses. The TS setpoints, allowable values, operating limits are selected such that the equipment parameter values are equal to or more conservative than the values used in the safety analyses. Therefore, there will be no significant changes in component and system reliability.

10.5.3 Operator Response

The operator responses to anticipated operational occurrences; accidents and special events for EPU with MELLLA+ conditions are basically the same as for EPU conditions. MELLLA+ does not cause changes in any of the automatic safety actions. After the applicable automatic responses have initiated, the post-event operator actions for plant safety (e.g., maintaining safe shutdown, core cooling, containment cooling) remain the same for MELLLA+. It is assumed these actions are performed by cognizant staff, using applicable procedures, to mitigate the accident scenario.

Because decay heat is unchanged, the time for boil-off is unchanged. Therefore, long term core cooling is not affected by the MELLLA+ operating domain expansion.

The MELLLA+ operating domain expansion changes the dynamics for ATWS and ATWS instability events. For ATWS and ATWS instability events, the mitigation effect of recirculation pump trip is reduced under MELLLA+ conditions. The SLCS initiation, ADS inhibit, and level reduction operator mitigation actions become more important. A plant specific ATWS evaluation is required for MELLLA+ (Section 9.3.1), the evaluation did not impose any new boron injection requirements utilizing increased enriched boron. Also, no change is required for the operator ATWS response requirements (SLCS initiation, ADS inhibit, and level reduction). The new operator action to require initiation of lowering RPV water level within 120 seconds to mitigate ATWS instability events is judged not to impact the PRA.

Because there are no new operator actions and there is no significant reduction in the time available for operator actions, operator response for MELLLA+ has no significant effect on PRA.

10.5.4 Success Criteria

Systems success criteria credited in a PRA to perform the critical safety functions were analyzed based on MELLLA+. The critical safety functions are as follows:

1) Reactivity Control (Timing)
2) Overpressure Control (RPV Overpressure Margin)
3) Overpressure Control (SRV Actuations)
4) Vessel Depressurization (RPV Emergency Depressurization)
5) Reactor Coolant Makeup (RPV Inventory Makeup Requirements)
6) Containment Heat Removal (Heat Load to the Pool)
7) Containment Heat Removal (Blowdown Loads)

The MELLLA+ operating domain expansion involves changes to the operating power/core flow map and a small number of setpoints and alarms. There is no change in the operating pressure, power, steam flow rate, and feedwater flow rate. The MELLLA+ operating domain expansion does not impose any additional requirements on any of the safety, balance-of-plant, electrical, or auxiliary systems. Adequate SRV capacity is provided to ensure that the ATWS overpressure requirement for MELLLA+ is satisfied. Therefore, MELLLA+ operating domain expansion will not affect the PRA success criteria.

10.5.5 External Events

The MELLLA+ operating domain expansion does not affect the elements of an internal event PRA, as discussed in Sections 10.5.1 to 10.5.4. Therefore, there is negligible on the external events PRA.

10.5.6 Shutdown Risks

The MELLLA+ operating domain expansion does not change the shutdown conditions; therefore, it has no effect on the plant PRA shutdown risks.

10.5.7 Probabilistic Risk Assessment (PRA) Quality

MELLLA+ does not have a significant effect on any PRA elements. The BNP Full Power Internal Events (FPIE) PRA models and documentation were updated to reflect the plant configuration, the accumulation of additional plant operating history and component failure data at the time of this analysis. The base reference model used in this risk assessment is the Rev. 10 BNP Level 1 and Level 2 Pre-MELLLA+ EPU PRA average maintenance model. This model includes EPU implemented plant modifications.

The Level 1 and Level 2 BNP PRA analyses were originally developed and submitted to the NRC in August 1992 as the Brunswick Individual Plant Examination (IPE) Submittal. The BNP Level 1 PRA models supporting the IPE have been subsequently periodically updated since the late 1990s; and, the Level 1 model has been fully upgraded in 2011 to address comments from the 2010 Full Power Internal Events (FPIE) PRA peer review. The Level 2 analysis was fully upgraded in 2010.

Therefore, the BSEP PRA model is of sufficient scope and quality to measure the potential changes in plant risk due to MELLLA+ implementation.

10.6 OPERATOR TRAINING AND HUMAN FACTORS

Some additional training is required to prepare for BSEP operation in the MELLLA+ operating domain. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Operator Training and Human Factors	Plant Specific	Acceptable

The description of the Operator Training and Human Factors topic in the M+LTR describes that the operator training program and plant simulator will be evaluated to determine the specific changes required. The selection of training topics, operator training, the control room modifications, and simulator modifications are within the scope of the Duke Energy. Required changes are part of the MELLLA+ implementation plan and will be made consistent with the Duke Entergy's current plant training program requirements. These changes will be made consistent with similar changes made for other plant modifications and include any changes to Technical Specifications, EOPs, and plant systems.

The operator responses to anticipated operational occurrences, accidents and special events are not significantly affected by operation in the MELLLA+ domain. Significant events result in automatic plant shutdown (scram). Some events result in automatic reactor coolant pressure boundary pressure relief, ADS actuation and/or automatic ECCS actuation (for low water level events). MELLLA+ operating domain expansion does not cause changes in any of the automatic safety functions. After the automatic responses have initiated, the operator actions for plant safety (e.g., maintaining safe shutdown, core cooling, containment cooling) do not change for MELLLA+ operating domain expansion.

Consistent with the requirements for the plant-specific analysis as described in the M+LTR, the operator training program and plant simulator will be evaluated to determine the specific changes required. Simulator changes and fidelity validation will be performed in accordance with applicable American National Standards Institute (ANSI) standards currently being used at the training simulator. Section 10.9 addresses the MELLLA+ operating domain effects on the Emergency Operating Procedures.

The primary effects of MELLLA+ operating domain expansion on Main Control Room (MCR) operation involve changes to the power/flow map. Other than the changes to the computer display for the power/flow map, there are no major physical changes to the MCR controls, displays or alarms. In support of MELLLA+, the PRNMS requires hardware and software changes through implementation of the DSS-CD solution, including an ABSP. As a result, some changes are required to MCR panel board alarm settings and automatic actuation setpoints to accommodate changes due to MELLLA+ operating domain expansion.

The APRM STP scram and rod block AVs are also being changed as a result of MELLLA+ operating domain expansion. These changes are described in Section 5.3. Changes to the automatic actuation setpoints are implemented as design changes in accordance with the BSEP approved change control procedures. The change control process includes a review by operations and training personnel. Training and implementation requirements are identified and tracked, including effects on the simulator. Verification of training is required as part of the design change closure process.

There are no planned upgrades of controls, displays or alarms from analog to digital instruments as part of MELLLA+ operating domain expansion. There are no changes to the analog and digital inputs for the Safety Parameter Display System (SPDS) for MELLLA+ operating domain expansion.

Training required to operate BSEP following the MELLLA+ operating domain expansion will be conducted prior to operation in the MELLLA+ domain. Training for the MELLLA+ startup testing program will be performed using "just in time" training of plant operation personnel where appropriate. Data obtained during operation in the MELLLA+ domain will be incorporated into additional training, as needed. The classroom training will cover various aspects of MELLLA+ operating domain expansion, including changes to the power/flow map, changes to important setpoints, changes to plant procedures, and startup test procedures. The classroom training may be combined with simulator training for normal operational sequences unique to operation in the MELLLA+ domain. Because the plant dynamics do not change substantially for operation in the MELLLA+ domain, specific simulator training on transients is not anticipated. However, enhanced training on ATWS event mitigation in the MELLLA+ domain will be conducted.

The BSEP operator training and human factors is consistent with the guidance presented in the M+LTR and meets current industry standards.

10.7 Plant Life

The plant life evaluation identifies degradation mechanisms influenced by increases in fluence and flow rate. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Irradiated Assisted Stress Corrosion Cracking (IASCC)	Plant Specific	Acceptable
Flow Accelerated Corrosion	Generic	Confirmed

10.7.1 Irradiated Assisted Stress Corrosion Cracking

With regard to IASCC, the M+LTR states that the longevity of most equipment is not affected by the MELLLA+ operating domain expansion. The peak fluence experienced by the reactor internals may increase, representing a minor increase in the potential for IASCC. Therefore, the current inspection strategy for the reactor internal components is adequate to manage any potential effects of MELLLA+.

Section 3.2.1 provides an evaluation of the change in fluence experienced by the reactor internals. The change in fluence is minor, resulting in an insignificant change in the potential for IASCC. Therefore, the current inspection strategy based on the BWRVIP inspection recommendations, including BWRVIP-25, 26, 76, and 183 (References 40, 41, 42, and 43), is sufficient to address the small increase in fluence.

Fluence calculations performed at MELLLA+ conditions as required by M+LTR SER Limitation and Condition 12.22 indicate that the top guide, core plate, and shroud exceed the 5E20 n/cm^2 threshold value for IASCC. The peak top guide fluence was calculated to be 3.25E22 n/cm^2. The peak core plate fluence was calculated to be 7.45E20 n/cm^2. The peak shroud fluence was calculated to be 3.80E21 n/cm^2.

The increase in fluence of the core plate due to MELLLA+ does cause an increased potential for IASCC. However, the inspection strategies and inspections recommended by BWRVIP-25, 26, and 76 (References 40, 41, and 42) are based on component configuration and field experience and this inspection program is considered adequate to address the increase in potential for IASCC in the core plate as well as the potential for IASCC in the top guide and shroud.

The BWRVIP evaluated the failure modes and effects of reactor vessel internals and published the results in BWRVIP-06 (Reference 44). This evaluation for the shroud concluded that the inspections and evaluations performed in response to GL 94-03 (Reference 45) provided conservative assurance that the shroud is able to perform its safety function. The inspections of the top guide, core plate and shroud are conducted using the guidance of BWRVIP-25, 26, 76 and 183 (References 40, 41, 42, and 43). These guidelines in the areas of detection, inspection, repair or mitigation ensure the long-term function of these components.

10.7.2 Flow Accelerated Corrosion

The generic disposition of the Flow Accelerated Corrosion (FAC) topic in the M+LTR describes that for MELLLA+, there is no increase in the MS flow rate or temperature, or the FW flow rate and temperature. As described in Section 3.3.3, the MCO may increase in the MS lines. If this occurs, it may slightly increase the FAC rates for a small period of time during the cycle when the plant is operating at or near the MELLLA+ minimum core flow. BSEP analytical limit analysis indicates that the moisture contain leaving the reactor vessel may be as high as 0.20 wt.% while operating in the MELLLA+ operating domain. [[

]] The Maintenance Rule also provides oversight for the other mechanical and electrical components important to plant safety, to guard against age-related degradation. Therefore, no further evaluation of this topic is required per the M+LTR.

Consistent with the generic disposition presented above, for BSEP there are no significant changes in MS or FW temperatures, MS or FW flow rates. As discussed in Section 3.3.3, there is a small increase in average moisture content during short periods of the cycle. This small increase in moisture content has no significant effect on FAC parameters. Therefore, there is no change in the potential for FAC. The evaluation of and inspection for flow-induced erosion/corrosion in piping systems affected by FAC is addressed by compliance with NRC Generic Letter (GL) 89-08. The requirements of GL 89-08 are implemented at BSEP by utilization of the Electric Power Research Institute generic program, "CHECWORKS." BSEP specific parameters are entered into this program to develop requirements for monitoring and maintenance of specific system components. No changes are required to the BSEP specific parameters that are entered into the CHECWORKS program. The BSEP FAC implementing documents (references 81 and 82) consider the FAC susceptibility of lines with steam quality above 99.5% to be low. Therefore, the FAC monitoring programs are adequate to manage potential effects of MELLLA+ operating domain expansion.

In addition to FAC, a periodic non-destructive examination program was established to inspect safety-related piping and heat exchangers at known or suspected high corrosion, biofouling or silt buildup areas in response to GL 89-13. This program is supplemented by visual inspections of opened piping and heat exchangers whenever possible.

The Maintenance Rule also provides oversight for other mechanical and electrical components important to plant safety, to monitor performance and guard against age-related degradation. The longevity of BSEP equipment is not affected by the MELLLA+ operating domain expansion.

The evaluation of effects of FAC in the MELLLA+ operating domain at BSEP is confirmed to be consistent with the generic disposition in the M+LTR.

10.8 NRC AND INDUSTRY COMMUNICATIONS

The topic addressed in this evaluation is:

Topic	M+LTR Disposition	BSEP Result
Plant Disposition of NRC and Industry Communications	Generic	Confirmed

The generic disposition of the NRC and Industry Communications topic in the M+LTR describes that NRC and industry communications could affect the plant design and safety analyses. As discussed in Section 1.0, the MELLLA+ operating domain expansion has a limited effect on the SEs and system assessments. Because the maximum thermal power and CF rate do not change for MELLLA+ operating domain expansion, the effect of the changes is limited to the NSSS, primarily within the core. The evaluations and calculations included in this M+SAR, along with any supplements, demonstrate that the MELLLA+ operating domain expansion can be accomplished within the applicable design criteria. Because these evaluations of plant design and safety analyses inherently include any effect as a result of NRC and industry communications, it is not necessary to review prior communications and no additional information is required in this area.

The evaluation of NRC and industry communications is confirmed to be consistent with the generic disposition in the M+LTR and no additional information is required.

10.9 EMERGENCY AND ABNORMAL OPERATING PROCEDURES

Emergency and abnormal operating procedures (EOPs, AOPs) can be affected by MELLLA+ operating domain expansion. The topics addressed in this evaluation are:

Topic	M+LTR Disposition	BSEP Result
Emergency Operating Procedures	Plant Specific	Acceptable
Abnormal Operating Procedures	Plant Specific	Acceptable

10.9.1 Emergency Operating Procedures

EOPs include variables and limit curves, which define conditions where operator actions are indicated. The EOPs remain symptom-based and thus the operator actions remain unchanged. MELLLA+ operating domain expansion is not expected to affect the BSEP EOPs. However, in accordance with M+LTR SER Limitation and Condition 12.23.4, the EOPs will be reviewed for any effect and revised as necessary prior to implementation of MELLLA+ operating domain expansion. Any changes identified to the EOPs will be included in the operator training to be conducted prior to implementation of MELLLA+. The ATWS calculation performed for MELLLA+ was based on the BSEP operator actions from the EOPs.

10.9.2 Abnormal Operating Procedures

AOPs include event based operator actions. No significant AOP revisions are expected as a result of MELLLA+ operating domain expansion. However, the AOPs will be reviewed for any effect and revised as necessary prior to implementation of MELLLA+ operating domain expansion. Any changes identified to the AOPs will be included in the operator training to be conducted prior to implementation of MELLLA+.

11.0 LICENSING EVALUATIONS

The proposed changes to the BSEP TS, Facility Operating License, Environmental Assessment and Significant Hazards Consideration Assessment are described in the BSEP MELLLA+ LAR.

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Appendix A

Limitations from the Final Safety Evaluation for LTR NEDC-33173P

Disposition of additional limitations and conditions related to the final SE for NEDC-33173P, "Applicability of GE Methods to Expanded Operating Domains"

There are 24 limitations and conditions listed in Section 9 of the Methods LTR SER. The table below lists each of the 24 limitations and conditions and identifies which section of the M+SAR discusses compliance with each limitation and condition.

Appendix A (continued)

Disposition of additional limitations and conditions related to the final SE for NEDC-33173P, "Applicability of GE Methods to Expanded Operating Domains"

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
9.1	TGBLA/PANAC Version	The neutronic methods used to simulate the reactor core response and that feed into the downstream safety analyses supporting operation at EPU/MELLLA+ will apply TGBLA06/PANAC11 or later NRC-approved version of neutronic method.	GEH - Comply AREVA – NA AREVA used the most current NRC approved neutronics methods (CASMO4/MICROBURN-B2 - EMF-2158(P)(A))	GEH - Table 1-1 and AREVA Table 1-1a, Section 2.6.1
9.2	3D Monicore	For EPU/MELLLA+ applications, relying on TGBLA04/PANAC10 methods, the bundle RMS difference uncertainty will be established from plant-specific core-tracking data, based on TGBLA04/PANAC10. The use of plant-specific trendline based on the neutronic method employed will capture the actual bundle power	N/A. Duke uses the POWERPLEX core monitoring system based on the NRC approved CASMO-4/ MICROBURN-B2 methodology. The uncertainties associated with POWERPLEX CMS are used in the statistical	BSEP core monitoring is not based on 3D Monicore using TGBLA 04 /PANAC10.

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		uncertainty of the core monitoring system.	analyses that are performed by AREVA.	
9.3	Power/Flow Ratio	Plant-specific EPU and expanded operating domain applications will confirm that the core thermal power to core flow ratio will not exceed 50 MWt/Mlbm/hr at any statepoint in the allowed operating domain. For plants that exceed the power-to-flow value of 50 MWt/Mlbm/hr, the application will provide power distribution assessment to establish that neutronic methods axial and nodal power distribution uncertainties have not increased.	Comply	Sections 1.2.1 and 2.2.5 (1) Consistent with Reference 2
9.4	SLMCPR 1	For EPU operation, a 0.02 value shall be added to the cycle-specific SLMCPR value. This adder is applicable to SLO, which is derived from the dual loop SLMCPR value.	N/A No adders are imposed on AREVA methods for EPU operation.	N/A

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
9.5	SLMCPR 2	For operation at MELLLA+, including operation at the EPU power levels at the achievable core flow statepoint, a 0.03 value shall be added to the cycle-specific SLMCPR value.	No adders are imposed on AREVA methods.	N/A
9.6	R-Factor	The plant specific R-factor calculation at a bundle level will be consistent with lattice axial void conditions expected for the hot channel operating state. The plant-specific EPU/MELLLA+ application will confirm that the R-factor calculation is consistent with the hot channel axial void conditions.	Comply The corresponding factors in AREVA methods are K-factors. These factors account for the conditions calculated within the fuel assembly.	Section 2.2
9.7	ECCS-LOCA 1	For applications requesting implementation of EPU or expanded operating domains, including MELLLA+, the small and large break ECCS-LOCA analyses will include top-peaked and mid-peaked power shape in establishing the maximum average planar linear heat generation	Comply LOCA analyses include top-peaked and bottom-peaked power shapes and both large and small breaks. The AREVA LOCA methodology does not	Sections 4.3.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		rate (MAPLHGR) and determining the PCT. This limitation is applicable to both the licensing bases PCT and the upper bound PCT. The plant-specific applications will report the limiting small and large break licensing basis and upper bound PCTs.	include an upper bound PCT.	
9.8	ECCS-LOCA 2	The ECCS-LOCA will be performed for all statepoints in the upper boundary of the expanded operating domain, including the minimum core flow statepoints, the transition statepoint, as defined in Reference 1 and the 55 percent core flow statepoint. The plant-specific application will report the limiting ECCS-LOCA results as well as the rated power and flow results. The SRLR will include both the limiting statepoint ECCS-LOCA results and the rated conditions ECCS-LOCA results.	Comply	Sections 4.3

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
9.9	Transient LHGR 1	Plant-specific EPU and MELLLA+ applications will demonstrate and document that during normal operation and core-wide AOOs, the thermal-mechanical (T-M) acceptance criteria as specified in Amendment 22 to GESTAR II will be met. Specifically, during an AOO, the licensing application will demonstrate that the: (1) loss of fuel rod mechanical integrity will not occur due to fuel melting and (2) loss of fuel rod mechanical integrity will not occur due to pellet–cladding mechanical interaction. The plant-specific application will demonstrate that the T-M acceptance criteria are met for the both the UO_2 and the limiting GdO_2 rods.	Comply Power- and flow-dependent multipliers on the LHGR limits are established to ensure that the T-M acceptance criteria (fuel melting and strain) are met during normal operation and AOOs as part of the standard reload process using AREVAs NRC approved methods.	Section 9.1.2
9.10	Transient LHGR 2	Each EPU and MELLLA+ fuel reload will document the calculation results of the analyses demonstrating compliance to transient T-M	Comply T-M analyses will be performed each cycle to	Section 9.1.2

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		acceptance criteria. The plant T-M response will be provided with the SRLR or COLR, or it will be reported directly to the NRC as an attachment to the SRLR or COLR.	establish or confirm the power- and flow-dependent LHGR multipliers. These results will be included in the cycle-specific RSAR.	
9.11	Transient LHGR 3	To account for the impact of the void history bias, plant-specific EPU and MELLLA+ applications using either TRACG or ODYN will demonstrate an equivalent to 10 percent margin to the fuel centerline melt and the 1 percent cladding circumferential plastic strain acceptance criteria due to pellet-cladding mechanical interaction for all of limiting AOO transient events, including equipment out-of-service. Limiting transients in this case, refers to transients where the void reactivity coefficient plays a significant role (such as pressurization events). If the void history bias is incorporated into the transient model within the code, then	N/A AREVAs NRC approved thermal mechanical methodology does not have a void history bias.	N/A

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		the additional 10 percent margin to the fuel centerline melt and the 1 percent cladding circumferential plastic strain is no longer required.		
9.12	LHGR and Exposure Qualification	In MFN 06-481, GE committed to submit plenum fission gas and fuel exposure gamma scans as part of the revision to the T-M licensing process. The conclusions of the plenum fission gas and fuel exposure gamma scans of GE 10x10 fuel designs as operated will be submitted for NRC staff review and approval. This revision will be accomplished through Amendment to GESTAR II or in a T-M licensing LTR. PRIME (a newly developed T-M code) has been submitted to the NRC staff for review (Reference 46). Once the PRIME LTR and its application are approved, future license applications for EPU and MELLLA+ referencing LTR NEDC-33173P must utilize the	Comply for GEH methods. GEH methods only. AREVA uses the most current NRC approved T-M methods described in Reference 67.	For GEH ATWS analysis see Sections 9.3.1.1 and 9.3.3. For AREVA as discussed in Section 2.2.4, AREVA uses RODEX4 in the T-M evaluation

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		PRIME T-M methods.		
9.13	Application of 10 Weight Percent Gd	Before applying 10 weight percent Gd to licensing applications, including EPU and expanded operating domain, the NRC staff needs to review and approve the T-M LTR demonstrating that the T-M acceptance criteria specified in GESTAR II and Amendment 22 to GESTAR II can be met for steady-state and transient conditions. Specifically, the T-M application must demonstrate that the T-M acceptance criteria can be met for TOP and MOP conditions that bounds the response of plants operating at EPU and expanded operating domains at the most limiting statepoints, considering the operating flexibilities (e.g., equipment out-of-service). Before the use of 10 weight percent Gd for modern fuel designs, NRC must review and approve TGBLA06	N/A AREVA used the most current NRC approved T-M methods described in Reference 67.	(5)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		qualification submittal. Where a fuel design refers to a design with Gd-bearing rods adjacent to vanished or water rods, the submittal should include specific information regarding acceptance criteria for the qualification and address any downstream impacts in terms of the safety analysis. The 10 weight percent Gd qualifications submittal can supplement this report.		
9.14	Part 21 Evaluation of GESTR-M Fuel Temperature Calculation	Any conclusions drawn from the NRC staff evaluation of the GE's Part 21 report will be applicable to the GESTR-M T-M assessment of this SE for future license application. GE submitted the T-M Part 21 evaluation, which is currently under NRC staff review. Upon completion of its review, NRC staff will inform GE of its conclusions.	N/A The evaluation of the impact of pellet thermal conductivity degradation on AREVA methods is described in Reference 60 Appendix F.	N/A

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
9.15	Void Reactivity 1	The void reactivity coefficient bias and uncertainties in TRACG for EPU and MELLLA+ must be representative of the lattice designs of the fuel loaded in the core.	N/A Related information for AREVA methods is presented in Reference 60 Appendix B.	(4)
9.16	Void Reactivity 2	A supplement to TRACG /PANAC11 for AOO is under NRC staff review (Reference 39). TRACG internally models the response surface for the void coefficient biases and uncertainties for known dependencies due to the relative moderator density and exposure on nodal basis. Therefore, the void history bias determined through the methods review can be incorporated into the response surface "known" bias or through changes in lattice physics/core simulator methods for establishing the instantaneous cross-sections. Including the bias in the calculations negates the need for	N/A AREVA has not identified any bias related to void history and has determined that the void coefficient determined by the methodology is accurate and provides the best possible information for the transient analysis. This assessment is documented in the Methodology Applicability document ANP- 3108(P) which is being provided to the NRC as a supporting document for the Brunswick MELLLA+ LAR.	(2)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		ensuring that plant-specific applications show sufficient margin. For application of TRACG to EPU and MELLLA+ applications, the TRACG methodology must incorporate the void history bias. The manner in which this void history bias is accounted for will be established by the NRC staff SE approving NEDE-32906P, Supplement 3, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10," May 2006 (Reference 39). This limitation applies until the new TRACG/PANAC methodology is approved by the NRC staff.	Specifically, AREVA methodology {{ }} the reactivity coefficients that are used in the transient analysis. Conservatisms in the methodology are used to produce conservative results that bound the uncertainties in the reactivity coefficients. Data presented in ANP-3108(P) indicate that there are no significant differences between EPFOD and non-EPFOD conditions that have an impact on the reactivity coefficients. The transient results have been demonstrated to be conservative, so there is no penalty needed.	

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
9.17	Steady-State 5 Percent Bypass Voiding	The instrumentation specification design bases limit the presence of bypass voiding to 5 percent (LRPM *(sic)* levels). Limiting the bypass voiding to less than 5 percent for long-term steady operation ensures that instrumentation is operated within the specification. For EPU and MELLLA+ operation, the bypass voiding will be evaluated on a cycle-specific basis to confirm that the void fraction remains below 5 percent at all LPRM levels when operating at steady-state conditions within the MELLLA+ upper boundary. The highest calculated bypass voiding at any LPRM level will be provided with the plant-specific SRLR.	Comply Compliance will be included in the plant- specific reload licensing report (RSAR).	Sections 2.1.2 and 5.1.5 (1) Consistent with Reference 2
9.18	Stability Setpoints Adjustment	The NRC staff concludes that the presence bypass voiding at the low-flow conditions where instabilities are likely can result in calibration errors of less than 5 percent for OPRM cells	N/A	Section 2.4.1 (3)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		and less than 2 percent for APRM signals. These calibration errors must be accounted for while determining the setpoints for any detect and suppress long term methodology. The calibration values for the different long-term solutions are specified in the associated sections of this SE, discussing the stability methodology.		
9.19	Void-Quality Correlation 1	For applications involving PANCEA/ODYN/ISCOR/TASC for operation at EPU and MELLLA+, an additional 0.01 will be added to the OLMCPR, until such time that GE expands the experimental database supporting the Findlay-Dix void-quality correlation to demonstrate the accuracy and performance of the void-quality correlation based on experimental data representative of the current fuel designs and operating conditions during steady-state,	N/A The void quality correlations used in the AREVA methods are addressed in Reference 60 Appendix B. No penalties are needed for AREVA methodology.	N/A

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		transient, and accident conditions.		
9.20	Void-Quality Correlation 2	The NRC staff is currently reviewing Supplement 3 to NEDE-32906P, "Migration to TRACG04/PANAC11 from TRACG02/PANAC10," dated May 2006 (Reference 39). The adequacy of the TRACG interfacial shear model qualification for application to EPU and MELLLA+ will be addressed under this review. Any conclusions specified in the NRC staff SE approving Supplement 3 to LTR NEDC-32906P (Reference 39) will be applicable as approved.	N/A	N/A for AREVA methodologies, 9.3.3 (2) (GEH)
9.21	Mixed Core Method 1	Plants implementing EPU or MELLLA+ with mixed fuel vendor cores will provide plant-specific justification for extension of GE's analytical methods or codes. The content of the plant-specific application will cover the topics addressed in this SE as well as	N/A, Because BSEP cores are not mixed vendor cores, this limitation and condition is not applicable. This limitation and condition relates to the use of GNF core design methods for the design of cores at	N/A The initial MELLLA+ Brunswick operation will contain only AREVA ATRIUM

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		subjects relevant to application of GE's methods to legacy fuel. Alternatively, GE may supplement or revise LTR NEDC-33173P (Reference 2) for mixed core application.	EPU/MELLLA+ using a combination of GNF and non-GNF fuel	10XM fuel.
9.22	Mixed Core Method 2	For any plant-specific applications of TGBLA06 with fuel type characteristics not covered in this review, GE needs to provide assessment data similar to that provided for the GE fuels. The Interim Methods review is applicable to all GE lattices up to GE14. Fuel lattice designs, other than GE lattices up to GE14, with the following characteristics are not covered by this review: • square internal water channels water crosses • Gd rods simultaneously adjacent to water and vanished rods • 11x11 lattices	N/A. The GEH Methods LTR L&C 9.22 Mixed Core Method does not literally apply to BSEP because the core contains only AREVA ATRIUM 10XM fuel. However, the qualification of TGBLA06 for modeling the AREVA ATRIUM 10XM fuel in the BSEP equilibrium design using PANAC11 has been demonstrated to be acceptable based on MCNP lattice level benchmarking compared to the existing GNF 10x10 fuel products (GE14 and GNF2) results.	N/A

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		• MOX fuel The acceptability of the modified epithermal slowing down models in TGBLA06 has not been demonstrated for application to these or other geometries for expanded operating domains. Significant changes in the Gd rod optical thickness will require an evaluation of the TGBLA06 radial flux and Gd depletion modeling before being applied. Increases in the lattice Gd loading that result in nodal reactivity biases beyond those previously established will require review before the GE methods may be applied.		
9.23	MELLLA+ Eigenvalue Tracking	In the first plant-specific implementation of MELLLA+, the cycle-specific eigenvalue tracking data will be evaluated and submitted to NRC to establish the performance of nuclear methods under the	N/A	BSEP is not the first LAR submittal for MELLLA+ for GEH or AREVA methods.

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		operation in the new operating domain. The following data will be analyzed: • Hot critical eigenvalue, • Cold critical eigenvalue, • Nodal power distribution (measured and calculated TIP comparison), • Bundle power distribution (measured and calculated TIP comparison), • Thermal margin, • Core flow and pressure drop uncertainties, and • The MIP Criterion (e.g., determine if core and fuel design selected is expected to produce a plant response outside the prior experience base). Provision of evaluation of the core-tracking data will provide the NRC staff with bases to establish if operation at the expanded operating		

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		domain indicates: (1) changes in the performance of nuclear methods outside the EPU experience base; (2) changes in the available thermal margins; (3) need for changes in the uncertainties and NRC-approved criterion used in the SLMCPR methodology; or (4) any anomaly that may require corrective actions.		
9.24	Plant-Specific Application	The plant-specific applications will provide prediction of key parameters for cycle exposures for operation at EPU (and MELLLA+ for MELLLA+ applications). The plant-specific prediction of these key parameters will be plotted against the EPU Reference Plant experience base and MELLLA+ operating experience, if available. For evaluation of the margins available in the fuel design limits, plant-specific applications will also provide quarter core map (assuming core symmetry) showing	Comply	Section 2.1.2

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		bundle power, bundle operating LHGR, and MCPR for BOC, MOC, and EOC. Since the minimum margins to specific limits may occur at exposures other than the traditional BOC, MOC, and EOC, the data will be provided at these exposures.		

Appendix A (continued)

Disposition of additional limitations and conditions related to the final SE for NEDC-33173P, "Applicability of GE Methods to Expanded Operating Domains"

Notes:

1. Correspondence concerning implementation of this limitation and condition is docketed in Reference 2.
2. Supplement 3 of NEDE-32906P has been approved by the NRC, and the BSEP analyses are performed consistent with Supplement 3-A. The BSEP M+SAR licensing basis uses TRACG for ATWS-I analysis. The void reactivity coefficients bias and uncertainties used in the latest version of TRACG are applicable to the ATRIUM™ 10XM lattice designs loaded in the core. The BSEP M+SAR analysis uses ODYN as the licensing basis code for transient analysis
3. Not applicable to DSS-CD because [[

   ]]
4. BSEP not based on TRACG.
5. RODEX4 is approved to 10.0 wt.% gadolinia for solid UO2 fuel pellet. BSEP currently uses up to 7.5 wt.% in ATRIUM 10XM fuel design (Reference 67).

Appendix B

Limitations from the Final Safety Evaluation for LTR NEDC-33006P

Disposition of additional limitations and conditions related to the final SE for NEDC-33006P, "Maximum Extended Load Line Limit Analysis Plus"

There are 52 limitations and conditions listed in Section 12 of the M+LTR SER. The table below lists each of the 52 limitations and conditions and identifies which section of the M+SAR discusses compliance with each limitation and condition.

Appendix B (continued)

Disposition of additional limitations and conditions related to the final SE for NEDC-33006P, "Maximum Extended Load Line Limit Analysis Plus"

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.1	GEXL-PLUS	The plant-specific application will confirm that for operation within the boundary defined by the MELLLA+ upper boundary and maximum CF range, the GEXL-PLUS experimental database covers the thermal-hydraulic conditions the fuel bundles will experience, including, bundle power, mass flux, void fraction, pressure, and subcooling. If the GEXL-PLUS experimental database does not cover the within bundle thermal-hydraulic conditions, during steady state, transient conditions, and DBA conditions, GHNE will inform the NRC at the time of submittal and obtain the necessary data for the submittal of the plant-specific MELLLA+ application. In addition, the plant-	Comply The ACE/ATRIUM 10XM critical power correlation has a range of applicability for key inputs. The ranges and conservative actions to be applied should the range be exceeded are presented in ANP-10298PA Revision 1. The conservative actions yield conservative critical power results using the correlation within the appropriate ranges. A discussion on thermal hydraulic comparisons in the extended power flow operating domain is presented in Reference	Section 1.1.3

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		specific application will confirm that the experimental pressure drop database for the pressure drop correlation covers the pressure drops anticipated in the MELLLA+ range. With subsequent fuel designs, the plant-specific applications will confirm that the database supporting the CPR correlations covers the powers, flows and void fractions BWR bundles will experience for operation at and within the MELLLA+ domain, during steady state, transient, and DBA conditions. The plant-specific submittal will also confirm that the NRC staff reviewed and approved the associated CPR correlation if the changes in the correlation are outside the GESTAR II (Amendment 22) process. Similarly, the plant-specific application will confirm that the experimental pressure drop database does cover the range of pressures the fuel	60.	

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		bundles will experience for operation within the MELLLA+ domain.		
12.2	Related LTRs	Plant-specific MELLLA+ applications must comply with the limitations and conditions specified in and be consistent with the purpose and content covered in the NRC staff SEs approving the latest version of the following LTRs: NEDC-33173P, NEDC-33075P-A, and NEDC-33147-A.	Comply AREVA complied with the limitations and conditions associated with all of the NRC approved AREVA methods that are being applied for BSEP as well as the applicable issues from NEDC-33173P and NEDC-33006P as discussed in Appendix A and B of this document.	Sections 1.0 and 1.1.3

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.3.a	Concurrent Changes	The plant-specific analyses supporting MELLLA+ operation will include all operating condition changes that are implemented at the plant at the time of MELLLA+ implementation. Operating condition changes include, but are not limited to, those changes that affect, an increase in the dome pressure, maximum CF, fuel cycle length, or any changes in the licensed operational enhancements. For example, with an increase in dome pressure, the following analyses must be analyzed: the ATWS analysis, the ASME overpressure analyses, the transient analyses, and the ECCS-LOCA analysis. Any changes to the safety system settings or any actuation setpoint changes necessary to operate with the increased dome pressure must be included in the evaluations (e.g., SRV setpoints).	Comply	Section 1.1.2

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.3.b		For all topics in LTR NEDC-33006P that are reduced in scope or generically dispositioned, the plant-specific application will provide justification that the reduced scope or generic disposition is applicable to the plant. If changes that invalidate the LTR dispositions are to be implemented at the time of MELLLA+ implementation, the plant-specific application will provide analyses and evaluations that demonstrate the cumulative effect with MELLLA+ operation. For example, if the dome pressure is increased, the ECCS performance will be evaluated on a plant-specific basis.	Comply	Section 1.1.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.3.c		Any generic bounding sensitivity analyses provided in LTR NEDC-33006P will be evaluated to ensure that the key plant-specific input parameters and assumptions are applicable and bounded. If these generic sensitivity analyses are not applicable or additional operating condition changes affect the generic sensitivity analyses, a plant-specific evaluation will be provided. For example, with an increase in the dome pressure, the ATWS sensitivity analyses that model operator actions (e.g., depressurization if the HCTL is reached) needs to be reanalyzed, using the bounding dome pressure condition.	Comply	Section 1.1.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition.
12.3.d		If a new GE fuel product line or another vendor's fuel is loaded at the plant, the applicability of any generic sensitivity analyses supporting the MELLLA+ application shall be justified in the plant-specific application. If the generic sensitivity analyses cannot be demonstrated to be applicable, the analyses will be performed including the new fuel. For example, the ATWS instability analyses supporting the MELLLA+ condition are based on the GE14 fuel response. New analyses that demonstrate the ATWS instability performance of the new GE fuel or another vendor's fuel for MELLLA+ operation shall be provided to support the plant-specific application.	Comply All fuel-related events have either been dispositioned as non-limiting, or analyzed to support MELLLA+ operation with ATRIUM 10XM fuel.	Section 9.3.3 for GEH ATWS instability evaluation of AREVA ATRIUM 10XM fuel.

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.3.e		If a new GE fuel product line or another vendor's fuel is loaded at the plant prior to a MELLLA+ application, the analyses supporting the plant-specific MELLLA+ application will be based on a specific core configuration or bounding core conditions. Any topics that are generically dispositioned or reduced in scope in LTR NEDC-33006P will be demonstrated to be applicable, or new analyses based on the specific core configuration or bounding core conditions will be provided.	Comply	Section 2.1.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.3.f		If a new GE fuel product line or another vendor's fuel is loaded at the plant prior to a MELLLA+ application, the plant-specific application will reference an NRC-approved stability method supporting MELLLA+ operation, or provide sufficient plant-specific information to allow the NRC staff to review and approve the stability method supporting MELLLA+ operation. The plant-specific application will demonstrate that the analyses and evaluations supporting the stability method are applicable to the fuel loaded in the core.	Comply	Section 2.4.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.3.g		For MELLLA+ operation, core instability is possible in the event a transient or plant maneuver places the reactor at a high power/low-flow condition. Therefore, plants operating at MELLLA+ conditions must have a NRC-approved instability protection method. In the event the instability protection method is inoperable, the applicant must employ an NRC-approved backup instability method. The licensee will provide technical specification (TS) changes that specify the instability method operability requirements for MELLLA+ operation, including any backup stability protection methods.	Comply	Section 2.4.3

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.4	Reload analysis submittal	The plant-specific MELLLA+ application shall provide the plant-specific thermal limits assessment and transient analysis results. Considering the timing requirements to support the reload, the fuel and cycle-dependent analyses including the plant-specific thermal limits assessment may be submitted by supplementing the initial M+SAR. Additionally, the SRLR for the initial MELLLA+ implementation cycle shall be submitted for NRC staff confirmation.	Comply AREVA RSAR for SRLR equivalent	Sections 1.1.1, 9.1.1 and 9.1.2 (Reference 78 presents the plant specific thermal limits and transient analysis results for a representative MELLLA+ cycle.) A BSEP-specific AREVA reload licensing report will be submitted for the initial M+ cycle
12.5.a	Operating Flexibility	The licensee will amend the TS LCO for any equipment out-of-service (i.e., SLO) or operating flexibilities prohibited in the plant-specific MELLLA+ application.	Comply	Section 1.1.1, 1.2.4 and 3.6.3

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.5.b		For an operating flexibility, such as FWHOOS, that is prohibited in the MELLLA+ plant-specific application but is not included in the TS LCO, the licensee will propose and implement a license condition.	Comply	Section 1.2.4
12.5.c		The power flow map is not specified in the TS; however, it is an important licensed operating domain. Licensees may elect to be licensed and operate the plant under plant-specific-expanded domain that is bounded by the MELLLA+ upper boundary. Plant-specific applications approved for operation within the MELLLA+ domain will include the plant-specific power/flow map specifying the licensed domain in the COLR.	Comply	Section 1.2.1 and 3.6.3
12.6	SLMCPR Statepoints and CF Uncertainty	Until such time when the SLMCPR methodology (References 47 and 48) for off-rated SLMCPR calculation is approved by the staff for MELLLA+	Comply	Section 2.2.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		operation, the SLMCPR will be calculated at the rated statepoint (120 percent P/100 percent CF), the plant-specific minimum CF statepoint (e.g., 120 percent P/80 percent CF), and at the 100 percent OLTP at 55 percent CF statepoint. The currently approved off-rated CF uncertainty will be used for the minimum CF and 55 percent CF statepoints. The uncertainty must be consistent with the CF uncertainty currently applied to the SLO operation or as NRC-approved for MELLLA+ operation. The calculated values will be documented in the SRLR.		
12.7	Stability	Manual operator actions are not adequate to control the consequences of instabilities when operating in the MELLLA+ domain. If the primary stability protection system is declared inoperable, a non-manual NRC-approved backup protection system must be provided, or the reactor core must be	Comply	Section 2.4.3

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		operated below a NRC-approved backup stability boundary specifically approved for MELLLA+ operation for the stability option employed.		
12.8	Fluence Methodology and Fracture Toughness	The applicant is to provide a plant-specific evaluation of the MELLLA+ RPV fluence using the most up-to-date NRC-approved fluence methodology. This fluence will then be used to provide a plant-specific evaluation of the RPV fracture toughness in accordance with RG 1.99, Revision 2.	Comply	Sections 3.2.1
12.9	Reactor Coolant Pressure Boundary	MELLLA+ applicants must identify all other than Category "A" materials, as defined in NUREG-0313, Revision 2, that exist in its RCPB piping, and discuss the adequacy of the augmented inspection programs in light of the MELLLA+ operation on a plant-specific basis.	Comply	Section 3.5.1.4

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.10.a	ECCS-LOCA Off-rated Multiplier	The plant-specific application will provide the 10 CFR Part 50, Appendix K, and the nominal PCTs calculated at the rated EPU power/rated CF, rated EPU power/minimum CF, at the low-flow MELLLA+ boundary (Transition Statepoint). For the limiting statepoint, both the upper bound and the licensing PCT will be reported. The M+SAR will justify why the transition statepoint ECCS-LOCA response bounds the 55 percent CF statepoint. The M+SAR will provide discussion on what power/flow combination scoping calculations were performed to identify the limiting statepoints in terms of DBA-LOCA PCT response for the operation within the MELLLA+ boundary. The M+SAR will justify that the upper bound and licensing basis PCT provided is in fact the limiting PCT considering uncertainty applications to the non-limiting statepoints.	Comply AREVA methods do not include a calculation of upper bound PCT	Section 4.3.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.10.b		LOCA analysis is not performed on cycle-specific basis; therefore, the thermal limits applied in the M+SAR LOCA analysis for the 55 percent CF MELLLA+ statepoint and/or the transition statepoint must be either bounding or consistent with cycle-specific off-rated limits. The COLR and the SRLR will contain confirmation that the off-rated limits assumed in the ECCS-LOCA analyses bound the cycle-specific off-rated limits calculated for the MELLLA+ operation. Every future cycle reload shall confirm that the cycle-specific off-rated thermal limits applied at the 55 percent CF and/or the transition statepoints are consistent with those assumed in the plant-specific ECCS-LOCA analyses.	Comply	Section 4.3.1
12.10.c		Off-rated limits will not be applied to the minimum CF statepoint.	Comply	Section 4.3.1(4)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.10.d		If credit is taken for these off-rated limits, the plant will be required to apply these limits during core monitoring.	Comply	Section 4.3.1
12.11	ECCS-LOCA Axial Power Distribution Evaluation	For MELLLA+ applications, the small and large break ECCS-LOCA analyses will include top-peaked and mid-peaked power shape in establishing the MAPLHGR and determining the PCT. This limitation is applicable to both the licensing bases PCT and the upper bound PCT. The plant-specific applications will report the limiting small and large break licensing basis and upper bound PCTs.	Comply AREVA methods do not include a calculation of upper bound PCT	Section 4.3.1
12.12.a	ECCS-LOCA Reporting	Both the nominal and Appendix K PCTs should be reported for all of the calculated statepoints, and	Comply AREVA only calculates and reports Appendix K PCTs.	Section 4.3.1(3)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.12.b		The plant-variable and uncertainties currently applied will be used, unless the NRC staff specifically approves a different plant variable uncertainty method for application to the non-rated statepoints.	Comply	Section 4.3.1 Reference 62 presents the important plant parameters used in the LOCA analyses
12.13	Small Break LOCA	Small break LOCA analysis will be performed at the MELLLA+ minimum CF and the transition statepoints for those plants that: (1) are small break LOCA limited based on small break LOCA analysis performed at the rated EPU conditions; or (2) have margins of less than or equal to [[ ]] relative to the Appendix K or the licensing basis PCT.	Comply	Section 4.3.1
12.14	Break Spectrum	The scope of small break LOCA analysis for MELLLA+ operation relies upon the EPU small break LOCA analysis results. Therefore, the NRC staff concludes that for plants that will implement	Comply	Section 4.3.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		MELLLA+, sufficient small break sizes should be analyzed at the rated EPU power level to ensure that the peak PCT break size is identified.		
12.15	Bypass Voiding Above the D-level	Plant-specific MELLLA+ applications shall identify where in the MELLLA+ upper boundary the bypass voiding greater than 5 percent will occur above the D-level. The licensee shall provide in the plant-specific submittal the operator actions and procedures that will mitigate the impact of the bypass voiding on the TIPs and the core simulator used to monitor the fuel performance. The plant-specific submittal shall also provide discussion on what impact the bypass voiding greater than 5 percent will have on the NMS as defined in Section 5.1.1.5. The NRC staff will evaluate on plant-specific bases acceptability of bypass voiding above D level.	Comply	Section 5.1.5

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.16	RWE	Plants operating at the MELLLA+ operating domain shall perform RWE analyses to confirm the adequacy of the generic RBM setpoints. The M+SAR shall provide a discussion of the analyses performed and the results.	AREVA methods do not use a generic RBM set point in the CRWE analysis. The AREVA analyses are performed each cycle and will use the BSEP RBM set points.	Section 9.1.1
12.17	ATWS LOOP	As specified in LTR NEDC-33006P, at least two plant-specific ATWS calculations must be performed: MSIVC and PRFO. In addition, if RHR capability is affected by LOOP, then a third plant-specific ATWS calculation must be performed that includes the reduced RHR capability. To evaluate the effect of reduced RHR capacity during LOOP, the plant-specific ATWS calculation must be performed for a sufficiently large period of time after HSBW injection is complete to guarantee that the suppression pool temperature is cooling, indicating that the RHR capacity is greater than the decay heat generation. The plant-	Comply	Section 9.3.1.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		specific application should include evaluation of the safety system performance during the long-term cooling phase, in terms of available NPSH.		
12.18.a	ATWS TRACG Analysis	For plants that do not achieve hot shutdown prior to reaching the heat capacity temperature limit (HCTL) based on the licensing ODYN code calculation, plant-specific MELLLA+ implementations must perform best-estimate TRACG calculations on a plant-specific basis. The TRACG analysis will account for all plant parameters, including water-level control strategy and all plant-specific emergency operating procedure (EOP) actions.	N/A	(2)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.18.b		The TRACG calculation is not required if the plant increases the boron-10 concentration/enrichment so that the integrated heat load to containment calculated by the licensing ODYN calculation does not change with respect to a reference OLTP/75 percent flow ODYN calculation.	Comply	Sections 9.3.1.1. and 9.3.1.2 (2)
12.18.c		Peak cladding temperature (PCT) for both phases of the transient (initial overpressure and emergency depressurization) must be evaluated on a plant-specific basis with the TRACG ATWS calculation.	Comply (Initial Overpressure) N/A (Emergency Depressurization)	(2) is applicable to GEH analyses.
12.18.d		In general, the plant-specific application will ensure that operation in the MELLLA+ domain is consistent with the assumptions used in the ATWS analysis, including equipment out of service (e.g., FWHOOS, SLO, SRVs, SLC pumps, and RHR pumps, etc.). If assumptions are not satisfied, operation	Comply	Section 9.3.1.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		in MELLLA+ is not allowed. The SRLR will specify the prohibited flexibility options for plant-specific MELLLA+ operation, where applicable. For key input parameters, systems and engineering safety features that are important to simulating the ATWS analysis and are specified in the Technical Specification (TS) (e.g., SLCS parameters, ATWS RPT, etc.), the calculation assumptions must be consistent with the allowed TS values and the allowed plant configuration. If the analyses deviate from the allowed TS configuration for long term equipment out of service (i.e., beyond the TS LCO), the plant-specific application will specify and justify the deviation. In addition, the licensee must ensure that all operability requirements are met (e.g., NPSH) by equipment assumed operable in the calculations.		

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.18.e		Nominal input parameters can be used in the ATWS analyses provided the uncertainty treatment and selection of the values of these input parameters are consistent with the input methods used in the original GE ATWS analyses in NEDE-24222. Treatment of key input parameters in terms of uncertainties applied or plant-specific TS value used can differ from the original NEDE-24222 approach, provided the manner in which it is used yields more conservative ATWS results.	Comply	Section 9.3.1
12.18.f		The plant-specific application will include tabulation and discussion of the key input parameters and the associated uncertainty treatment.	Comply	Section 9.3.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.19	Plant-Specific ATWS Instability	Until such time that NRC approves a generic solution for ATWS instability calculations for MELLLA+ operation, each plant-specific MELLLA+ application must provide ATWS instability analysis that satisfies the ATWS acceptance criteria listed in SRP Section 15.8. The plant-specific ATWS instability calculation must: (1) be based on the peak-reactivity exposure conditions, (2) model the plant-specific configuration important to ATWS instability response including mixed core, if applicable, and (3) use the regional-mode nodalization scheme. In order to improve the fidelity of the analyses, the plant-specific calculations should be based on latest NRC-approved neutronic and thermal-hydraulic codes such as TGBLA06/PANAC11 and TRACG04.	Comply	Section 9.3.3
12.20	Generic ATWS	Once the generic solution is approved, the plant-specific applications must	N/A	(1)

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
	Instability	provide confirmation that the generic instability analyses are relevant and applicable to their plant. Applicability confirmation includes review of any differences in plant design or operation that will result in significantly lower stability margins during ATWS such as: • turbine bypass capacity, • fraction of steam-driven feedwater pumps, • any changes in plant design or operation that will significantly increase core inlet subcooling during ATWS events, • significant differences in radial and axial power distributions, • hot-channel power-to-flow ratio, • fuel design changes beyond GE14.		
12.21	Individual Plant	Licensees that submit a MELLLA+ application should address the plant-specific risk impacts associated with	Comply	Section 10.5

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
	Evaluation	MELLLA+ implementation, consistent with approved guidance documents (e.g., NEDC-32424P-A, NEDC-32523P-A, and NEDC-33004P-A) and the Matrix 13 of RS-001 and re-address the plant-specific risk impacts consistent with the approved guidance documents that were used in their approved EPU application and Matrix 13 of RS-001. If an EPU and MELLLA+ application come to the NRC in parallel, the expectation is that the EPU submittal will have incorporated the MELLLA+ impacts.		
12.22	IASCC	The applicant is to provide a plant-specific IASCC evaluation when implementing MELLLA+, which includes the components that will exceed the IASCC threshold of $5x10^{20}$ n/cm^2 (E>1MeV), the impact of failure of these components on the integrity of the reactor internals and core support structures under licensing design bases conditions, and the inspections that will	Comply	Section 10.7.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
		be performed on components that exceed the IASCC threshold to ensure timely identification of IASCC, should it occur.		
12.23.1	Limitations from the ATWS RAI Evaluations	See limitation 12.18.d.	Comply	Section 9.3.1.1
12.23.2		The plant-specific ODYN and TRACG key calculation parameters must be provided to the staff so they can verify that all plan t-specific automatic settings are modeled properly.	Comply	Sections 1.1.3 and 9.3.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.23.3		The ATWS peak pressure response would be dependent upon SRVs upper tolerances assumed in the calculations. For each individual SRV, the tolerances used in the analysis must be consistent with or bound the plant-specific SRV performance. The SRV tolerance test data would be statistically treated using the NRC's historical 95/95 approach or any new NRC-approved statistical treatment method. In the event that current EPU experience base shows propensity for valve drift higher than pre-EPU experience base, the plant-specific transient and ATWS analyses would be based on the higher tolerances or justify the reason why the propensity for the higher drift is not applicable the plant's SRVs.	Comply	Section 9.3.1.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.23.4		EPG/SAG parameters must be reviewed for applicability to MELLLA+ operation in a plant-specific basis. The plant-specific MELLLA+ application will include a section that discusses the plant-specific EOPs and confirms that the ATWS calculation is consistent with the operator actions.	Comply	Sections 9.3.1.1 and 10.9.1
12.23.5		The conclusions of this LTR and associated SE are limited to reactors operating with a power density lower than 52.5 MW/MLBM/hr for operation at the minimum allowable CF at 120 percent OLTP. Verification that reactor operation will be maintained below this analysis limit must be performed for all plant-specific applications.	Comply	Section 9.3.3

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.23.6		For MELLLA+ applications involving GE fuel types beyond GE14 or other vendor fuels, bounding ATWS Instability analysis will be provided to the staff. Note: this limitation does not apply to special test assemblies.	Comply	Section 9.3.3
12.23.7		See limitation 12.23.6.	Comply	Section 9.3.3
12.23.8		The plant-specific ATWS calculations must account for all plant- and fuel-design-specific features, such as the debris filters.	Comply	Section 9.3.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.23.9		Plant-specific applications must review the safety system specifications to ensure that all of the assumptions used for the ATWS SE indeed apply to their plant-specific conditions. The NRC staff review will give special attention to crucial safety systems like HPCI, and physical limitations like NPSH and maximum vessel pressure that RCIC and HPCI can inject. The plant-specific application will include a discussion on the licensing bases of the plant in terms of NPSH and system performance. It will also include NPSH and system performance evaluation for the duration of the event.	Comply	Section 4.2.6 and 9.3.1
12.23.10		Plant-specific applications must ensure that an increase in containment pressure resulting from ATWS events with EPU/MELLLA+ operation does not affect adversely the operation of safety-grade equipment.	Comply	Section 4.2.6 and 9.3.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.23.11		The plant-specific applications must justify the use of plant-specific suppression pool temperature limits for the ODYN and TRACG calculations that are higher than the HCTL limit for emergency depressurization.	Comply	Section 9.3.1.1

Limitation and Condition Number from NRC SER	Limitation and Condition Title	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
12.24.1	Limitations from Fuel Dependent Analyses RAI Evaluations	For EPU/MELLLA+ plant-specific applications that use TRACG or any code that has the capability to model in-channel water rod flow, the supporting analysis will use the actual flow configuration.	Comply	Sections 2.6.2 and 9.3.3
12.24.2		The EPU/MELLLA+ application would provide the exit void fraction of the high-powered bundles in the comparison between the EPU/MELLLA+ and the pre-MELLLA+ conditions.	Comply	Section 2.1.2
12.24.3		See limitation 12.6.	N/A	N/A
12.24.4		See limitation 12.18.d.	Comply	Section 9.3.1.1

Appendix B (Continued)

Disposition of additional limitations and conditions related to the final SE for NEDC-33006P, "Maximum Extended Load Line Limit Analysis Plus"

Notes:

1. This requirement relates to implementation of a generic ATWS instability solution, which is not yet approved by the NRC. BSEP MELLLA+ is based on a plant-specific ATWS instability analysis.
2. BSEP MELLLA+ does not require a best estimate TRACG analysis to confirm ODYN calculations. The ODYN calculation does not achieve hot shutdown prior to reaching the HCTL based on the licensing ODYN code calculation, but the integrated heat load to containment calculated by the licensing ODYN calculation does not change with respect to a reference OLTP/75 percent flow ODYN calculation. PCT has been calculated for the initial pressurization phase.
3. AREVA provides ECCS-LOCA analyses with acceptance criteria based on 10 CFR 50.46 in accordance with approved methodologies contained in 10 CFR 50 Appendix K to determine Peak Cladding Temperatures for the full spectrum of LOCA break sizes.
4. In the LOCA-ECCS analyses, {{

}} Therefore, the ATRIUM 10XM LOCA-ECCS analysis complies with Limitation and Condition 12.10.c.

Appendix C

Limitations from the Final Safety Evaluation for LTR NEDC-33075P Revision 7

Disposition of additional limitations and conditions related to the final SE for NEDC-33075P, Revision 7, "GE Hitachi Boiling Water Reactor Detect and Suppress Solution – Confirmation Density"

There are 4 limitations and conditions listed in Section 5 of the DSS-CD LTR SER. The table below lists each of the 4 limitations and conditions and identifies which section of the M+SAR discusses compliance with each limitation and condition.

Appendix C (continued)

Disposition of additional limitations and conditions related to the final SE for NEDC-33075P, Revision 7, "GE Hitachi Boiling Water Reactor Detect and Suppress Solution – Confirmation Density"

Limitation and Condition Number from NRC SER	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
5.1	The NRC staff previously reviewed and approved the implementation of DSS-CD using the approved GEH Option III hardware and software. The DSS-CD solution is not approved for use with non-GEH hardware. The hardware components required to implement DSS-CD are expected to be those currently used for the approved Option III. If the DSS-CD hardware implementation deviates from the approved Option III solution, a hardware review by the NRC staff will be required. Implementations on other Option III platforms will require plant-specific reviews.	Comply	Section 2.4 (1)
5.2	The CDA setpoint calculation formula and the adjustable parameters values are defined in NEDC-33075P, Revision 7 (Reference 49). Deviation from the stated values or calculation formulas is not allowed without NRC review. To this end, the subject TR, when approved and implemented by a licensed nuclear power plant, must be referenced in the plant TSs, so that these values become controlled and part of the licensing bases.	Comply	Section 2.4.1 (2)

Limitation and Condition Number from NRC SER	Limitation and Condition Description	Disposition	Section of BSEP M+SAR which addresses the Limitation and Condition
5.3	The NRC staff previously concluded that the plant-specific settings for eight of the FIXED parameters and three of the ADJUSTABLE parameters, as stated in section 3.6.3 of the NRC staff's SE for NEDC-33075P, Revision 5 (see Reference 52), are licensing basis values. The process by which these values will be controlled must be addressed by licensees.	Comply	(3)
5.4	If plants other than Brunswick Steam Electric Plant, Units 1 and 2, use the DSS-CD trip function, those plant licensees must ensure the DSS-CD trip function is applicable in their plant licensing bases, including the optional BSP trip function, if it is to be installed.	N/A	(4)

Appendix C (continued)

Disposition of additional limitations and conditions related to the final SE for NEDC-33075P, Revision 7, "GE Hitachi Boiling Water Reactor Detect and Suppress Solution – Confirmation Density"

Notes:

1. The DSS-CD solution is implemented on GEH hardware that is currently installed and approved by the NRC for the Option III stability LTS.
2. The subject topical report or GESTAR that includes the subject topical report is referenced in the BSEP EPU/MELLLA+ TS.
3. The values of the FIXED and ADJUSTABLE parameters are established by GEH and are documented in a DSS-CD Settings Report.
4. This limitation and condition does not apply to BSEP.

Affidavit from General Electric-Hitachi (GE-H)
Regarding Withholding DUKE-0B21-1104-000(P),
Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2
Maximum Extended Load Line Limit Analysis Plus

GE-Hitachi Nuclear Energy Americas LLC

AFFIDAVIT

I, Lisa K. Schichlein, state as follows:

(1) I am a Senior Project Manager, NPP/Services Licensing, Regulatory Affairs, GE-Hitachi Nuclear Energy Americas LLC (GEH), and have been delegated the function of reviewing the information described in paragraph (2) which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in Duke Energy Corporation report DUKE-0B21-1104-000(P), "Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2 Maximum Extended Load Line Limit Analysis Plus," dated July 2016. GEH proprietary information in DUKE-0B21-1104-000(P) is identified by a dotted underline placed within double square brackets. [[This sentence is an example.{3}]]. GEH proprietary information in figures and large objects is identified by double square brackets before and after the object. In each case, the superscript notation {3} refers to Paragraph (3) of this affidavit, which provides the basis for the proprietary determination.

(3) In making this application for withholding of proprietary information of which it is the owner or licensee, GEH relies upon the exemption from disclosure set forth in the *Freedom of Information Act* ("FOIA"), 5 U.S.C. §552(b)(4), and the *Trade Secrets Act*, 18 U.S.C. §1905, and NRC regulations 10 CFR 9.17(a)(4), and 2.390(a)(4) for trade secrets (Exemption 4). The material for which exemption from disclosure is here sought also qualifies under the narrower definition of trade secret, within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975 F.2d 871 (D.C. Cir. 1992), and Public Citizen Health Research Group v. FDA, 704 F.2d 1280 (D.C. Cir. 1983).

(4) The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraphs (4)a and (4)b. Some examples of categories of information that fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by GEH's competitors without a license from GEH constitutes a competitive economic advantage over other companies;

b. Information that, if used by a competitor, would reduce its expenditure of resources or improve its competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information that reveals aspects of past, present, or future GEH customer-funded development plans and programs, resulting in potential products to GEH;

d. Information that discloses trade secret or potentially patentable subject matter for which it may be desirable to obtain patent protection.

(5) To address 10 CFR 2.390(b)(4), the information sought to be withheld is being submitted to NRC in confidence. The information is of a sort customarily held in confidence by GEH, and is in fact so held. The information sought to be withheld has, to the best of my knowledge and belief, consistently been held in confidence by GEH, not been disclosed publicly, and not been made available in public sources. All disclosures to third parties, including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions for proprietary or confidentiality agreements or both that provide for maintaining the information in confidence. The initial designation of this information as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in the following paragraphs (6) and (7).

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, who is the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge, or who is the person most likely to be subject to the terms under which it was licensed to GEH.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist, or other equivalent authority for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GEH are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary and/or confidentiality agreements.

(8) The information identified in paragraph (2) is classified as proprietary because it contains detailed results and conclusions regarding supporting evaluations of the safety-significant changes necessary to demonstrate the regulatory acceptability of the Maximum Extended Load Line Limit Analysis Plus analysis for a GEH Boiling Water Reactor ("BWR"). The analysis utilized analytical models and methods, including computer codes, which GEH has developed, obtained NRC approval of, and applied to perform evaluations of Maximum Extended Load Line Limit Analysis Plus for a GEH BWR.

The development of the evaluation processes along with the interpretation and application of the analytical results is derived from the extensive experience and information databases that constitute major GEH assets.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GEH's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GEH's comprehensive BWR safety and

technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical and NRC review costs comprise a substantial investment of time and money by GEH. The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial. GEH's competitive advantage will be lost if its competitors are able to use the results of the GEH experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GEH would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GEH of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in developing and obtaining these very valuable analytical tools.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this 1st day of August 2016.

Lisa K. Schichlein

Lisa K. Schichlein
Senior Project Manager, NPP/Services Licensing
Regulatory Affairs
GE-Hitachi Nuclear Energy Americas LLC
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Wilmington, NC 28401
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Affidavit from AREVA NP
Regarding Withholding DUKE-0B21-1104-000(P),
Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2
Maximum Extended Load Line Limit Analysis Plus

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Alan B. Meginnis. I am Manager, Product Licensing, for AREVA Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA to determine whether certain AREVA information is proprietary. I am familiar with the policies established by AREVA to ensure the proper application of these criteria.

3. I am familiar with the AREVA information contained in the report DUKE-0B21-1104-000P, "Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2 Maximum Extended Load Line Limit Analysis Plus," dated July 2016 and referred to herein as "Document." Information contained in this Document has been classified by AREVA as proprietary in accordance with the policies established by AREVA for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by AREVA to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA in product optimization or marketability.

(e) The information is vital to a competitive advantage held by AREVA, would be helpful to competitors to AREVA, and would likely cause substantial harm to the competitive position of AREVA.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b), 6(d) and 6(e) above.

7. In accordance with AREVA's policies governing the protection and control of information, proprietary information contained in this Document have been made available, on a limited basis, to others outside AREVA only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

Alan B Meg

SUBSCRIBED before me this 18th day of July, 2016.

SUSAN K MCCOY
NOTARY PUBLIC - WASHINGTON
MY COMMISSION EXPIRES 01-14-2020

Susan K McCoy

Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/14/2020

Affidavit from Electric Power Research Institute (EPRI)
Regarding Withholding DUKE-0B21-1104-000(P),
Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2
Maximum Extended Load Line Limit Analysis Plus

ELECTRIC POWER RESEARCH INSTITUTE

Ref. EPRI Project Number 669

Randy Stark
Director, Research and Develop,
Fuel & Chemistry

August 1, 2016

Document Control Desk
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Subject: Request for Withholding of the following Proprietary Information Included in:

"Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2 Maximum Extended Load Line Limit Analysis Plus" DUKE-OB21-1104-000(P), dated July 2016.

To Whom It May Concern:

This is a request under 10 C.F.R. §2.390(a)(4) that the U.S. Nuclear Regulatory Commission ("NRC") withhold from public disclosure the report identified in the enclosed Affidavit consisting of the proprietary information owned by Electric Power Research Institute, Inc. ("EPRI") identified in the attached report. Proprietary and non-proprietary versions of the Report and the Affidavit in support of this request are enclosed.

EPRI desires to disclose the Proprietary Information in confidence to assist the NRC review of the enclosed submittal to the NRC by Duke Energy. The Proprietary Information is not to be divulged to anyone outside of the NRC or to any of its contractors, nor shall any copies be made of the Proprietary Information provided herein. EPRI welcomes any discussions and/or questions relating to the information enclosed.

If you have any questions about the legal aspects of this request for withholding, please do not hesitate to contact me at (650) 855-2122. Questions on the content of the Report should be directed to Andy McGehee of EPRI at (704) 502-6440.

Sincerely,

Randy Stark

Attachment(s)
c: Sheldon Stuchell, NRC (sheldon.stuchell@nrc.gov)

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

AFFIDAVIT

RE: Request for Withholding of the Following Proprietary Information Included In:

"Safety Analysis Report for Brunswick Steam Electric Plant Units 1 and 2 Maximum Extended Load Line Limit Analysis Plus" DUKE-OB21-1104-000(P), dated July 2016.

I, Randy Stark, being duly sworn, depose and state as follows:

I am the Director at Electric Power Research Institute, Inc. whose principal office is located at 3420 Hillview Avenue, Palo Alto, CA. ("EPRI") and I have been specifically delegated responsibility for the above-listed report that contains EPRI Proprietary Information that is sought under this Affidavit to be withheld "Proprietary Information". I am authorized to apply to the U.S. Nuclear Regulatory Commission ("NRC") for the withholding of the Proprietary Information on behalf of EPRI.

EPRI Proprietary Information is identified in the above referenced report by a solid underline inside double brackets. An example of such identification is as follows:

[[This sentence is an example.[E]]]

Tables containing EPRI Proprietary Information are identified with double brackets before and after the object. In each case the superscript notation [E] refers to this affidavit and all the bases included below, which provide the reasons for the proprietary determination.

EPRI requests that the Proprietary Information be withheld from the public on the following bases:

Withholding Based Upon Privileged And Confidential Trade Secrets Or Commercial Or Financial Information (see e.g., 10 C.F.R. § 2.390(a)(4):

a. The Proprietary Information is owned by EPRI and has been held in confidence by EPRI. All entities accepting copies of the Proprietary Information do so subject to written agreements imposing an obligation upon the recipient to maintain the confidentiality of the Proprietary Information. The Proprietary Information is disclosed only to parties who agree, in writing, to preserve the confidentiality thereof.

b. EPRI considers the Proprietary Information contained therein to constitute trade secrets of EPRI. As such, EPRI holds the Information in confidence and disclosure thereof is strictly limited to individuals and entities who have agreed, in writing, to maintain the confidentiality of the Information.

c. The information sought to be withheld is considered to be proprietary for the following reasons. EPRI made a substantial economic investment to develop the Proprietary Information and, by prohibiting public disclosure, EPRI derives an economic benefit in the form of licensing royalties and other additional fees from the confidential nature of the Proprietary Information. If the Proprietary Information were publicly available to consultants and/or other businesses providing services in the electric and/or nuclear power industry, they would be able to use the Proprietary Information for their own commercial benefit and profit and without expending the substantial economic resources required of EPRI to develop the Proprietary Information.

d. EPRI's classification of the Proprietary Information as trade secrets is justified by the Uniform Trade Secrets Act which California adopted in 1984 and a version of which has been adopted by over forty states. The California Uniform Trade Secrets Act, California Civil Code §§3426 – 3426.11, defines a "trade secret" as follows:

> "'Trade secret' means information, including a formula, pattern, compilation, program device, method, technique, or process, that:
>
> (1) Derives independent economic value, actual or potential, from not being generally known to the public or to other persons who can obtain economic value from its disclosure or use; and
>
> (2) Is the subject of efforts that are reasonable under the circumstances to maintain its secrecy."

e. The Proprietary Information contained therein are not generally known or available to the public. EPRI developed the Information only after making a determination that the Proprietary Information was not available from public sources. EPRI made a substantial investment of both money and employee hours in the development of the Proprietary Information. EPRI was required to devote these resources and effort to derive the Proprietary Information. As a result of such effort and cost, both in terms of dollars spent and dedicated employee time, the Proprietary Information is highly valuable to EPRI.

f. A public disclosure of the Proprietary Information would be highly likely to cause substantial harm to EPRI's competitive position and the ability of EPRI to license the Proprietary Information both domestically and internationally. The Proprietary Information can only be acquired and/or duplicated by others using an equivalent investment of time and effort.

I have read the foregoing and the matters stated herein are true and correct to the best of my knowledge, information and belief. I make this affidavit under penalty of perjury under the laws of the United States of America and under the laws of the State of North Carolina.

Executed at 3420 Hillview Avenue, Palo Alto, CA 94304 being the premises and place of business of Electric Power Research Institute, Inc.

Date: 8/1/2016

Randy Stark

Randy Stark

California All-Purpose Acknowledgement **Civil Code 1189**

A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

(State of California)
(County of Santa Clara)

Subscribed and sworn to (or affirmed) before me on this 11th day of August, 2016 by Karan Stark, proved to me on the basis of satisfactory evidence to be the person(s) who appeared before me.

Signature Berte A Dahl (Seal)

My Commission Expires 20 day of March, 2019

BERTE A. DAHL
Commission # 2100695
Notary Public - California
Santa Clara County
My Comm. Expires Mar 20, 2019

List of Regulatory Commitments

The following table identifies the actions in this document to which the Brunswick Steam Electric Plant (BSEP) has committed. Statements in this submittal, with the exception of those in the table below, are provided for information purposes and are not considered commitments.

Please direct questions regarding these commitments to Mr. Lee Grzeck, Manager – Regulatory Affairs, at (910) 457-2487.

COMMITMENT DESCRIPTION	ONE-TIME ACTION	CONTINUING COMPLIANCE	SCHEDULED COMPLETION DATE (If Required)
Testing will be performed near the Current Licensed Thermal Power and the MELLLA+ minimum core flow state point of 85% as well as other state points that may be deemed valuable for the purpose of confirming operational performance and control aspects of the MELLLA+ changes. (M+SAR Section 10.4)	☒		Within 30 days of beginning operation in the MELLLA+ domain.
Consistent with the requirements for the plant-specific analysis as described in the M+LTR, the operator training program and plant simulator will be evaluated to determine the specific changes required. Simulator changes and fidelity validation will be performed in accordance with applicable American National Standards Institute (ANSI) standards currently being used at the training simulator. (M+SAR Section 10.6)	☒		Prior to operation in the MELLLA+ domain.
Operator training required to operate BSEP following the MELLLA+ operating domain expansion will be conducted prior to operation in the MELLLA+ domain. (M+SAR Section 10.6)	☒		Prior to operation in the MELLLA+ domain.
Operator training for the MELLLA+ startup testing program will be performed using "just in time" training of plant operation personnel where appropriate. (M+SAR Section 10.6)	☒		Prior to operation in the MELLLA+ domain.

COMMITMENT DESCRIPTION	ONE-TIME ACTION	CONTINUING COMPLIANCE	SCHEDULED COMPLETION DATE (If Required)
Enhanced operator training on ATWS event mitigation in the MELLLA+ domain will be conducted. (M+SAR Section 10.6)	☒		Prior to operation in the MELLLA+ domain.
In accordance with M+LTR Safety Evaluation Report (SER) Limitation and Condition 12.10.b, the Core Operating Limits Report and the Reload Safety Analysis Report (RSAR) will contain confirmation that the off-rated flow-dependent linear Heat Generation Rate (LHGR) set-down will bound the cycle-specific off-rated LHGR limits calculated for the MELLLA+ operation.		☒	Prior to operation in the MELLLA+ domain.
In accordance with M+LTR SER Limitation and Condition 12.23.4, Emergency Operating Procedures (EOPs) will be reviewed for any effect and revised as necessary prior to implementation of MELLLA+ operating domain expansion. Any changes identified to the EOPs will be included in the operator training to be conducted prior to implementation of MELLLA+. (M+SAR Section 10.9.1)	☒		Prior to operation in the MELLLA+ domain.
Abnormal Operating Procedures (AOPs) will be reviewed for any MELLLA+ effects and revised as necessary prior to implementation of MELLLA+ operating domain expansion. Any changes identified to the AOPs will be included in the operator training to be conducted prior to implementation of MELLLA+. (M+SAR Section 10.9.2)	☒		Prior to operation in the MELLLA+ domain.

SECY-11-0014 Discussion - Use of Containment Accident Pressure (CAP)
in Analyzing ECCS and Containment Heat Removal System Pump Performance

SECY-11-0014 Discussion -Use of Containment Accident Pressure (CAP) in Analyzing ECCS and Containment Heat Removal System Pump Performance

Background

Like many domestic BWRs, the Brunswick Steam Electric Plant (BSEP) relies on containment pressure higher than that present before the postulated design basis accident to provide net positive suction head (NPSH) margin for the pumps in the Emergency Core Cooling System (ECCS) and the containment heat removal system. In May 2002, the Nuclear Regulatory Commission (NRC) issued the Safety Evaluation (SE) for the extended power uprate for BSEP, Units 1 and 2 (i.e., Amendment No. 222 to Facility Operating License No. DPR-71 and Amendment No. 247 to Facility Operating License No. DPR-62). In the SE, the NRC reviewed BSEP's rationale, calculation, and evaluation for ECCS NPSH requirements and found that the requested containment overpressure credit of up to 5.0 psig for NPSH requirements from the available post-LOCA containment pressure of 11.3 psig is acceptable at EPU conditions. The SE also clarified that the containment overpressure of up to 5.0 psig will be credited for calculating ECCS pump NPSH margins and that this allowance can be used to address potential future ECCS NPSH margin issues.

In recent years the use of CAP to increase NPSH margin was questioned by the Advisory Committee on Reactor Safeguards (ACRS), by participants in the NRC hearing process and by members of the public. The NRC presented analyses and recommendations in SECY-11-0014 that were subsequently adopted, in part, for use by the NRC as guidance when reviewing applications relying on CAP. Duke Energy agreed to address the issues outlined in the SECY as part of the BSEP Units 1 and 2 MELLLA+ License Amendment Request.

Purpose

The purpose of this enclosure is to describe the NPSH margin calculations performed by Duke Energy for BSEP Units 1 and 2, using the guidance in SECY-11-0014 as an adjunct to the MELLLA+ licensing submittal. The SECY document consists of ten criteria that should be evaluated for NPSH margins as they apply to the Residual Heat Removal (RHR) and Core Spray (CS) pumps. The criteria apply to Design Basis Accidents (DBA) and Special Events such as Station Blackout (SBO), Appendix R fire, and Anticipated Transients without SCRAM (ATWS). Each of these events can add significant heat to the suppression pool and may require CAP to meet NPSH requirements. For BSEP, the DBA Loss of Coolant Accident (LOCA) was established as the limiting DBA that challenges ECCS and containment heat removal pump NPSH margins.

Calculations were developed for MELLLA+ conditions to address SECY 11-0014 criteria as they relate to crediting CAP to meet NPSH margin requirements. Each component of the SECY guidance is addressed below. For purposes of this enclosure the term "CAP" is defined as containment pressure higher than that present prior to the event whether a design basis event or some other special event (e.g., ATWS). In the discussion of the SECY requirements the term "containment overpressure" or "COP" is specifically not used consistent with NRC practice. This term was discontinued by the NRC because the industry uses several definitions of containment overpressure and the term has been confused with exceeding containment design pressure. The containment design pressure is never exceeded while crediting CAP.

SECY 11-0014 Criteria

1. **For Design Basis Accidents (DBA), a value of $NPSHR_{eff}$ should be used in the analyses concerning the use of containment accident pressure. $NPSHR_{eff}$ includes the uncertainty in the value of $NPSHR_{3\%}$ based on vendor testing and installed operation. The effects of motor slip, suction piping configuration, air content, and wear ring leakage are included in the uncertainty.**

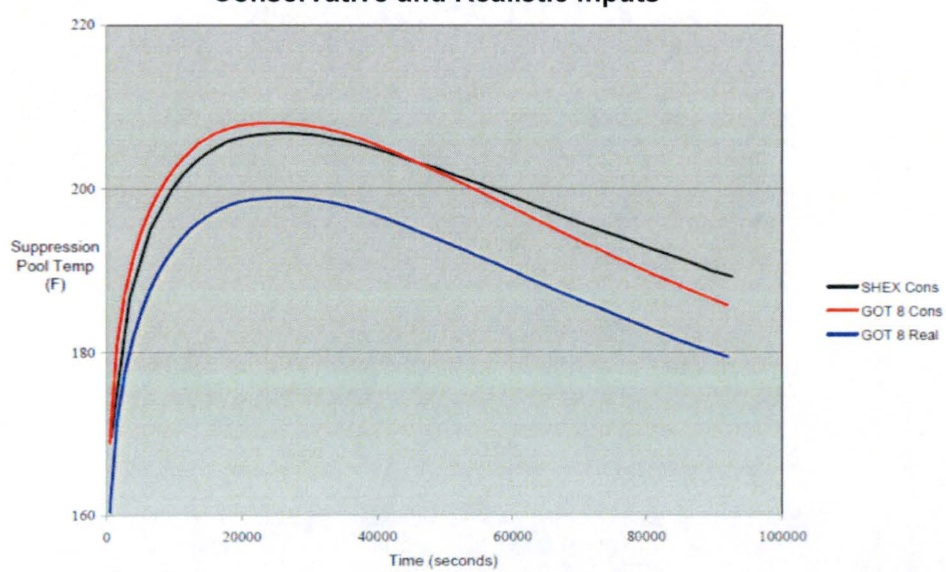
$$NPSHR_{eff,3\%} = (1 + \text{uncertainty}) * NPSHR_{3\%}$$

For non-DBAs, $NPSHR_{3\%}$ may be used.

Design Basis LOCA

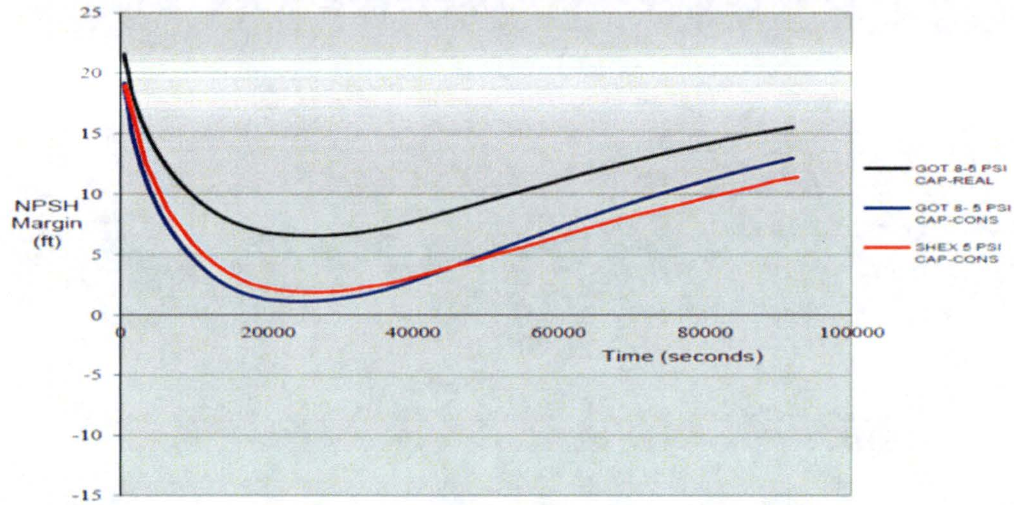
The calculation evaluated DBA LOCA NPSH margin from time 0 out to approximately 35 days which exceeded the 30-day mission time for the RHR and CS pumps. The calculation was divided to address the short term (< 600 seconds) which is the period of maximum run-out flow for the RHR and CS pumps and the long term (> 600 seconds) which is governed by lower RHR and CS flows due to operator action to throttle flow to meet core and containment cooling requirements. Containment parameters that affect Net Positive Suction Head Available (NPSHA) were taken from the design basis SHEX evaluation for EPU and also from a GOTHIC model which provided an alternative containment response for comparison. The comparison for suppression pool temperature is illustrated in the following figure.

Suppression Pool Temperature, GE SHEX and GOTHIC 8.0 Conservative and Realistic Inputs

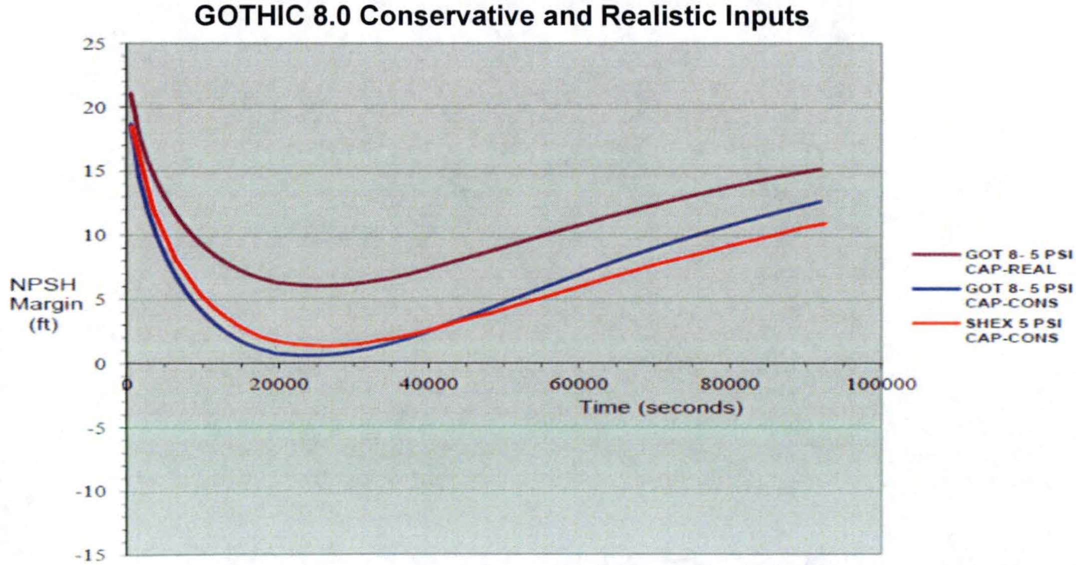


Net Positive Suction Head Required (NPSHR) effects from motor slip, suction piping configuration, air content, and wear ring clearance were not individually quantified but rather were combined to increase NPSHR by 21 percent. NPSH margin (NPSHA – $NPSHR_{eff,3\%}$) for long-term RHR operation [2 pumps each delivering 5750 gpm into 1 loop (11500 gpm total) for containment cooling] and CS operation (5000 gpm) following the DBA , each using 5 psi CAP, are shown in the following figures.

RHR NPSH Margin with 21% NPSHR Uncertainty, SHEX and GOTHIC 8.0 Conservative and Realistic Inputs



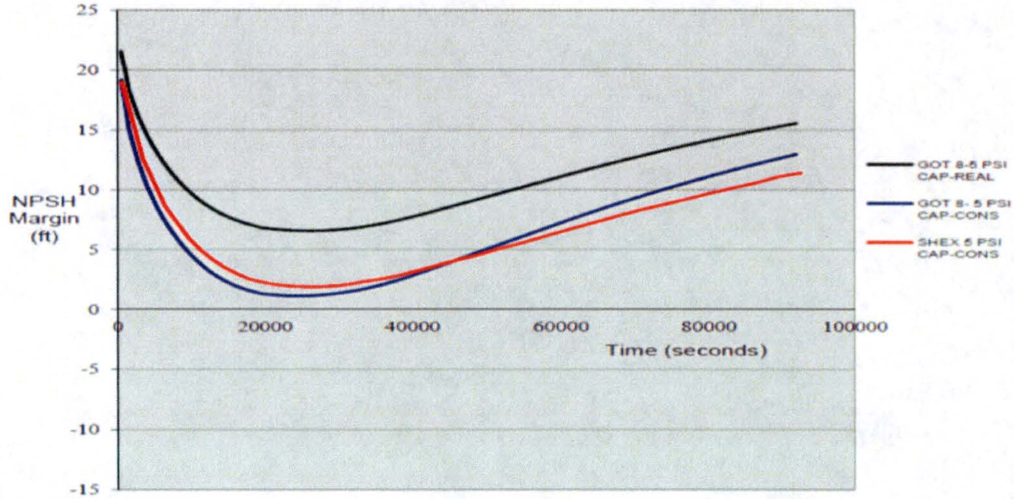
CS NPSH Margin with 21% NPSHR Uncertainty, SHEX and GOTHIC 8.0 Conservative and Realistic Inputs



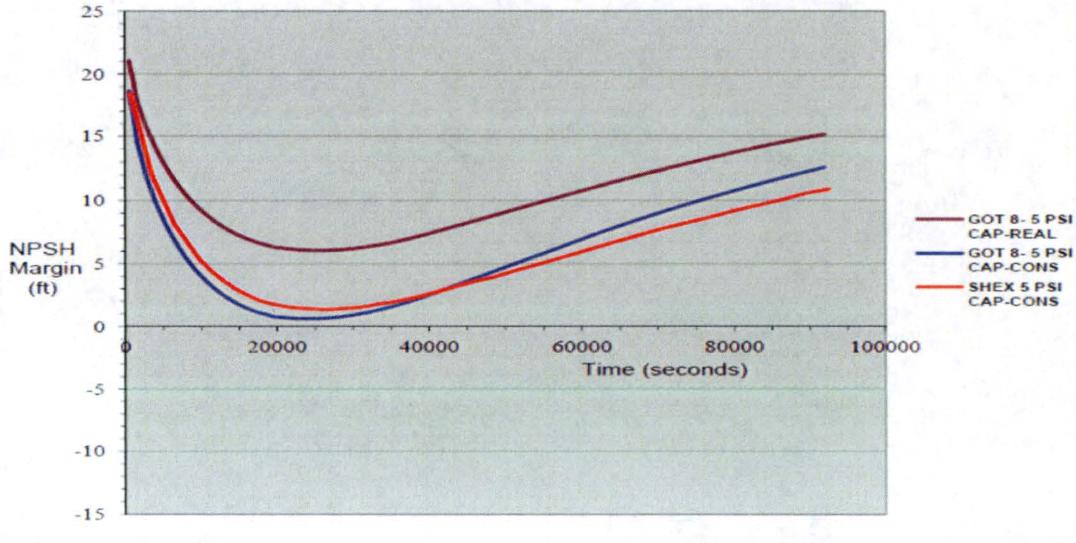
Positive NPSH margin existed for all cases. The GOTHIC conservative case was most limiting but still provided a minimum margin of 1.1 feet for RHR and 0.6 feet for CS pumps (at 24,000 seconds). The short term case results are discussed in the response to Criterion 2. Criterion 1 was addressed in the calculation.

cooling] and CS operation (5000 gpm) following the DBA , each using 5 psi CAP, are shown in the following figures.

RHR NPSH Margin with 21% NPSHR Uncertainty, SHEX and GOTHIC 8.0 Conservative and Realistic Inputs



CS NPSH Margin with 21% NPSHR Uncertainty, SHEX and GOTHIC 8.0 Conservative and Realistic Inputs



Positive NPSH margin existed for all cases. The GOTHIC conservative case was most limiting but still provided a minimum margin of 1.1 feet for RHR and 0.6 feet for CS pumps (at 24,000 seconds). The short term case results are discussed in the response to Criterion 2. Criterion 1 was addressed in the calculation.

Station Blackout (SBO)

SBO is not a design basis event; therefore, $NPSH_{3\%}$ was used for the SBO NPSH evaluation. The limiting system (i.e., RHR) was evaluated assuming two pumps per loop. The results demonstrate that CAP is not required to ensure adequate NPSH margin for suppression pool cooling following a Station Blackout. The SBO analysis is not impacted by the introduction of MELLLA+. Criterion 1 was addressed in the calculation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Nonetheless, the component selection and circuit analysis needed to deterministically support CAP remains part of the Nuclear Safety Compliance Assessment (NSCA) required by Section 2.4.2 of NFPA 805, consistent with the GE Appendix R EPU Analysis. Using risk informed, performance based methods, BSEP has addressed the need to maintain CAP post fire for any fire scenario modeled in the Fire Probabilistic Risk Assessment (FPRA). The net result is that fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to Core Damage Frequency (CDF) and Large Early Release Fraction (LERF) risk.

ATWS

GEH performed an updated MELLLA+ SHEX containment analysis to produce the bounding peak suppression pool temperature and evaluated NPSH margin availability for the limiting ATWS scenario. Only the RHR pumps are in operation with suction from the suppression pool. The NPSH calculation evaluated NPSH margin from 660 seconds where the suppression pool cooling mode of RHR is initiated. The available NPSH margin and maximum erosion rate were evaluated throughout the event until time = 14,400 seconds (i.e., 4 hours). The RHR flow used in the evaluation was 11,500 gpm, 5750 gpm per pump, and the $NPSH_{3\%}$ was 15.2 ft. NPSH margin was maintained positive without the use of CAP for the duration of the event. Criterion 1 was addressed by this evaluation.

2. **The maximum flow rate chosen for the NPSHA analysis should be greater than or equal to the flow rate assumed in the safety analyses that demonstrates adequate core and containment cooling. This ensures that the safety analysis and the NPSH analysis are consistent. If the NPSHA is assumed to equal the $NPSHR_{3\%}$ (the usual assumption for determining the amount of containment accident pressure used), then the flow rate used in the core and containment cooling analyses should also be equal to or greater than the flow rate resulting from a 3 percent decrease in pump Total Dynamic Head (TDH).**

Design Basis LOCA

The flow rates used in the DBA-LOCA calculation were equal to the flow rates used in the safety analysis. However, it was found that the limiting short term (<600 sec) RHR flow (i.e. two RHR pumps delivering a total of 21,100 gpm into a broken recirculation line) could not be maintained due to degraded NPSH margin. Input from the RHR pump manufacturer was obtained, which showed that the RHR pumps could operate at a reduced flow rate until the pumps could be throttled at 600 seconds. Since cavitation would occur during the initial 600 seconds, there is a concern of related damage. The manufacturer evaluated this condition and provided qualitative assurance the pumps could operate for this short time without damage. As outlined in the response to Criterion 1, the long term analysis showed that the RHR and CS pumps could deliver the flow rates used in the safety analysis provided current CAP allowance was assumed. Criterion 2 was addressed in the calculation.

Station Blackout (SBO)

CAP is not required to ensure adequate NPSH margin for suppression pool cooling following a Station Blackout. However, the RHR flow rate assumed in the NPSH analysis is the same as that assumed in the safety analyses. Criterion 2 was addressed by the evaluation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

ATWS

No CAP allowance was used in the ATWS analysis. The flow rates used in the NPSH evaluation were the same as the safety analysis. Criterion 2 was addressed by the evaluation.

3. A 95/95 lower tolerance limit should be used to calculate the containment accident pressure used to determine the NPSHA.

Design Basis LOCA

The 95/95 analysis is performed to quantify uncertainties in the containment response evaluation by randomly selecting values of critical parameters within a probable range of values. The Duke Energy calculation performed deterministic evaluations using conservative and bounding inputs. Although Criterion 3 was not addressed in the calculation, the deterministic evaluations use conservative inputs to determine the containment response.

Station Blackout (SBO)

As discussed in the SECY, the use of a Monte Carlo analysis with the 95/95 tolerance limit NPSH margin analysis (Criterion 3) is not applicable to the non-design basis SBO. No CAP allowance was used in the SBO NPSH margin analysis. Criterion 3 was addressed by this evaluation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

ATWS

As discussed in the SECY, the use of a Monte Carlo analysis with the 95/95 tolerance limit NPSH margin analysis (Criterion 3) is not applicable to the non-design basis ATWS event. However, the containment analysis prepared for MELLLA+ makes conservative assumptions and uses a combination of realistic and bounding input values. Additional detail on the assumptions and inputs for the containment analysis and the NPSH margin evaluation are discussed in the response to Criterion 9. Also note that no CAP allowance was used in the ATWS NPSH margin analysis. Criterion 3 was addressed by this evaluation.

4. It should be demonstrated conservatively that, for the plant examined, loss of containment integrity from containment venting, circuit issues associated with an Appendix R fire, or other causes cannot occur or that they would occur only after use of containment accident pressure is no longer needed.

Design Basis LOCA

During the evaluation of Extended Power Uprate (EPU), increased peak suppression pool temperatures demonstrated the need for wetwell pressure, or CAP, to assist in providing the NPSH requirements for the RHR and CS pumps. The NRC's Safety Evaluation for EPU clarified that the containment overpressure of up to 5.0 psig will be credited for calculating ECCS pump NPSH margins and that this allowance can be used to address potential future ECCS NPSH margin issues. This aspect of the BSEP licensing basis remains unchanged with the introduction of MELLLA+.

Loss of the containment design function due to loss of containment venting or other causes is considered a beyond design basis event; however, the response to Criterion 7 demonstrates that when full CAP is credited, significant leakage (640 L_a) is required to impact NPSH margins. Primary containment is maintained at a positive pressure with a control room alarm if the pressure drops below 0.1 psig. Existing alarm response procedures specifically identify the loss containment integrity as a potential cause and provides specific actions for operators to resolve the condition. In addition, the BSEP Technical Specifications (TS 3.6.3.1) requires periodic monitoring and maintenance of the containment oxygen concentration along with daily logs that record containment instrument and trending information. This is expected to result in a relatively short "non-detection interval" sufficient to ensure that a degradation in containment integrity is identified well before containment leakage would challenge ECCS pump NPSH margins.

Station Blackout (SBO)

This criterion is not applicable as no CAP allowance was used in the SBO NPSH margin analysis. Criterion 4 was addressed by this evaluation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

ATWS

No CAP allowance was used in the ATWS analysis. NPSH margin was maintained positive without the use of CAP for the duration of the event. Criterion 4 was addressed by this evaluation.

5. Operator action to control containment accident pressure is acceptable. The NRC staff should approve any operator actions, and the appropriate plant procedures (e.g. emergency, abnormal) should include them.

Design Basis LOCA

The plant's Emergency Operating Procedures (EOPs) control long term operator actions during a DBA LOCA and other events that exceed specified entry conditions. The plant is approved for 5 psig CAP long term and the current procedures are written to maintain sufficient NPSHA to meet NPSHR requirements. Criterion 5 was not specifically addressed in the calculation but was assumed to be in compliance since the NPSH margin requirements for the long term were not changed.

Station Blackout (SBO)

This criterion is not applicable as no CAP allowance was used in the SBO NPSH margin analysis. Criterion 5 was addressed by this evaluation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

ATWS

As discussed above, the plant's EOPs dictate operator actions to control containment pressure when needed to meet NPSHR requirements. No CAP allowance was used in the ATWS NPSH analysis.

NPSH margin was maintained positive without the use of CAP for the duration of the event; therefore, operator action to control containment accident pressure to maintain NPSH are not expected. Criterion 5 was addressed by this evaluation.

6. **It is possible that the NPSHA may be less than $NPSHR_{eff}$ (DBA LOCA) or $NPSHR_{3\%}$ (non-DBA). Operation in this mode is acceptable if appropriate tests are done to demonstrate that the pump will continue to perform its safety functions. The following conditions should apply:**

    - **Predicted operation during the postulated accident below $NPSHR_{eff}$ (LOCA) or $NPSHR_{3\%}$ (nondesign-basis event) is of limited duration (less than 100 hours).**
    - **The tests are conducted on the actual pump with the same mechanical shaft seal (including flush system) or at least a pump of the same model, size, impeller diameter, materials of construction, and pump seal and flush system.**
    - **The test is conducted at the same (field application) speed.**
    - **The test is conducted at the actual predicted NPSHA since testing at a lower NPSHA can actually reduce, rather than increase, the cavitation erosion rate in some cases.**
    - **The test duration should be for the time NPSHA is predicted to be less than $NPSHR_{eff}$ (LOCA) or $NPSHR_{3\%}$ (nondesign-basis event).**
    - **The flow rate and discharge head must remain above the values necessary to provide adequate core and containment cooling.**

Design Basis LOCA

The most limiting short term evaluation showed that NPSHA was less than $NPSHR_{eff}$ for approximately 400 seconds. During this time, there was a relatively small drop in flow from nominally 21,100 gpm to about 19,600 gpm. The flow drop was the result of assuming no CAP for the short term analysis. Since this was a limiting break for RHR, the evaluation performed by the pump manufacturer provided qualitative assurance that no damage would occur rendering RHR pumps capable of performing the long term containment heat removal function. No tests were performed in addressing this criterion but rather an analytical evaluation was performed using original test data and performing extrapolations as a result of higher suction cavitation. Criterion 6 was addressed in this calculation.

Station Blackout (SBO)

This criterion is not applicable as no CAP allowance was used in the SBO NPSH margin analysis. CAP is not required to ensure adequate NPSH margin for suppression pool cooling following a Station Blackout. Criterion 6 was addressed by this evaluation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

ATWS

Criterion 6 is not applicable to the ATWS event. No CAP allowance was used in the ATWS analysis. NPSH margin above NPSHR3% was maintained positive without the use of CAP for the duration of the event. Criterion 6 was addressed by this evaluation.

7. **Licensees and applicants should consider a loss of containment isolation that could compromise containment integrity. Possible losses of containment integrity include containment venting required by procedures or loss of containment isolation from a postulated Appendix R fire. It should be demonstrated conservatively that, for the plant examined, loss of containment integrity from these causes cannot occur or that they would occur only after use of containment accident pressure is no longer needed. To reduce the likelihood of a preexisting leak, licensees proposing to use containment accident pressure in determining NPSH margin should do the following:**

   (1) Determine the minimum containment leakage rate sufficient to lose the containment accident pressure needed for adequate NPSH margin.

   (2) Propose a method to determine whether the actual containment leakage rate exceeds the leakage rate determined in (1) above. For inert containments, this method could consist of a periodic quantitative measurement of the nitrogen makeup performed at an appropriate frequency to ensure that no unusually large makeup of nitrogen occurs. Monitoring oxygen content is another method. For sub-atmospheric containments, a similar procedure might be used.

   (3) Propose a limit on the time interval that the plant operates when the actual containment leakage rate exceeds the leakage rate determined in (1) above.

Design Basis LOCA

The calculation evaluated NPSH margin for the long term DBA LOCA under several containment leakage rates that were multiples of the containment leakage rate (L_a), where the design basis leakage is 1.0 L_a. The evaluations were performed using the GOTHIC model and increasing the laminar leakage rate factor accordingly. It was found that there was sufficient NPSH margin for all leakage rates considered up to 640 L_a. As discussed in response to Criterion 4, periodic surveillances required by the BSEP TS and daily monitoring are expected to alert operators if significant containment leakage occurs. Since containment leakage sufficient to impact NPSH margins is well in excess of L_a, the BSEP TS require essentially an immediate shutdown if the primary containment is not OPERABLE. This evaluation did not cover loss of containment isolation caused by a postulated Appendix R fire, nor did it evaluate postulated failures due to containment venting. Criterion 7 was addressed by this evaluation.

Station Blackout (SBO)

This criterion is not applicable as no CAP allowance was used in the SBO NPSH margin analysis. CAP is not required to ensure adequate NPSH margin for suppression pool cooling following a Station Blackout. Criterion 7 was addressed by this evaluation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

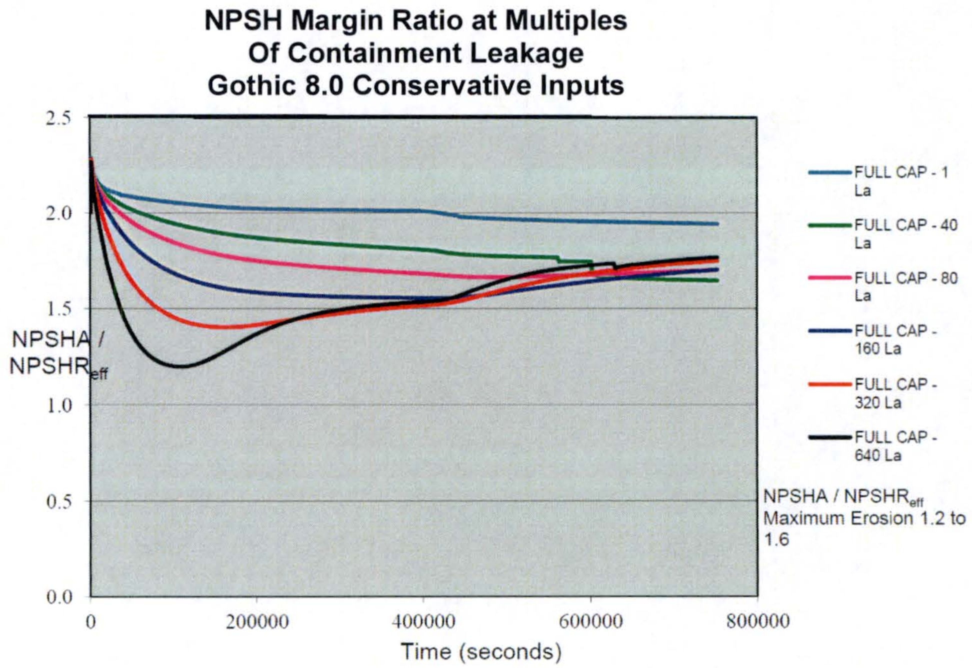
ATWS

This criterion is not applicable to the ATWS event since no CAP allowance was used in the ATWS NPSH analysis. NPSH margin was maintained positive without the use of CAP for the duration of the event. Criterion 7 was addressed by this evaluation.

8. The zone of maximum erosion rate should be considered to lie between NPSH margin ratios of 1.2 to 1.6. The permissible time in this range, for very-high-suction energy pumps, should be limited unless operating experience, testing, or analysis justifies a longer time. Realistic calculations should be used to determine the time within this band of NPSH ratio values.

Design Basis LOCA

The erosion zone evaluation was performed as part of the DBA LOCA evaluations using increasing levels of containment leakage. Criterion 8 was addressed in this calculation. The zone of maximum erosion rate is determined in the long term portion of this calculation. Since this should be based on realistic expectations of NPSH margin, the actual containment pressure response, designated as full CAP, at multiples of 1.0 L_a was evaluated. The figure below shows the long-term NPSH margin ratio.



It was found that the NPSH margin ratio remained above 1.6 for leakage rates up to 160 L_a. Therefore, NPSH margin is acceptable and pump erosion is not likely for leakage rates that far exceed the design basis leakage rate of 1.0 L_a.

Station Blackout (SBO)

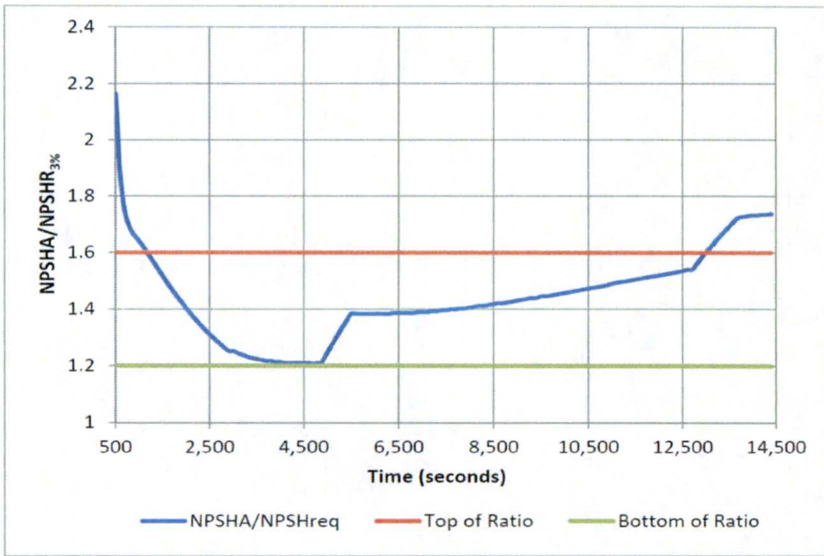
The limiting system (i.e., RHR) was evaluated assuming two pumps per loop. CAP is not required to ensure adequate NPSH margin for suppression pool cooling following a Station Blackout. The SBO NPSH analysis uses conservative assumptions and inputs. The analysis did not determine duration where RHR pumps could be operated with margin ratios between 1.2 and 1.6 since this is beyond the scope of a typical NPSH calculation; however, the duration is expected to be much less than the 100 hour maximum recommended in the SECY.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

ATWS

Although CAP was not credited in the ATWS NPSH analysis, the analysis included an assessment of the RHR pump operating time in the zone of maximum erosion. The figure below shows the RHR pump NPSH margin ratio for the duration of the analysis.



The time RHR pumps operated in the zone of maximum erosion was found to be 3.3 hours which is less than the 100 hours (i.e., maximum) recommended in the SECY. Criterion 8 was addressed by this evaluation.

9. A realistic calculation of NPSHA should be performed to compare with the NPSHA determined from the Monte Carlo 95/95 calculation.

Design Basis LOCA

A realistic analysis was performed for comparison to the Design Basis DBA LOCA. The results were compared to the conservative GOTHIC and SHEX results. The comparison for the long-term case is presented in response to Criterion 1. The Monte Carlo 95/95 analysis was not performed. Therefore, Criterion 9 was partially addressed in the calculation.

> Note: ATWS and other special events generally use realistic inputs for the containment analysis. The realistic analysis performed in this calculation applied only to the DBA LOCA.

Station Blackout (SBO)

As discussed in the response to Criterion 3 and in the SECY, the use of a Monte Carlo analysis with the 95/95 tolerance limit NPSH margin analysis (i.e., Criterion 3) is not applicable to the non-design basis SBO. No CAP allowance was used in the SBO NPSH margin analysis. The NPSH calculation used conservative assumptions and bounding values. Criterion 9 was addressed by this evaluation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

ATWS

As discussed in the response to Criterion 3 and in the SECY, the use of a Monte Carlo NPSH margin analysis (i.e., Criterion 9) is not applicable to the ATWS event consistent with NRC guidance. However, the ATWS NPSH margin evaluation prepared for MELLLA+ makes conservative assumptions and the inputs for the containment response analysis were developed using conservative assumptions. Specifically the aggregate NPSH margin analyses make the following assumptions:

- Decay heat is bounding relative to the decay heat that would be generated by the loaded AREVA fuel under similar ATWS conditions.
- The RPV is held at 50 psig after the ADS blowdown. This maximizes the energy transfer to the suppression pool after ADS is completed.
- Suppression pool level is assumed at the Technical Specification minimum for the NPSH evaluation.
- No CAP credit is assumed in the NPSH evaluation.

For the ATWS event, NPSH margin was maintained positive without the use of CAP for the duration of the event. Criterion 9 was addressed by this evaluation.

10. The necessary mission time for a pump using containment accident pressure should include not only the duration of the accident when the NPSH margin may be limited, but any additional time needed for operation of the pump after recovery from the accident when the pump is needed to maintain the reactor or containment, or both, in a stable, cool condition but at a much greater NPSH margin. This additional time is usually taken as 30 days.

Design Basis LOCA

The calculation evaluated the DBA LOCA out to approximately 35 days. Long-term RHR and CS NPSH performance results (i.e., > 30 days) assuming 5.0 psi CAP are presented in response to Criterion 1. Criterion 10 was addressed by this calculation.

Station Blackout (SBO)

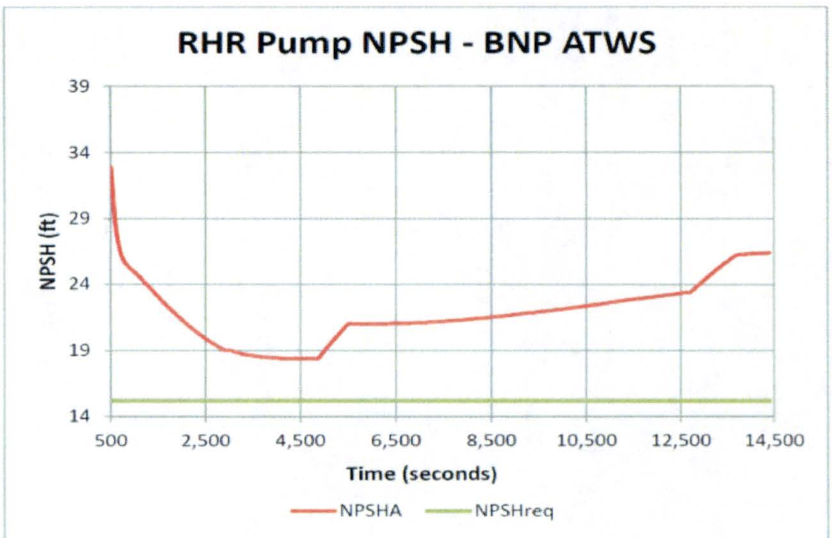
This criterion is not applicable as no CAP allowance was used in the SBO NPSH margin analysis. CAP is not required to ensure adequate NPSH margin for suppression pool cooling following a Station Blackout. Criterion 10 was addressed by this evaluation.

Appendix R

Compliance with Appendix R is no longer required as BSEP has transitioned to a new licensing condition under 10 CFR 50.48(c) under NFPA 805. Fire induced cable faults, including those that cause spurious or mal-operation of equipment otherwise needed to maintain CAP are not significant contributors to CDF and LERF risk.

ATWS

The ATWS analysis models the containment response for four hours which is sufficient to ensure that suppression pool temperature is decreasing. It is important to note relative to Criterion 10 that the results demonstrate (see figure below) that prior to the end of the four hour analyzed accident duration that the NPSH margin ratio is no longer in the zone of maximum erosion (see Criterion 8 response) and NPSHA is increasing as the suppression pool cools.



Therefore, accident recovery and the associated long-term pump performance is not expected to be affected by NPSH considerations following an ATWS. Criterion 10 was addressed by this calculation.