**ENCLOSURE 1**

**MONTICELLO NUCLEAR GENERATING PLANT**
**RELOAD 26 CYCLE 27 SUPPLEMENTAL RELOAD LICENSING REPORT,**
**000N0154-SRLR, REVISION 5**

**EXTENDED POWER UPRATE (EPU)**
**AND**
**MAXIMUM EXTENDED LOAD LINE LIMIT PLUS (MELLLA+)**

**50 pages follow**

Global Nuclear Fuel
A Joint Venture of GE, Toshiba, & Hitachi

**000N0154-SRLR**
**Revision 5**
**Class I**
**December 2013**

# Supplemental Reload Licensing Report

# for

# Monticello

# Reload 26 Cycle 27

# Extended Power Uprate (EPU)

# and

# Maximum Extended Load Line Limit Plus (MELLLA+)

# Important Notice Regarding Contents of This Report

## Please Read Carefully

This report was prepared by Global Nuclear Fuel - Americas, LLC (GNF-A) solely for use by Northern States Power Company (NSP) ("Recipient") in support of the operating license for Monticello (the "Nuclear Plant"). The information contained in this report (the "Information") is believed by GNF-A to be an accurate and true representation of the facts known by, obtained by or provided to GNF-A at the time this report was prepared.

The only undertakings of GNF-A respecting the Information are contained in the contract between Recipient and GNF-A for nuclear fuel and related services for the Nuclear Plant (the "Fuel Contract") and nothing contained in this document shall be construed as amending or modifying the Fuel Contract. The use of the Information for any purpose other than that for which it was intended under the Fuel Contract, is not authorized by GNF-A. In the event of any such unauthorized use, GNF-A neither (a) makes any representation or warranty (either expressed or implied) as to the completeness, accuracy or usefulness of the Information or that such unauthorized use may not infringe privately owned rights, nor (b) assumes any responsibility for liability or damage of any kind which may result from such use of such information.

This report supports the licensing work done for the Nuclear Plant EPU/MELLLA+ license. This reload design was initiated prior to the PRIME transition commitment to utilize PRIME for reload analyses. The cycle-specific reload analyses are based on GESTR-M, with one exception, and the PCT impact of PRIME was evaluated as part of 10 CFR 50.46 Error Notification 2012-01. The one exception is the DSS-CD BSP analysis, which was performed using PRIME. The use of PRIME for the DSS-CD BSP analysis is consistent with NEDO-33173 Supplement 4-A, Rev. 1, "Implementation of PRIME Models and Data in Downstream Methods," November 2012.

## Acknowledgement

The engineering and reload licensing analyses, which form the technical basis of this Supplemental Reload Licensing Report, were performed by GNF-A/GEH Nuclear Analysis personnel. The revision of the Supplemental Reload Licensing Report was prepared by J. Su. This revised document has been verified by L. Leatherwood.

# *Table of Contents*

The basis for this report is *General Electric Standard Application for Reactor Fuel*, NEDE-24011-P-A-19, May 2012; and the U.S. Supplement, NEDE-24011-P-A-19-US, May 2012.

A proprietary *Fuel Bundle Information Report* (FBIR) supplements this licensing report. The FBIR specifies the thermal-mechanical linear heat generation rate limits and also provides a description of the fuel bundles to be loaded. The document number for this report is 0000-0146-5423-FBIR.

## 1. Plant Unique Items

Appendix A: Analysis Conditions
Appendix B: Thermal-Mechanical Compliance
Appendix C: Decrease in Core Coolant Temperature Event
Appendix D: Off-Rated Limits
Appendix E: Mislocated Fuel Loading Error
Appendix F: Turbine Trip with Bypass and Degraded Scram
Appendix G: Monticello Non-Standard SRLR Items
Appendix H: TRACG04 AOO Supplementary Information
Appendix I: NEDC-33173P-A Supplementary Information
Appendix J: MELLLA+ Supplementary Information
Appendix K: List of Acronyms

## 2. Reload Fuel Bundles

| Fuel Type | Cycle Loaded | Number |
|---|---|---|
| **Irradiated:** | | |
| GE14-P10DNAB392-16GZ-100T-145-T6-2931 (GE14C) | 24 | 9 |
| GE14-P10DNAB392-17GZ-100T-145-T6-2932 (GE14C) | 24 | 11 |
| GE14-P10DNAB392-16GZ-100T-145-T6-2931 (GE14C) | 25 | 40 |
| GE14-P10DNAB424-14GZ-100T-145-T6-3100 (GE14C) | 25 | 16 |
| GE14-P10DNAB375-16GZ-100T-145-T6-3101 (GE14C) | 25 | 52 |
| GE14-P10DNAB392-16GZ-100T-145-T6-3102 (GE14C) | 25 | 40 |
| GE14-P10DNAB391-12GZ-100T-145-T6-3103 (GE14C) | 25 | 16 |
| GE14-P10DNAB373-16GZ-100T-145-T6-3375 (GE14C) | 26 | 32 |
| GE14-P10DNAB391-16GZ-100T-145-T6-3376 (GE14C) | 26 | 40 |
| GE14-P10DNAB391-15GZ-100T-145-T6-3377 (GE14C) | 26 | 32 |
| GE14-P10DNAB391-12GZ-100T-145-T6-3378 (GE14C) | 26 | 44 |
| **New:** | | |
| GE14-P10DNAB389-11GZ-100T-145-T6-4178 (GE14C) | 27 | 24 |
| GE14-P10DNAB386-16GZ-100T-145-T6-4177 (GE14C) | 27 | 24 |
| GE14-P10DNAB386-16GZ-100T-145-T6-4176 (GE14C) | 27 | 48 |
| GE14-P10DNAB372-17GZ-100T-145-T6-4175 (GE14C) | 27 | 56 |
| **Total:** | | **484** |

## 3. Reference Core Loading Pattern

| | Core Average Exposure | Cycle Exposure |
|---|---|---|
| Nominal previous end-of-cycle exposure: | 30776 MWd/MT (27919 MWd/ST) | 12595 MWd/MT (11426 MWd/ST) |
| Minimum previous end-of-cycle exposure (for cold shutdown considerations): | 30326 MWd/MT (27511 MWd/ST) | 12145 MWd/MT (11018 MWd/ST) |
| Assumed reload beginning-of-cycle exposure: | 17040 MWd/MT (15459 MWd/ST) | 0 MWd/MT (0 MWd/ST) |
| Assumed reload end-of-cycle exposure (rated conditions): | 30929 MWd/MT (28059 MWd/ST) | 13889 MWd/MT (12600 MWd/ST) |
| Reference core loading pattern: | Figure 1 | |

## 4. Calculated Core Effective Multiplication and Control System Worth

| | |
|---|---|
| Beginning of Cycle, $k_{effective}$ | |
| Uncontrolled (20°C) | 1.110 |
| Fully controlled (20°C) | 0.955 |
| Strongest control rod out (most reactive condition, 20°C) | 0.987 |
| R, Maximum increase in strongest rod out reactivity during the cycle (Δk) | 0.000 |
| Cycle exposure at which R occurs | 0 MWd/MT<br>(0 MWd/ST) |

## 5. Standby Liquid Control System Shutdown Capability

| Boron (ppm) (at 20°C) | Shutdown Margin (Δk) (at 160°C, Xenon Free) | |
|---|---|---|
| | Analytical Requirement | Achieved |
| 660 | ≥0.010 | 0.021 |

## 6. Reload Unique Anticipated Operational Occurrences (AOO) Analysis Initial Condition Parameters [1]

**Operating domain: ICF (HBB)**
**Exposure range : BOC to EOC ( Application Condition: 1)**

| | Peaking Factors | | | | | | |
|---|---|---|---|---|---|---|---|
| Fuel Design | Local | Radial | Axial | R-Factor | Bundle Power (MWt) | Bundle Flow (1000 lb/hr) | Initial MCPR |
| GE14C | 1.0 | 1.42 | 1.42 | 0.974 | 5.877 | 112.8 | 1.76 |

**Operating domain: LCF (HBB)**
**Exposure range : BOC to EOC ( Application Condition: 1)**

| | Peaking Factors | | | | | | |
|---|---|---|---|---|---|---|---|
| Fuel Design | Local | Radial | Axial | R-Factor | Bundle Power (MWt) | Bundle Flow (1000 lb/hr) | Initial MCPR |
| GE14C | 1.0 | 1.44 | 1.32 | 0.975 | 5.966 | 83.8 | 1.58 |

[1] Exposure range designation is defined in Table 7-1. Application condition number is defined in Section 11.

| **Operating domain: ICF (UB)**<br>**Exposure range : BOC to EOC ( Application Condition: 1)** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Peaking Factors** | | | | | | |
| **Fuel Design** | **Local** | **Radial** | **Axial** | **R-Factor** | **Bundle Power (MWt)** | **Bundle Flow (1000 lb/hr)** | **Initial MCPR** |
| GE14C | 1.0 | 1.41 | 1.25 | 0.974 | 5.839 | 111.2 | 1.87 |

| **Operating domain: LCF (UB)**<br>***Exposure range : BOC to EOC ( Application Condition: 1)*** | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Peaking Factors** | | | | | | |
| **Fuel Design** | **Local** | **Radial** | **Axial** | **R-Factor** | **Bundle Power (MWt)** | **Bundle Flow (1000 lb/hr)** | **Initial MCPR** |
| GE14C | 1.0 | 1.40 | 1.35 | 0.975 | 5.798 | 83.2 | 1.69 |

## 7. Selected Margin Improvement Options [2]

| | |
|---|---|
| Recirculation pump trip: | No |
| Rod withdrawal limiter: | No |
| Thermal power monitor: | Yes |
| Improved scram time: | Yes<br>(Option B) |
| Measured scram time: | No |
| Exposure dependent limits: | No |
| Exposure points analyzed: | 1 |

[2] Refer to the GESTAR basis document identified at the beginning of this report for the margin improvement options currently supported therein.

**Table 7-1 Cycle Exposure Range Designation**

| Name | Exposure Range [3] |
|---|---|
| BOC to EOC | BOC27 to EOC27 |

## 8. Operating Flexibility Options [4]

The following information presents the operational domains and flexibility options which are supported by the reload licensing analysis.

| | |
|---|---|
| **Extended Operating Domain (EOD):** | Yes |
| EOD type: Extended Power Uprate (EPU) | |
| Maximum Extended Load Line Limit Plus (MELLLA+) | |
| Minimum core flow at rated power: | 80.0 % |
| **Increased Core Flow:** | Yes |
| Flow point analyzed throughout cycle: | 105.0 % |
| **Feedwater Temperature Reduction:** | No |
| **ARTS Program:** | Yes |
| **Single Loop Operation:** | Yes |
| **Equipment Out of Service:** | |
| Safety/relief valves Out of Service: (credit taken for 5 valves) | Yes |
| PROOS | Yes |

## 9. Core-wide AOO Analysis Results [5,6]

**Methods used:** GEXL-PLUS, TRACG04

[3] End of Rated (EOR) is defined as the cycle exposure corresponding to all rods out, 100% power/100% flow, and normal feedwater temperature. For plants without mid-cycle OLMCPR points, EOR is not applicable.
[4] Refer to the GESTAR basis document identified at the beginning of this report for the operating flexibility options currently supported therein.
[5] Exposure range designation is defined in Table 7-1. Application condition number is defined in Section 11.
[6] The Heat Flux, Q/A (% rated) output is not available from TRACG04, so the Simulated Thermal Power (STP) (% rated) is shown.

| Operating domain: ICF (UB)<br>Exposure range : BOC to EOC ( Application Condition: 1) | | | | |
|---|---|---|---|---|
| | | | Uncorrected ΔCPR/ICPR | |
| Event | Flux (% rated) | STP (% rated) | GE14C | Fig. |
| FW Controller Failure | 548.5 | 114.4 | 0.238 | 2 |
| Turbine Trip with Bypass | 621.3 | 110.3 | 0.291 | 3 |
| Turbine Trip w/o Bypass | 550.8 | 108.5 | 0.228 | 4 |
| Load Rejection w/o Bypass | 335.4 | 106.2 | 0.169 | 5 |
| Inadvertent HPCI /L8 | 530.8 | 120.5 | 0.248 | 6 |

## 10. Rod Withdrawal Error AOO Summary

The Rod Withdrawal Error (RWE) event was analyzed in the GE BWR Licensing Topical Report *Average Power Range Monitor, Rod Block Monitor and Technical Specification Improvement (ARTS) Program for Monticello Nuclear Generating Plant*, NEDC-30492-P, April 1984.

**RWE Results:**

| RBM Setpoint (%) | ΔCPR |
|---|---|
| 114.0 | 0.25 |

The more limiting of the cycle specific and the generic ΔCPR values are reported in the table above. The RWE OLMCPR is determined by adding the ΔCPR for the desired RBM setpoint from the table above to the SLMCPR in Section 11.

The ITSP and LTSP MCPR limits associated with the HTSP reported in the above table are bounded by the Kp limits for this cycle.

The ARTS RWE analysis validated that the following MCPR values provide the required margin for full withdrawal of any control rod during this cycle:

For Power < 90%: MCPR ≥ 1.70

For Power ≥ 90%: MCPR ≥ 1.40

The RBM operability requirements have been evaluated and shown to be sufficient to ensure that the SLMCPR and cladding 1% plastic strain criteria will not be exceeded in the event of a RWE.

## 11. Cycle SLMCPR and OLMCPR Summary [7] [8] [9]

Two Loop Operation (TLO) safety limit: 1.15

Single Loop Operation (SLO) safety limit: 1.15

Stability MCPR Design Basis: See Section 15

ECCS MCPR Design Basis: See Section 16 (Initial MCPR)

**Non-pressurization Events:**

| **Exposure range: BOC to EOC** | |
|---|---|
| | **All Fuel Types** |
| Rod Withdrawal Error (114.0 % RBM Setpoint) | 1.40 |
| Loss of Feedwater Heating | 1.34 |
| Fuel Loading Error (Mislocated) | Not Limiting |
| Fuel Loading Error (Misoriented) | 1.37 |
| Rated Equivalent SLO Pump Seizure [10] | 1.45 |

**Limiting Pressurization Events OLMCPR Summary Table:** [11]

| **Appl. Cond.** | **Exposure Range** | **Option A** | **Option B** |
|---|---|---|---|
| | | **GE14C** | **GE14C** |
| 1 | **Base Case** | | |
| | BOC to EOC | 1.74 | 1.62 |

[7] Exposure range designation is defined in Table 7-1.
[8] For SLO, the MCPR operating limit is equal to the two loop value.
[9] The safety limit values presented include a 0.03 adder in accordance with extended operating domain licensing commitments up to and including operation in the MELLLA+ operating domain.
[10] The cycle-independent OLMCPR for the recirculation pump seizure event for GE14C is 1.62 based on the cycle-specific SLO SLMCPR. When adjusted for the off-rated power/flow conditions of SLO, this limit corresponds to a rated OLMCPR of 1.45. This limit does not require an adjustment for the SLO SLMCPR.
[11] Each application condition (Appl. Cond.) covers the entire range of licensed flow and feedwater temperature unless specified otherwise. The OLMCPR values presented apply to rated power operation based on the two loop operation safety limit MCPR.

**Pressurization Events:**[12]

| **Operating domain: ICF (UB)**<br>**Exposure range : BOC to EOC ( Application Condition: 1)** | | |
|---|---|---|
| | **Option A** | **Option B** |
| | **GE14C** | **GE14C** |
| FW Controller Failure | Not Limiting | Not Limiting |
| Turbine Trip with Bypass | 1.62 | 1.62 |
| Turbine Trip w/o Bypass | Not Limiting | Not Limiting |
| Load Rejection w/o Bypass | Not Limiting | Not Limiting |
| Inadvertent HPCI /L8 | 1.74 | 1.54 |

## 12. Overpressurization Analysis Summary [13]

| Event | Psl (psig) | Pdome (psig) | Pv (psig) | Plant Response |
|---|---|---|---|---|
| MSIV Closure (Flux Scram) - ICF (HBB) | 1321 | 1327 | 1351 | Figure 7 |
| MSIV Closure (Flux Scram) - LCF (HBB) | 1306 | 1312 | 1333 | Figure 8 |

## 13. Fuel Loading Error Results

Variable water gap misoriented bundle analysis: Yes [14]

| Misoriented Fuel Bundle | ΔCPR |
|---|---|
| GE14-P10DNAB373-16GZ-100T-145-T6-3375 (GE14C) | 0.21 |
| GE14-P10DNAB391-16GZ-100T-145-T6-3376 (GE14C) | 0.15 |
| GE14-P10DNAB391-15GZ-100T-145-T6-3377 (GE14C) | 0.07 |
| GE14-P10DNAB391-12GZ-100T-145-T6-3378 (GE14C) | 0.15 |
| GE14-P10DNAB372-17GZ-100T-145-T6-4175 (GE14C) | 0.21 |
| GE14-P10DNAB386-16GZ-100T-145-T6-4176 (GE14C) | 0.18 |
| GE14-P10DNAB386-16GZ-100T-145-T6-4177 (GE14C) | 0.22 |
| GE14-P10DNAB389-11GZ-100T-145-T6-4178 (GE14C) | 0.20 |

[12] Application condition numbers shown for each of the following pressurization events represent the application conditions for which this event contributed in the determination of the limiting OLMCPR value.
[13] Overpressure calculated at an initial dome pressure of 1010 psig.
[14] Includes a 0.02 penalty due to variable water gap R-factor uncertainty.

## 14. Control Rod Drop Analysis Results

This is a banked position withdrawal sequence plant, therefore, the control rod drop accident analysis is not required. NRC approval is documented in NEDE-24011-P-A-19-US.

## 15. Stability Analysis Results

Northern States Power Company is seeking approval for operating Monticello in the MELLLA+ operating domain, which would provide greater core flow flexibility, particularly as power approaches 120% of the Original Licensed Thermal Power. SLO will not be allowed in conjunction with operation in the MELLLA+ domain. Implementation of MELLLA+ operating domain requires the use of the Detect and Suppress Solution – Confirmation Density (DSS-CD) stability solution. Stability results for operation at EPU with MELLLA+ and DSS-CD are contained in this section.

### 15.1 Stability DSS-CD Solution

Monticello will implement the stability DSS-CD solution using the Oscillation Power Range Monitor (OPRM) as described in Reference 1 in Section 15.4. Plant-specific analyses for the DSS-CD Solution are provided in Reference 2 in Section 15.4. The Detect and Suppress function of the DSS-CD solution based on the OPRM system relies on the Confirmation Density Algorithm (CDA), which constitutes the licensing basis. The Backup Stability Protection (BSP) solution may be used by the plant in the event that the OPRM system is declared inoperable.

The CDA enabled through the OPRM system and the BSP solution described in Reference 2 in Section 15.4 provide the stability licensing bases for Monticello Cycle 27. The safety evaluation report for Reference 1 in Section 15.4 concluded that the DSS-CD solution is acceptable subject to certain cycle-specific limitations and conditions. These cycle-specific limitations and conditions are met for Monticello Cycle 27.

### 15.2 Detect and Suppress Evaluation

A reload DSS-CD evaluation has been performed in accordance with the licensing methodology described in Reference 1 in Section 15.4 to confirm the Amplitude Discriminator Setpoint ($S_{AD}$) of the CDA established in Reference 2 in Section 15.4. The Cycle 27 DSS-CD evaluation and the results for the DSS-CD Reload Confirmation Applicability Checklist documented in Table 15-1 demonstrate that: 1) the DSS-CD Solution is applicable to Monticello Cycle 27; and, 2) the $S_{AD}$=1.10 established in Reference 2 in Section 15.4 is confirmed for operation of Monticello Cycle 27.

The $S_{AD}$=1.10 setpoint is applicable to TLO and to SLO.

**Table 15-1 DSS-CD Reload Confirmation Applicability Checklist**

| Parameter | DSS-CD Criterion | Monticello Cycle 27 Results | Acceptance |
|---|---|---|---|
| BWR Product Line | BWR/3-6 design | BWR/3 | Confirmed |
| Fuel Product Line | GE14 and earlier GE designs | GE14 | Confirmed |
| Operating Domain (TLO) | ≤ EPU/MELLLA+ including currently licensed operational flexibility features | EPU/MELLLA+ including currently licensed operational flexibility features | Confirmed |
| Operating Domain (SLO) | ≤ EPU/MELLLA including currently licensed operational flexibility features | EPU/MELLLA including currently licensed operational flexibility features | Confirmed |
| Rated $T_{FW}$ Reduction | ≤ 120°F (EPU/MELLLA) No $T_{FW}$ Reduction (MELLLA+ Extension) | No $T_{FW}$ Reduction | Confirmed |
| Margin for TLO (see Table 2-2 in Reference 2 in Section 15.4) | see Table 2-2 in Reference 2 in Section 15.4 | 0.29 | Confirmed |
| Margin for SLO (see Table 2-2 in Reference 2 in Section 15.4) | see Table 2-2 in Reference 2 in Section 15.4 | 0.37 | Confirmed |

## 15.3 Backup Stability Protection

Reference 1 in Section 15.4 describes two BSP options that are based on selected elements from three distinct constituents: BSP Manual Regions, BSP Boundary, and Automated BSP (ABSP) setpoints.

The Manual BSP region boundaries and the BSP Boundary were calculated for Monticello Cycle 27 for normal feedwater temperature operation. The endpoints of the regions are defined in Table 15-2. The Scram Region boundary, the Controlled Entry Region boundary, and the BSP Boundary are shown in

Figure 9.

The ABSP APRM Simulated Thermal Power setpoints associated with the ABSP Scram Region from Reference 3 are confirmed for Cycle 27 and are defined in Table 15-3. These ABSP setpoints bound both TLO and SLO.

**Table 15-2 BSP Endpoints for Normal Feedwater Temperature**

| Endpoint | Power (%) | Flow (%) | Definition |
|---|---|---|---|
| A1 | 71.3 | 43.0 | Scram Region Boundary, HFCL |
| B1 | 42.6 | 33.7 | Scram Region Boundary, NCL |
| A2 | 83.6 | 58.9 | Controlled Entry Region Boundary, HFCL |
| B2 | 28.6 | 31.2 | Controlled Entry Region Boundary, NCL |
| A3 | 100.0 | 85.2 | BSP Boundary Intercept, HFCL |
| B3 | 75.3 | 57.4 | BSP Boundary Intercept, MELLLA+ Boundary at Minimum Flow |

**Table 15-3 ABSP Setpoints for the Scram Region**

| Parameter | Symbol | Value |
|---|---|---|
| Slope of ABSP APRM flow-biased trip linear segment. | m | 1.30 |
| ABSP APRM flow-biased trip setpoint power intercept. Constant Power Line for Trip from zero Drive Flow to Flow Breakpoint value. | $P_{BSP-TRIP}$ | 38.0 % RTP* |
| ABSP APRM flow-biased trip setpoint drive flow intercept. Constant Flow Line for Trip. | $W_{BSP-TRIP}$ | 55.8 % RDF** |
| Flow Breakpoint value | $W_{BSP-BREAK}$ | 37.9 % RDF** |

* RTP – Rated Thermal Power
** RDF – Recirculation Drive Flow

## 15.4 References

1. *General Electric Boiling Water Reactor Detect and Suppress Solution – Confirmation Density*, NEDC-33075P-A, Revision 6, January 2008.

2. *Safety Analysis Report for Monticello Maximum Extended Load Line Limit Analysis Plus*, NEDC-33435P, Revision 1, December 2009.

3. *Instrument Limits Calculation, Northern States Power – Minnesota (NSPM), Monticello Nuclear Generating Plant, Average Power Range Monitor NUMAC PRNM Setpoints - MELLLA+ Automatic Backup Stability Protection (ABSP),* 0000-0105-4810-R2 MNGP-M+ABSP-APRM-Calc-2009-P, Revision 2, June 2011.

# 16. Loss-of-Coolant Accident Results [15]

## 16.1 10CFR50.46 Licensing Results

The ECCS-LOCA analysis is based on the SAFER/GESTR-LOCA methodology. The licensing results in the new cycle are summarized in the following table.

[15] Lattice numbers are defined in the Fuel Bundle Information Report, 0000-0146-5423-FBIR.

**Table 16.1-1 Licensing Results**

| Fuel Type | Licensing Basis PCT (°F) | Local Oxidation (%) | Core-Wide Metal-Water Reaction (%) |
|---|---|---|---|
| GE14C | 2140 | <10.00 | < 0.20 |

The SAFER/GESTR-LOCA analysis results for GE14C are documented in Reference 1 for EPU and Reference 2 for MELLLA+ in Section 16.4.

The RHR intertie open line analysis is documented in Reference 3 for GE14C in Section 16.4. Reference 1 for GE14C extends the Reference 3 analysis to EPU. Reference 2 for GE14C extends the Reference 3 analysis to MELLLA+. These analyses indicate that plant operation up to 376 MWt with the RHR intertie line open is acceptable from an ECCS performance standpoint, provided a MAPLHGR multiplier of 0.75 is implemented or that the peak bundle power does not exceed 3.9 MWt.

In addition to the power and flow dependent multipliers, Monticello also requires an ECCS MAPLHGR multiplier of 0.9908 for operation at or below 99% core flow. This multiplier ensures that the off-rated limits assumed in the EPU ECCS-LOCA analyses bound the cycle-specific off-rated limits calculated for MELLLA+ operation.

For GE14C, the large break Appendix K ECCS-LOCA result at EPU power and MELLLA+ core flow is 2123°F as documented in Reference 2. The large break Appendix K ECCS-LOCA result at EPU power and rated core flow is 2119°F as documented in Reference 1.

## 16.2 10CFR50.46 Error Evaluation

The 10CFR50.46 errors applicable to the Licensing Basis PCT are shown in the following table.

**Table 16.2-1 Impact on Licensing Basis Peak Cladding Temperature for GE14C**

| 10CFR50.46 Error Notifications | | |
|---|---|---|
| **Number** | **Subject** | **PCT Impact (°F)** |
| 2012-01 | PRIME Code Implementation for Fuel Rod T/M Performance, Replacing GESTR | +10 |
| | **Total PCT Adder (°F)** | +10 |

After accounting for the error impact, the GE14C Licensing Basis PCT remains below the 10CFR50.46 limit of 2200°F, the Local Oxidation remains below the 10CFR50.46 limit of 17%, and the Core-Wide Metal-Water Reaction remains below the 10CFR50.46 limit of 1%.

## 16.3 ECCS-LOCA Operating Limits

The ECCS-LOCA composite MAPLHGR operating limits for all fuel bundles in this EPU/MELLLA+ analysis are identical to the EPU MAPLHGR operating limits provided in the Monticello Cycle 27 EPU SRLR as documented in Reference 4.

The core monitoring system monitors LHGR limits and ECCS-LOCA MAPLHGR limits separately; therefore, the new ECCS-LOCA MAPLHGR limits shown in Reference 1 for GE14C in Section 16.4 are unaffected by changes to the LHGR curve, and application of the GE14L-B36-G7-IMLTR LHGR curve is acceptable from the ECCS-LOCA perspective.

The single loop operation multiplier on MAPLHGR and the ECCS-LOCA analytical initial MCPR values applicable to GE14C fuel type in the new cycle core are shown in the following table.

**Table 16.3-15 Initial MCPR and Single Loop Operation Multiplier on MAPLHGR**

| Fuel Type | Initial MCPR | Single Loop Operation Multiplier on MAPLHGR |
|---|---|---|
| GE14C | 1.350 | 0.83 |

The GE14C SLO multiplier applies to the EPU operating domain only, and SLO operation in the MELLLA+ domain is not permitted.

Monticello has an ECCS-LOCA PLHGR of 11.62 kW/ft for GE14C fuel type.

## 16.4 References

The SAFER/GESTR-LOCA analysis base reports applicable to the new cycle core are listed below.

**References for GE14C**

1. *Project Task Report Nuclear Management Company, LLC (NMC) Monticello Nuclear Generating Plant Extended Power Uprate Task T0407: ECCS-LOCA SAFER/GESTR*, GE-NE-0000-0060-9286-TR-R2, Revision 2, October 2011.
2. *Project Task Report Northern States Power - Minnesota (NSPM) Monticello Nuclear Generating Plant MELLLA+ Task T0407: ECCS-LOCA SAFER/GESTR*, 0000-0096-6889-TR-R1, Revision 1, October 2011.
3. *Monticello Nuclear Plant GE14 ECCS-LOCA Evaluation with the RHR Intertie Line Open*, NSA 01-459, October 10, 2001.
4. *Supplemental Reload Licensing Report for Monticello Reload 26 Cycle 27 Extended Power Uprate (EPU)*, 0000-0146-5423-SRLR-R3, October 2013.

```
52                                        5  6  9  9  6  5
50                                       11  9 10 10  9 11
48                           9  9  7  8 10  3 13 13 14 10  8  7  9  9
46                           9  9 15 15 20 18 18 18 18 20 15 15  9  9
44                     6  7 11 14 20 18 19 18 12 12 18 19 18 20 14 11  9  5
42                     9 10 13 20 10 18 15 12 17 17 12 15 18 10 20 13 10  9
40               9  9 11 13  7 18 19 14 17  7 15 15  7 17 14 19 18  7 13 11  9  9
38               9  9 14 20 18 15 14 17 15 17  8  8 17 15 17 14 15 18 20 14  1  9
36               7 15 20 10 19 14 10 13 17 10 12 12 10 17 13 10 14 19 10 20 15  7
34               8 15 18 18 14 17 13  7 13 17  7  7 17 13  7 13 17 14 18 18 15  8
32    5 11 10 20 19 15 17 15 17 13 17 12 19 19 12 17 13 17 15 17 15 19 20 10 11  5
30    6  9 14 18 18 12  7 17 10 17 12 17 13 13 17 12 17 10 17  7 12 18 18 14  9  6
28    9 10 13 18 12 17 15  8 12  7 19 13  7  7 13 19  7 12  8 15 17 12 18 13 10  9
26    9 10 13 18 12 17 15  8 12  7 19 13  7  7 13 19  7 12  8 15 17 12 18 13 10  9
24    6  9 14 18 18 12  7 17 10 17 12 17 13 13 17 12 17 10 17  7 12 18 18 14  9 16
22    5 11 10 20 19 15 17 15 17 13 17 12 19 19 12 17 13 17 15 17 15 19 20 10 11  5
20          8 15 18 18 14 17 13  7 13 17  7  7 17 13  7 13 17 14 18 18 15  8
18          7 15 20 10 19 14 10 13 17 10 12 12 10 17 13 10 14 19 10 20 15  7
16          9  2 14 20 18 15 14 17 15 17  8  8 17 15 17 14 15 18 20 14  9  9
14          9  9 11 13  7 18 19 14 17  7 15 15  7 17 14 19 18  7 13 11  9  9
12                9 10 13 20 10 18 15 12 17 17 12 15 18 10 20 13 10  9
10                6  7 11 14 20 18 19 18 12 12 18 19 18 20 14 11  7  6
 8                      9  9 15 15 20 18 18 18 18 20 15 15  9  9
 6                      9  9  7  8 10 14 13 13  3 10  8  7  9  9
 4                                  11  9 10 10  9 11
 2                                   5  6  9  9  6  5

      1  3  5  7  9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39 41 43 45 47 49 51
```

| Fuel Type | | | |
|---|---|---|---|
| 1=GE14-P10DNAB392-16GZ-100T-145-T6-2931 | (Cycle 25) | 12=GE14-P10DNAB373-16GZ-100T-145-T6-3375 | (Cycle 26) |
| 2=GE14-P10DNAB375-16GZ-100T-145-T6-3101 | (Cycle 25) | 13=GE14-P10DNAB391-16GZ-100T-145-T6-3376 | (Cycle 26) |
| 3=GE14-P10DNAB391-15GZ-100T-145-T6-3377 | (Cycle 26) | 14=GE14-P10DNAB391-15GZ-100T-145-T6-3377 | (Cycle 26) |
| 5=GE14-P10DNAB392-16GZ-100T-145-T6-2931 | (Cycle 24) | 15=GE14-P10DNAB391-12GZ-100T-145-T6-3378 | (Cycle 26) |
| 6=GE14-P10DNAB392-17GZ-100T-145-T6-2932 | (Cycle 24) | 16=GE14-P10DNAB392-17GZ-100T-145-T6-2932 | (Cycle 24) |
| 7=GE14-P10DNAB392-16GZ-100T-145-T6-2931 | (Cycle 25) | 17=GE14-P10DNAB372-17GZ-100T-145-T6-4175 | (Cycle 27) |
| 8=GE14-P10DNAB424-14GZ-100T-145-T6-3100 | (Cycle 25) | 18=GE14-P10DNAB386-16GZ-100T-145-T6-4176 | (Cycle 27) |
| 9=GE14-P10DNAB375-16GZ-100T-145-T6-3101 | (Cycle 25) | 19=GE14-P10DNAB386-16GZ-100T-145-T6-4177 | (Cycle 27) |
| 10=GE14-P10DNAB392-16GZ-100T-145-T6-3102 | (Cycle 25) | 20=GE14-P10DNAB389-11GZ-100T-145-T6-4178 | (Cycle 27) |
| 11=GE14-P10DNAB391-12GZ-100T-145-T6-3103 | (Cycle 25) | | |

**Figure 1 Reference Core Loading Pattern**

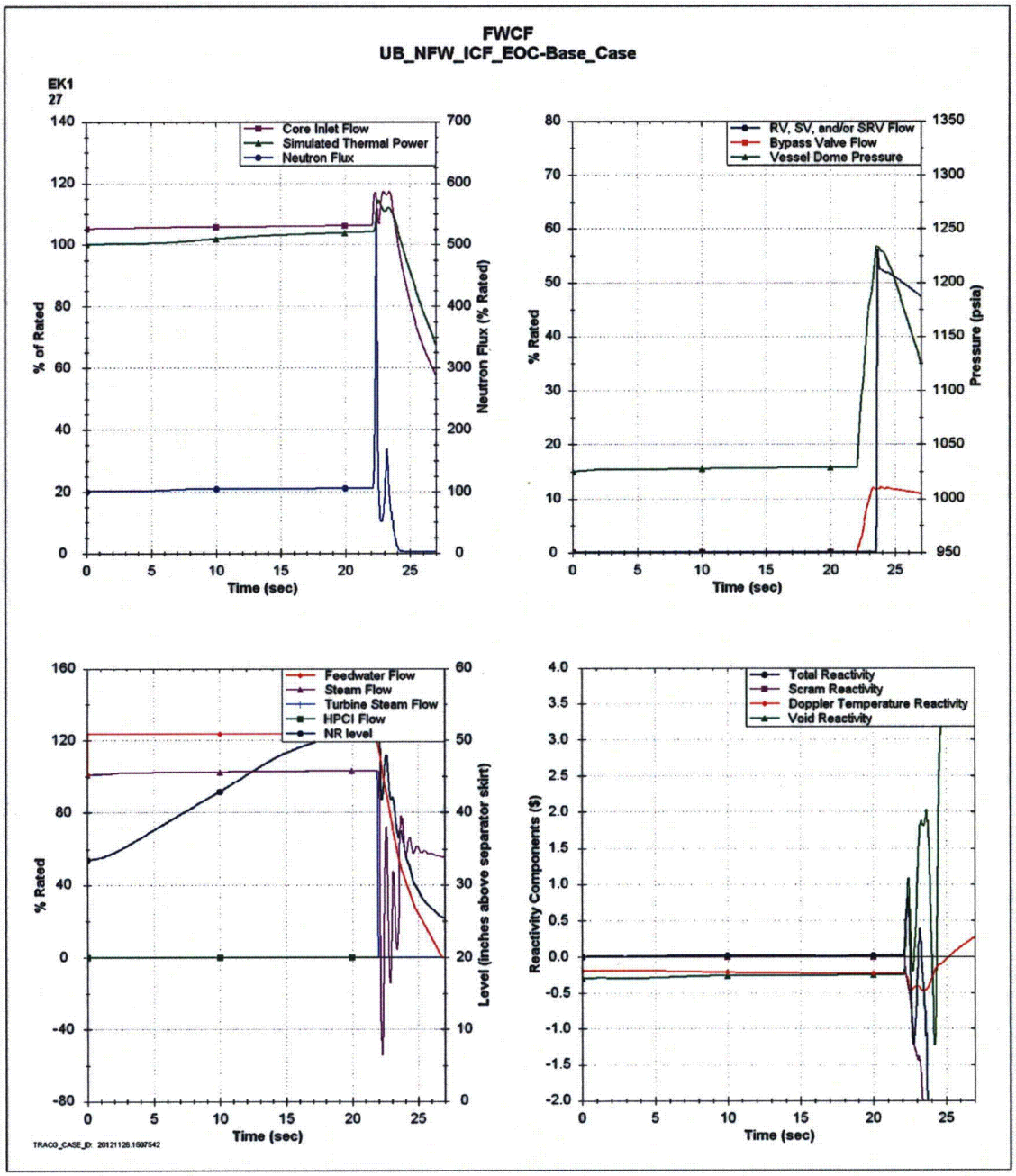


**Figure 2 Plant Response to FW Controller Failure**
**( EOC ICF (UB) )**

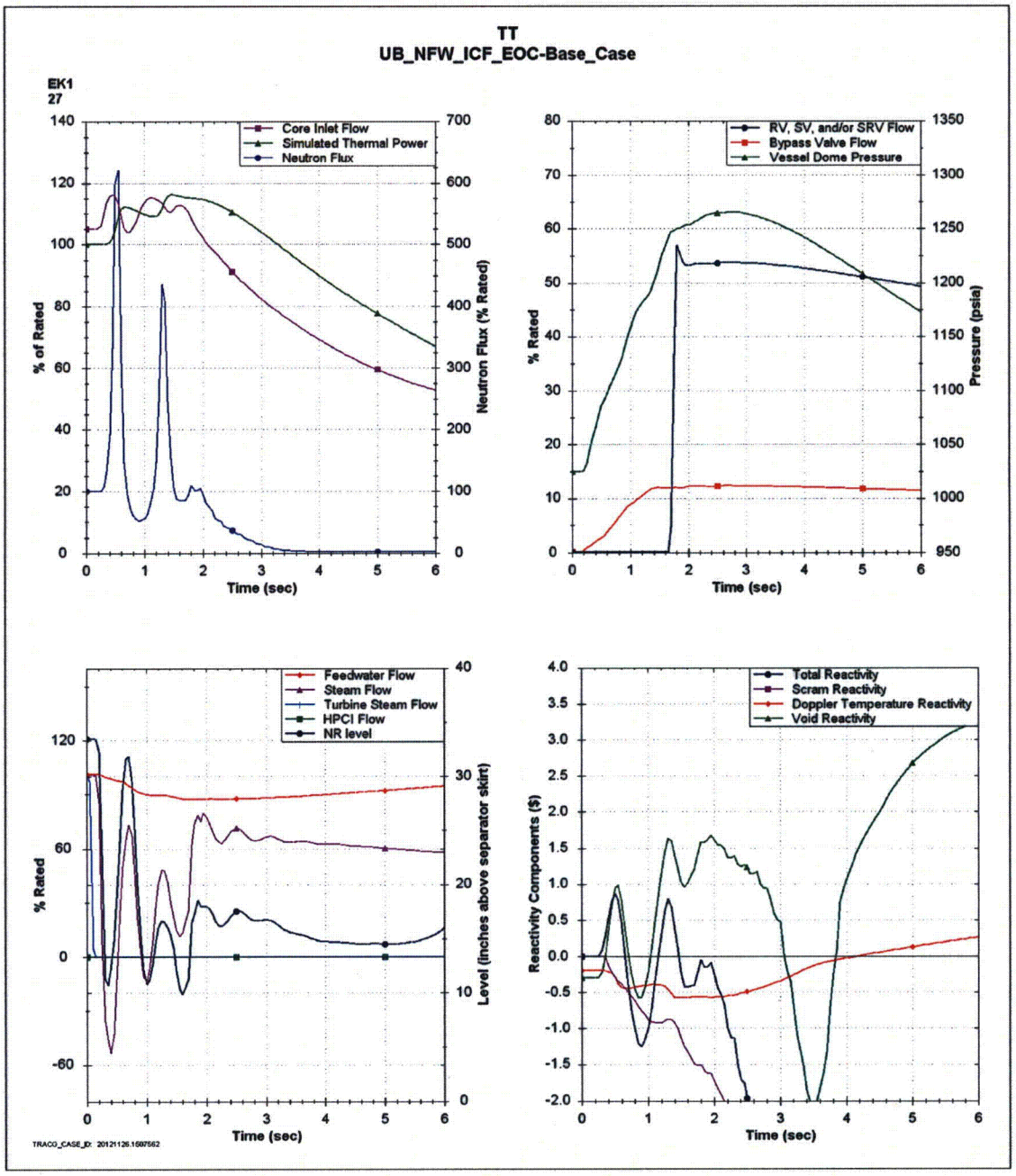


**Figure 3 Plant Response to Turbine Trip with Bypass**
**( EOC ICF (UB) )**

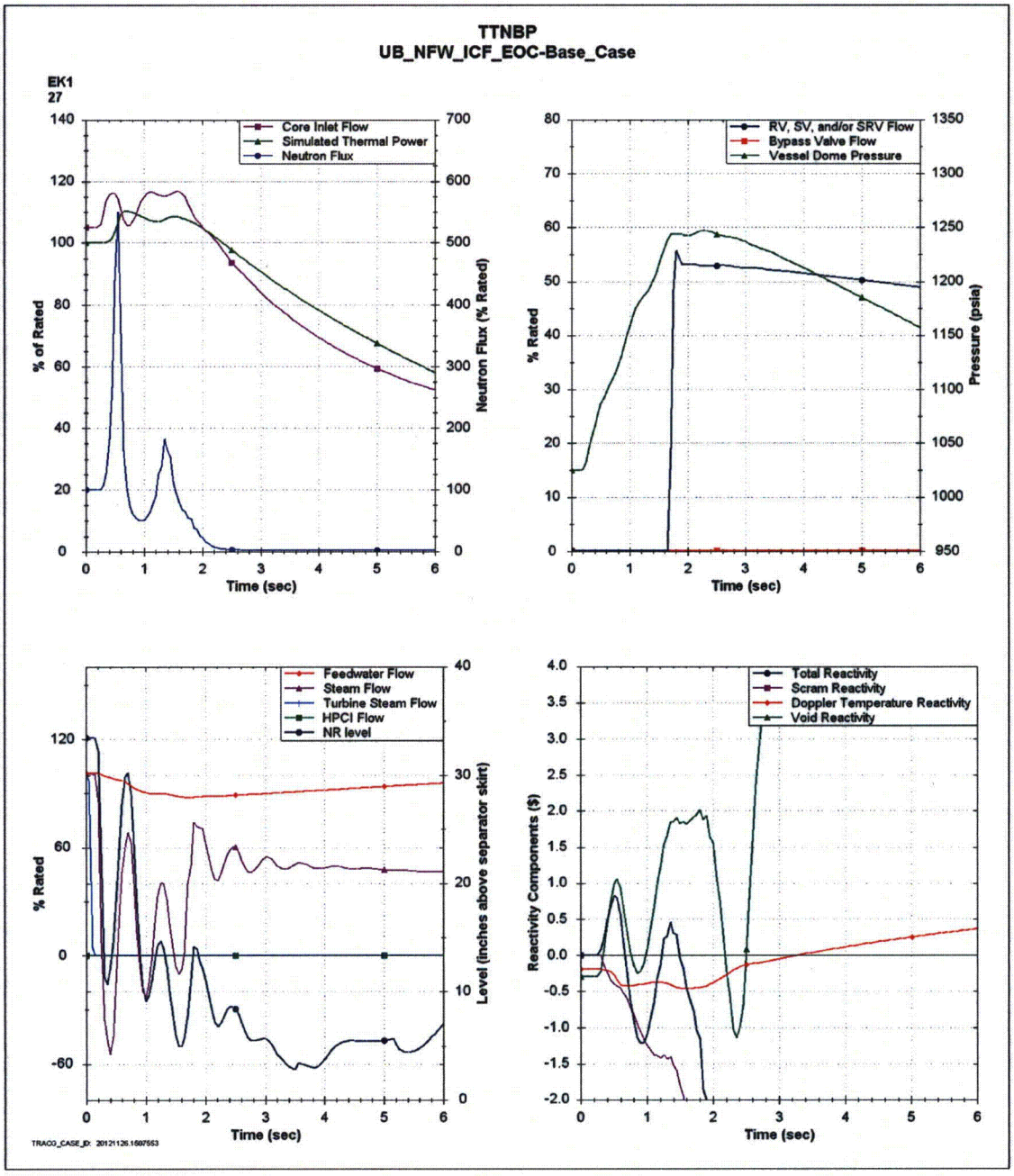


**Figure 4 Plant Response to Turbine Trip w/o Bypass**
**( EOC ICF (UB) )**

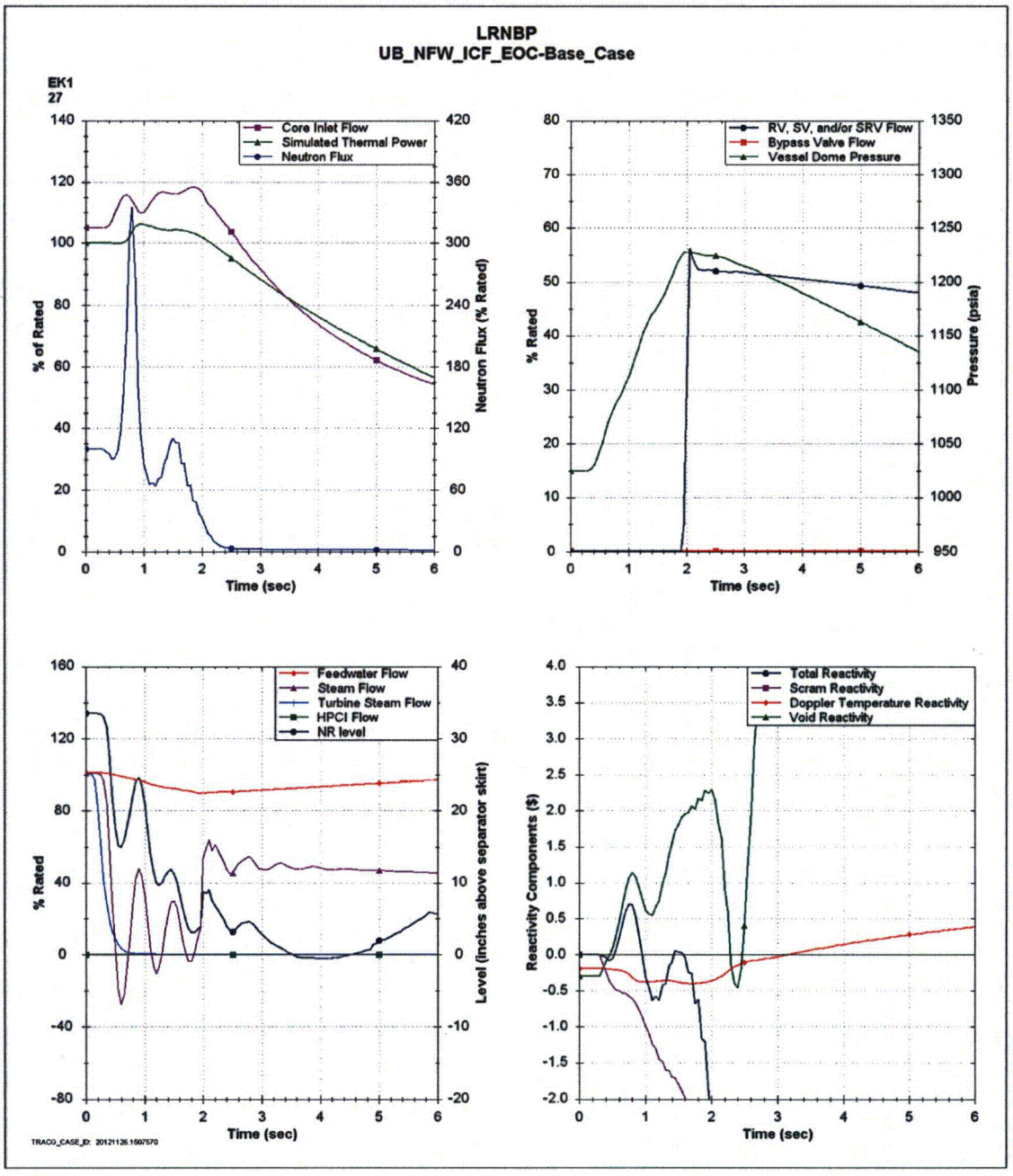


**Figure 5 Plant Response to Load Rejection w/o Bypass**
**( EOC ICF (UB) )**

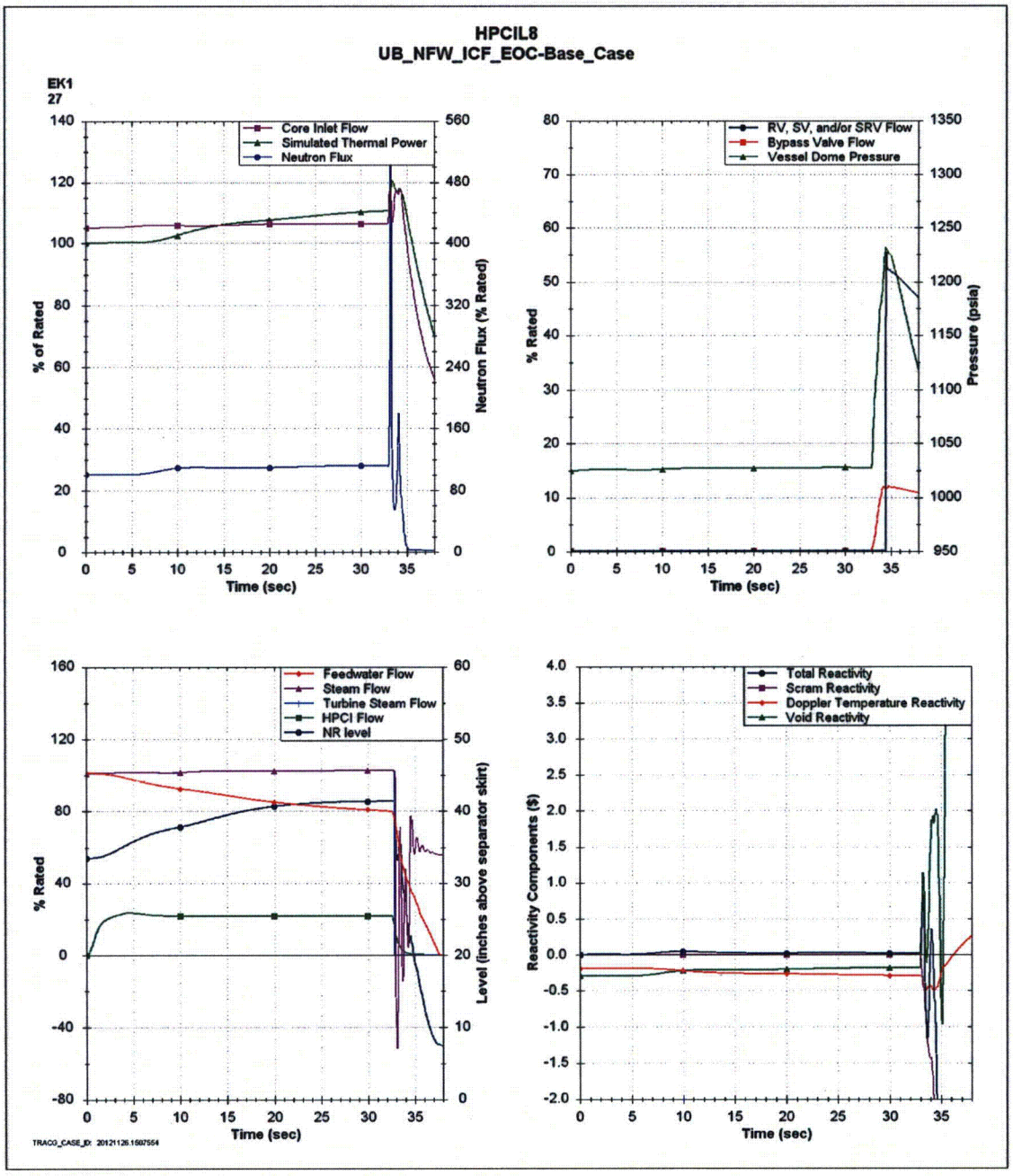


**Figure 6 Plant Response to Inadvertent HPCI /L8**
**( EOC ICF (UB) )**

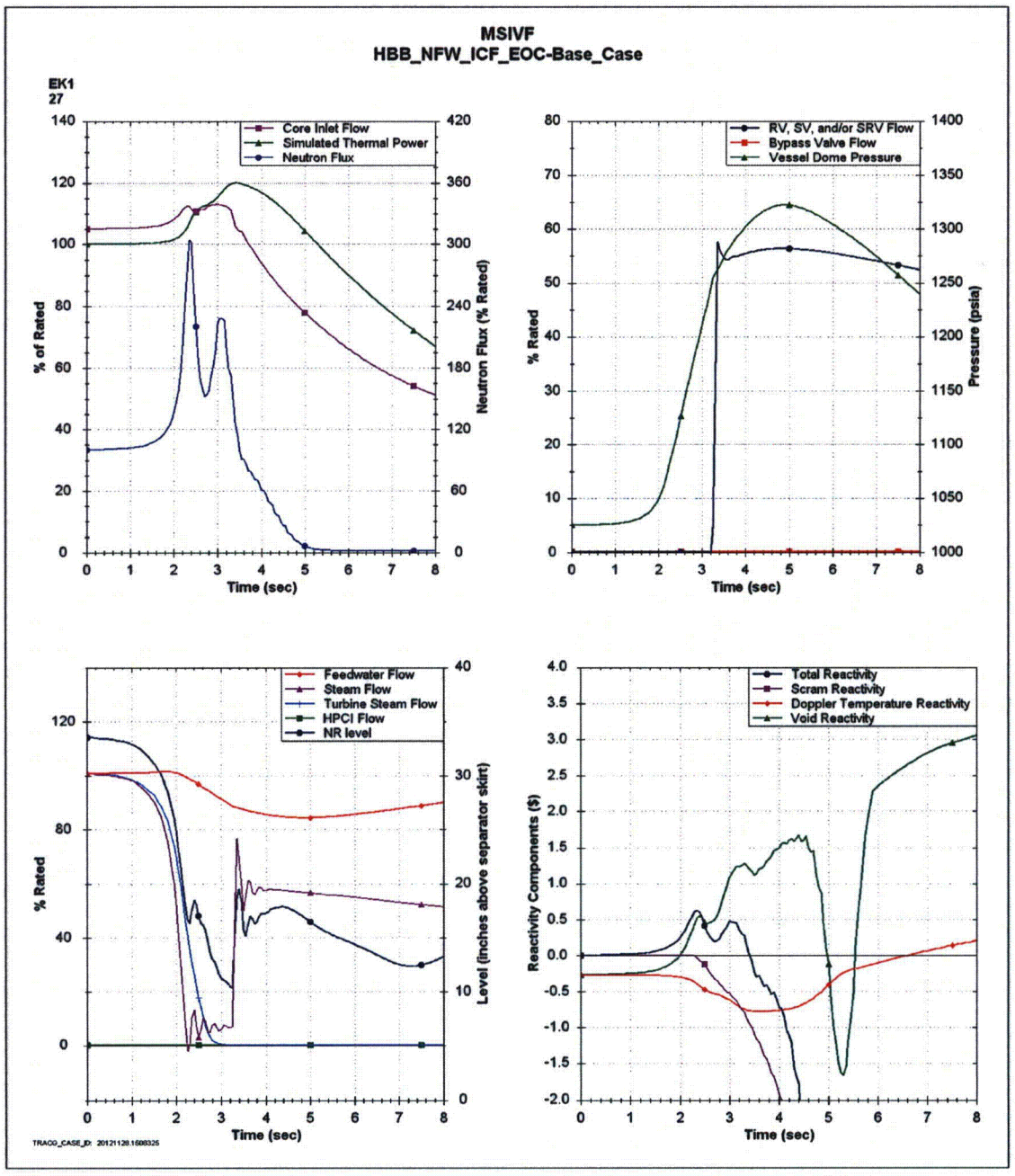


**Figure 7 Plant Response to MSIV Closure (Flux Scram) – (EOC ICF (HBB) )**

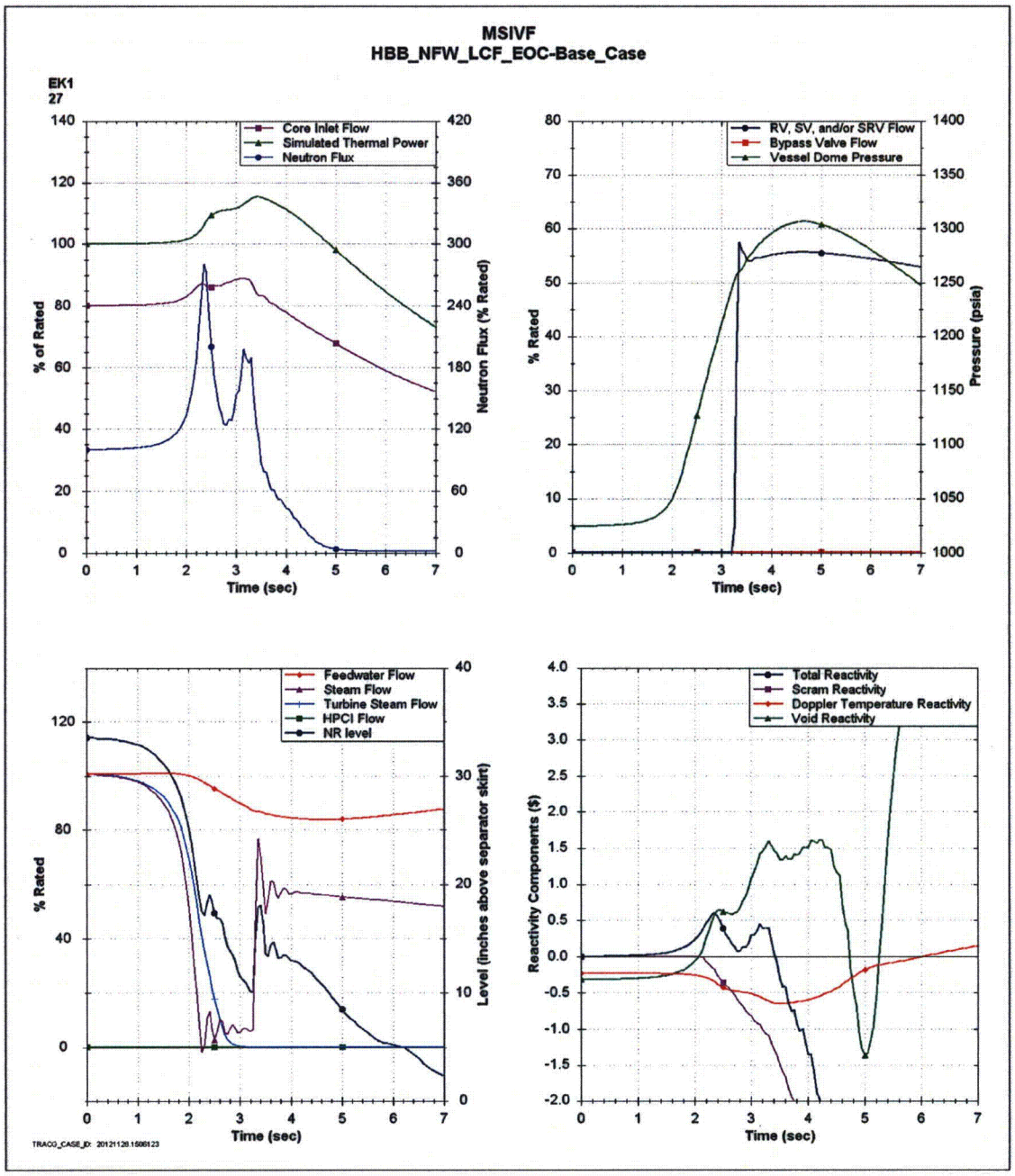


**Figure 8 Plant Response to MSIV Closure (Flux Scram) – (EOC LCF (HBB) )**

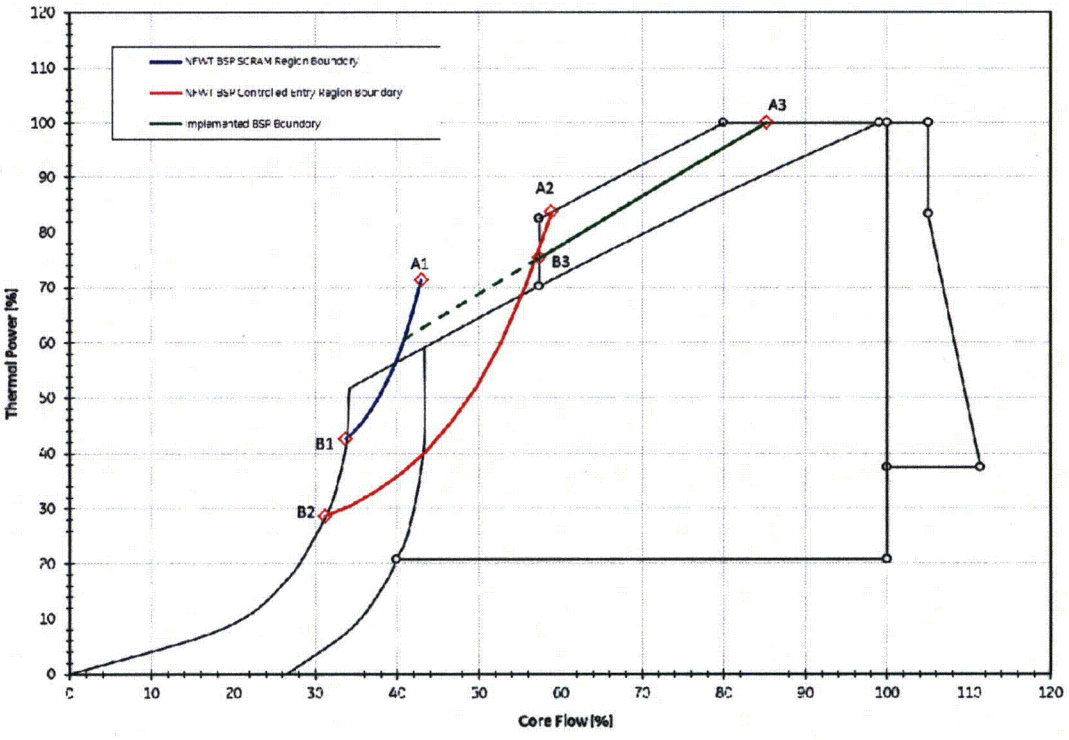


**Figure 9 Manual BSP Regions and BSP Boundary for Normal Feedwater Temperature Operation**

# Appendix A
# Analysis Conditions

The reactor operating conditions used in the reload licensing analysis for this plant and cycle are presented in Table A-1. The pressure relief and safety valve configuration for this plant are presented in Table A-2. Additionally, the operating flexibility options listed in Section 8 are supported by the reload licensing analysis.

**Table A-1 Reactor Operating Conditions**

| Parameter | Analysis Value | |
|---|---|---|
| | ICF NFWT | LCF NFWT |
| Thermal power, MWt | 2004.0 | 2004.0 |
| Core flow, Mlb/hr | 60.5 | 46.1 |
| Reactor pressure (core mid-plane), psia | 1041.0 | 1036.3 |
| Inlet enthalpy, Btu/lb | 524.8 | 517.1 |
| Non-fuel power fraction[16] | NA | NA |
| Steam flow, Mlb/hr | 8.39 | 8.39 |
| Dome pressure, psig | 1010.2 | 1009.8 |
| Turbine pressure, psig | 943.9 | 943.7 |

**Table A-2 Pressure Relief and Safety Valve Configuration**

| Valve Type | Number of Valves | Lowest Setpoint (psig) |
|---|---|---|
| Safety/Relief Valve | 8 | 1170 (Relief Mode) |

[16] The non-fuel power fraction is not available from TRACG04

# Appendix B
# Thermal-Mechanical Compliance

A thermal-mechanical compliance check is performed to assure that the fuel will operate without violating the thermal-mechanical design limits. These limits are designed such that reactor operation within these limits provides assurance that the fuel will not exceed any thermal-mechanical design or licensing limits during all modes of operation. The fuel thermal-mechanical limits are met for the current cycle.

# Appendix C
# Decrease in Core Coolant Temperature Event

The Loss-of-Feedwater Heating event was analyzed at 100% rated power using the BWR Simulator Code. The use of this code is consistent with the approved methodology. The transient plots, neutron flux and heat flux values normally reported in Section 9 are not an output of the BWR Simulator Code; therefore, those items are not included in this document. The OLMCPR result is shown in Section 11.

# Appendix D
# Off-Rated Limits

## Off-Rated Power Dependent Limits

ARTS power dependent thermal limits have been developed for operation with all Equipment In-Service and a Pressure Regulator Out-Of-Service (PROOS) in Reference D-1.

The MCPRp limits provided in Reference D-1 are based on a SLMCPR of 1.15.

| **MCPRp Limits for:**<br>**Base Case** | | | |
|---|---|---|---|
| ***Limits for Power < 40.0%*** | | | |
| **Flow > 50.0%** | | **Flow ≤ 50.0%** | |
| **Power (%)** | **Limit**<br>*MCPRp* | **Power (%)** | **Limit**<br>*MCPRp* |
| 25.0 | 3.62 | 25.0 | 2.83 |
| 40.0 | 2.91 | 40.0 | 2.37 |
| ***Limits for Power ≥ 40.0%*** | | | |
| **Power (%)** | | **Limit**<br>*Kp* | |
| 40.0 | | 1.323 | |
| 60.0 | | 1.150 | |
| 90.0 | | 1.056 | |
| 100.0 | | 1.000 | |

| **MCPRp Limits for:**<br>**Pressure Regulator Out-of-Service** | | | |
|---|---|---|---|
| ***Limits for Power < 40.0%*** | | | |
| **Flow > 50.0%** | | **Flow ≤ 50.0%** | |
| **Power (%)** | **Limit**<br>*MCPRp* | **Power (%)** | **Limit**<br>*MCPRp* |
| 25.0 | 3.62 | 25.0 | 2.83 |
| 40.0 | 2.91 | 40.0 | 2.37 |
| ***Limits for Power ≥ 40.0%*** | | | |
| **Power (%)** | | **Limit**<br>*Kp* | |
| 40.0 | | 1.550 | |
| 60.0 | | 1.460 | |
| 85.0 | | 1.240 | |
| 85.0 | | 1.072 | |
| 90.0 | | 1.056 | |
| 100.0 | | 1.000 | |

| **LHGRFACp Limits for:**<br>**Base Case** | | | |
|---|---|---|---|
| ***Limits for Power < 40.0%*** | | | |
| **Flow > 50.0%** | | **Flow ≤ 50.0%** | |
| **Power (%)** | **Limit** | **Power (%)** | **Limit** |
| 25.0 | 0.496 | 25.0 | 0.522 |
| 40.0 | 0.519 | 40.0 | 0.638 |
| ***Limits for Power ≥ 40.0%*** | | | |
| **Power (%)** | | **Limit** | |
| 40.0 | | 0.687 | |
| 100.0 | | 1.000 | |

| **LHGRFACp Limits for:**<br>**Pressure Regulator Out-of-Service** | | | |
|---|---|---|---|
| ***Limits for Power < 40.0%*** | | | |
| **Flow > 50.0%** | | **Flow ≤ 50.0%** | |
| **Power (%)** | **Limit** | **Power (%)** | **Limit** |
| 25.0 | 0.496 | 25.0 | 0.522 |
| 40.0 | 0.519 | 40.0 | 0.638 |
| ***Limits for Power ≥ 40.0%*** | | | |
| **Power (%)** | | **Limit** | |
| 40.0 | | 0.645 | |
| 85.0 | | 0.825 | |
| 85.0 | | 0.894 | |
| 100.0 | | 1.000 | |

| **MAPFACp Limits for:**<br>**Base Case** | | | |
|---|---|---|---|
| ***Limits for Power < 40.0%*** | | | |
| **Flow > 50.0%** | | **Flow ≤ 50.0%** | |
| **Power (%)** | **Limit** | **Power (%)** | **Limit** |
| 25.0 | 0.496 | 25.0 | 0.522 |
| 40.0 | 0.519 | 40.0 | 0.638 |
| ***Limits for Power ≥ 40.0%*** | | | |
| **Power (%)** | | **Limit** | |
| 40.0 | | 0.687 | |
| 100.0 | | 1.000 | |

| **MAPFACp Limits for:**<br>**Pressure Regulator Out-of-Service** | | | |
|---|---|---|---|
| ***Limits for Power < 40.0%*** | | | |
| **Flow > 50.0%** | | **Flow ≤ 50.0%** | |
| **Power (%)** | **Limit** | **Power (%)** | **Limit** |
| 25.0 | 0.496 | 25.0 | 0.522 |
| 40.0 | 0.519 | 40.0 | 0.638 |
| ***Limits for Power ≥ 40.0%*** | | | |
| **Power (%)** | | **Limit** | |
| 40.0 | | 0.645 | |
| 85.0 | | 0.825 | |
| 85.0 | | 0.894 | |
| 100.0 | | 1.000 | |

## Off-Rated Flow Dependent Limits

The flow dependent ARTS thermal limits are documented in Reference D-1. The off-rated flow dependent limits provided in Reference D-1 have been validated for this cycle. The flow dependent LHGRFAC/MAPFAC limits include an ECCS-LOCA MAPLHGR limit for core flow ≤99.0% rated flow.

The MCPRf limits provided in Reference D-1 are based on a SLMCPR of 1.15.

| **MCPRf Limits for:**<br>**Base Case** | |
|---|---|
| ***Limits for a Maximum Runout Flow of 107.0%*** | |
| **Flow (%)** | **Limit**<br>*MCPRf* |
| 30.0 | 1.64 |
| 94.4 | 1.23 |
| 107.0 | 1.23 |

| **MCPRf Limits for:**<br>**Pressure Regulator Out-of-Service** | |
|---|---|
| ***Limits for a Maximum Runout Flow of 107.0%*** | |
| **Flow (%)** | **Limit**<br>*MCPRf* |
| 30.0 | 1.64 |
| 94.4 | 1.23 |
| 107.0 | 1.23 |

| **LHGRFACf Limits for:**<br>**Base Case** | |
|---|---|
| ***Limits for a Maximum Runout Flow of 107.0%*** | |
| **Flow (%)** | **Limit** |
| 30.0 | 0.660 |
| 78.6 | 0.991 |
| 99.0 | 0.991 |
| 99.0 | 1.000 |
| 107.0 | 1.000 |

| **LHGRFACf Limits for:**<br>**Pressure Regulator Out-of-Service** | |
|---|---|
| ***Limits for a Maximum Runout Flow of 107.0%*** | |
| **Flow (%)** | **Limit** |
| 30.0 | 0.660 |
| 78.6 | 0.991 |
| 99.0 | 0.991 |
| 99.0 | 1.000 |
| 107.0 | 1.000 |

| **MAPFACf Limits for:**<br>**Base Case** | |
|---|---|
| ***Limits for a Maximum Runout Flow of 107.0%*** | |
| **Flow (%)** | **Limit** |
| 30.0 | 0.660 |
| 78.6 | 0.991 |
| 99.0 | 0.991 |
| 99.0 | 1.000 |
| 107.0 | 1.000 |

| **MAPFACf Limits for:**<br>**Pressure Regulator Out-of-Service** | |
|---|---|
| ***Limits for a Maximum Runout Flow of 107.0%*** | |
| **Flow (%)** | **Limit** |
| 30.0 | 0.660 |
| 78.6 | 0.991 |
| 99.0 | 0.991 |
| 99.0 | 1.000 |
| 107.0 | 1.000 |

## Reference

D-1 *Monticello Nuclear Generating Plant Offrated Limits and Pressure Regulator Downscale Failure Analysis at MELLLA+*, 0000-0131-4356-R1, Revision 1, January 2012.

# Appendix E
# Mislocated Fuel Loading Error

The Monticello Nuclear Generating Plant Cycle 27 Mislocated Fuel Loading Error analysis was evaluated. The event is non-limiting for fuel types through GE14 if the following condition is satisfied:

$$OLMCPR_{plant/cycle} \geq 1.28 \times (SLMCPR_{plant/cycle} / 1.07)$$

This criterion has been demonstrated to be generically applicable to GE14 reloads.

The minimum OLMCPR calculated for Monticello Cycle 27 is 1.62 (shown in Section 11 for GE14 fuel from BOC27 to EOC27) while the plant/cycle specific SLMCPR is 1.15. Using 1.15 in the equation yields 1.38 on the right side.

Using these values the above equation would yield $1.62 \geq 1.38$.

Therefore, the Mislocated Fuel Loading Error is non-limiting for Monticello Cycle 27.

# Appendix F
# Turbine Trip with Bypass and Degraded Scram

The Turbine Trip with Bypass (TTWBP) event was analyzed with the postulated Option A degraded scram and an OLMCPR value was determined. No Option B analysis was performed for the TTWBP. The Option A calculated OLMCPR for the TTWBP is used for Option B and this value sets the OLMCPR limit for Option B because it is higher than the most limiting OLMCPR calculated for a pressurization event. Therefore, if the cycle average scram time does not satisfy the criterion provided in Reference F-1 and Monticello Nuclear Generating Plant decides to interpolate between Option A and Option B scram times, this can be accomplished by using the procedure provided in Reference F-1 with the following modification to Equation 4 of Reference F-1:

The modified equation to establish the new operating limit for pressurization events is given below:

$$OLMCPR_{New} = MAX\left( OLMCPR_{Option\ B} + \frac{\tau_{ave} - \tau_B}{\tau_A - \tau_B} \Delta OLMCPR, OLMCPR_{TTWBP} \right) \quad (4)$$

where: $\tau_{ave}$ and $\tau_B$ are defined in Equations 1 and 3 of Reference F-1, respectively;

$\tau_A$ = the technical specification limit on core average scram time to the 20 percent insertion position

OLMCPR Option B = the most limiting OLMCPR calculated for a pressurization event actually analyzed for Option B

$\Delta$OLMCPR = the difference between OLMCPR Option A and OLMCPR Option B

For Monticello Cycle 27, the OLMCPRs for the HPCIL8 event are 1.74 for Option A and 1.54 for Option B. Therefore, the $\Delta$OLMCPR for the HPCIL8 event is 0.20. The OLMCPR for the TTWBP event is 1.62.

This approach is cycle independent with the TTWBP analyzed in this manner as long as the cycle specific OLMCPR Option B and $\Delta$OLMCPR values are used in the calculation.

## Reference

F-1. *Monticello Option B Licensing Basis,* LRC03.040, March 24, 2003 from L. R. Conner to Rick Rohrer.

# Appendix G
# Monticello Non-Standard SRLR Items

This appendix contains Monticello non-standard SRLR items that are being provided at the request of Xcel Energy.

Additional Section 9 Information

For the inadvertent HPCI event, the level 8 trip was modeled as the OPL-3 setpoint value. The turbine trip signal is initiated manually after the narrow-range water level has reached equilibrium. This was done since confirmation could not be obtained that a level 8 event would not occur during this event.

Additional Section 11 Information

The following table summarizes the cycle rated power and flow MCPR values for the events reported in this SRLR. If the event's Option A or Option B limit are merged together in a single column, then the event cannot be interpolated based on scram times. For a description of how to implement Option B scram times see Appendix F.

| **Cycle MCPR values**<br>**Exposure range: BOC27 to EOC27** | | |
|---|---|---|
| | **Option A** | **Option B** |
| | **GE14C** | **GE14C** |
| FW Controller Failure | Not Limiting | Not Limiting |
| Load Reject w/o Bypass | Not Limiting | Not Limiting |
| Turbine Trip w/o Bypass | Not Limiting | Not Limiting |
| Inadvertent HPCI /L8 Turbine Trip | 1.74 | 1.54 |
| Loss of Feedwater Heating | 1.34 | |
| Fuel Loading Error (misoriented) | 1.37 | |
| Fuel Loading Error (mislocated) | Determined to be non-limiting | |
| SLO Pump Seizure | 1.45 | |
| Turbine Trip with Bypass | 1.62 | |
| Control Rod Withdrawal Error (RBM setpoint at 114%) | 1.40 | |
| Load Rejection with Bypass[17] | Determined to be non-limiting | |
| LOCA Analysis Limit MCPR | 1.350 | |

[17] This event corresponds to "Single Turbine Control Valve Slow Closure (GESIL 502)". Since Cycle 22 results for this event were far from limiting and no significant changes have occurred that would significantly increase this event's results for this cycle, this event was determined to be non-limiting.

Additional Section 12 Information

The Dome Pressure Safety Limit, provided via the OPL-3, of 1332.0 psig is satisfied.

Additional Section 16 Information

These analyses indicate that plant operation up to 376 MWt with the RHR intertie line open is acceptable from an ECCS performance standpoint, provided a MAPLHGR multiplier of 0.75 is implemented or that the peak bundle power does not exceed 3.9 MWt.

In addition to the power and flow dependent multipliers, Monticello also requires an ECCS MAPLHGR multiplier of 0.9908 for operation at or below 99% core flow.

No single-loop operation multiplier on PLHGR is required.

Maximum Subcritical Banked Withdrawal Position (MSBWP)

The Maximum Subcritical Banked Withdrawal Position analysis confirmed that the reference core loading pattern satisfied cold shutdown margin requirements including bank position 04.

# Appendix H
# TRACG04 AOO Supplementary Information

Reference H-1 provides the results of the evaluations supporting the application of TRACG04 for AOO analyses for Monticello. Section 11 of this report presents the MCPR limits based on the TRACG04 methodology of Reference H-2.

The safety evaluation report for licensing topical report NEDE-32906P Supplement 3 (Reference H-2) concluded that the application of TRACG04 methods to AOO and overpressure transient analyses were acceptable subject to certain limitations and conditions. Several of these conditions request that additional, application-specific information be provided. The information provided below responds to these requests for the identified items.

## Limitation/Condition 23 (Transient LHGR Limitation 3)

The Transient LHGR Limitation 3 specified in Reference H-2 requires that in order to account for the impact of void history bias, plant-specific EPU and MELLLA+ applications using either TRACG04 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 the 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).

The analyses for Monticello Cycle 27 met the conditions of the Void Reactivity Coefficient Correction Model Condition (Limitation 21 of Reference H-2) and the Void Reactivity Coefficient Correction Model Basis Condition (Limitation 22 of Reference H-2); and therefore per Limitation 23 of Reference H-2, the pressurization transient events are not required to demonstrate 10 percent margin to the fuel centerline melt and the 1 percent cladding circumferential plastic strain acceptance criteria.

### References for Appendix H

H-1. *Monticello TRACG Implementation for Reload Licensing Transient Analysis*, 0000-0082-0062-R1, Revision 1, May 2010.

H-2. *Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*, NEDE-32906P, Supplement 3-A, Revision 1, April 2010.

# Appendix I
# NEDC-33173P-A Supplementary Information

The safety evaluation for licensing topical report NEDC-33173P-A (Reference I-1) concluded that the application of GEH/GNF methods to expanded operating domains was acceptable subject to certain limitations and conditions. Several of these conditions request that additional, application-specific information be provided. The information provided below responds to these requests for the identified items.

It is confirmed that the max allowable peak bundle power and average power density are not changed from the EPU license as documented in Reference I-5.

### Limitation/Condition 5 (SLMCPR 2)

For operation at MELLLA+, a 0.03 value was added to the cycle specific SLMCPR value which bounds the 0.02 value as specified in the limitation. The SLMCPR values reported in Section 11 reflect this adder.

### Limitation/Condition 6 (R-factor)

The plant specific R-factor calculation at a bundle level was performed consistent with lattice axial void conditions expected for the hot channel operating state applicable to this cycle of operation. For Monticello Cycle 27 at the EPU/MELLLA+ licensed power level, a 60% void profile was used for the calculation of bundle R-factors.

### Limitation/Condition 8 (ECCS-LOCA 2)

This limitation is satisfied by reporting the Appendix K PCTs for the evaluated power and flow points in the upper boundary of the expanded operating domains in Section 16.1 of this SRLR.

### Limitation/Condition 10 (Transient LHGR 2)

The Transient LHGR 2 limitation specified in Reference I-1 requires each EPU and MELLLA+ fuel reload to document the calculation results of the analyses demonstrating compliance to transient T-M acceptance criteria. Table I-1 summarizes the percent margin to the Thermal Overpower and Mechanical Overpower limits.

**Table I-1 Margin to the Thermal Overpower and Mechanical Overpower Limits**

| Criteria | GE14C |
|---|---|
| Thermal Overpower | 7.85% |

| Criteria | GE14C |
|---|---|
| Mechanical Overpower | 7.91% |

**Limitation/Condition 11 (Transient LHGR 3)**

The Transient LHGR 3 limitation specified in Reference I-1 requires that in order to account for the impact of the void history bias, plant-specific EPU and MELLLA+ applications using either TRACG04 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 the 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).

However, as stated in Appendix H the void history bias was incorporated into the transient model within the TRACG04 code, and therefore the 10 percent margin to the fuel centerline melt and the 1 percent cladding circumferential plastic strain acceptance criteria is no longer required.

**Limitation/Condition 14 (Part 21 Evaluation of GESTR-M Fuel Temperature Calculation)**

GE14 LHGR limits applied to Monticello Cycle 27 EPU/MELLLA+ incorporate a 350 psi penalty on fuel rod critical pressure in the fuel rod internal pressure design ratio. These limits comply with the NRC's conclusions regarding this subject (Reference I-2).

**Limitation/Condition 15 (Void Reactivity 1)**

This limitation/condition is the same as Limitation/Condition 22 of NEDE-32906P, which is described in Appendix H. Because Limitation/Condition 22 of NEDE-32906P is met, Limitation/Condition 15 from NEDC-33173P is also met.

**Limitation/Condition 16 (Void Reactivity 2)**

This limitation/condition applies until the new TRACG/PANAC methodology is approved by the NRC. Monticello Cycle 27 EPU/MELLLA+ was analyzed with TRACG04/PANAC11, so this limitation/condition no longer applies.

**Limitation/Condition 17 (Steady State 5 Percent Bypass Voiding)**

The bypass voiding condition was evaluated for the licensed core loading and confirmed that the bypass void fraction remained below 5 percent at all LPRM levels when operating at steady-state conditions within the licensed upper boundary. For a power/flow condition that conservatively bounded the licensed power/flow upper boundary, the bypass void fraction at the D level LPRM location was calculated to be 0.0%.

**Limitation/Condition 19 (Void-Quality Correlation 1)**

The OLMCPR limitation requiring an additional 0.01 adder on the OLMCPR does not apply to EPU or MELLLA+ licensing calculations when TRACG04 methods are used (Reference I-3). Therefore, the OLMCPR adder is not applied to Monticello Cycle 27.

**Limitation/Condition 20 (Void-Quality Correlation 2)**

This limitation/condition applies until the new TRACG/PANAC methodology is approved by the NRC. Monticello Cycle 27 EPU/MELLLA+ was analyzed with TRACG04/PANAC11, so this limitation/condition no longer applies.

**NEDC-33006P-A Supplementary Information**

The safety evaluation for licensing topical report NEDC-33006P-A (Reference I-4) approved the operation of GE BWRs in the MELLLA+ expanded operating domain, subject to certain limitations and conditions. One of these conditions requested that additional, application-specific information be provided as part of the SRLR. The information provided below responds to this request.

**Limitation/Condition 6 (SLMCPR Statepoints and CF Uncertainty)**

As requested in Limitation/Condition 6, the SLMCPR calculated results at specified off-rated power/flow conditions are reported in Table I-2 below.

**Table I-2 Two-Loop SLMCPR Results for MELLLA+ Conditions**

| Power (% Rated) | Flow (% Rated) | SLMCPR |
|---|---|---|
| 100 | 100 | 1.08 |
| 100 | 80 | 1.10 |
| 82.5 | 57.4 | 1.12 |
| 100 | 105 | 1.07 |

**Limitation/Condition 10.B (ECCS-LOCA Off-Rated Multiplier)**

In addition to the power and flow dependent multipliers, Monticello also requires an ECCS MAPLHGR multiplier of 0.9908 for operation at or below 99% core flow. This multiplier ensures that the off-rated limits assumed in the EPU ECCS-LOCA analyses bound the cycle-specific off-rated limits calculated for MELLLA+ operation.

**Limitation/Condition 18.D (ATWS TRACG Analysis)**

For operation in the MELLLA+ domain, SLO will not be allowed as expressed by EOOS options in Section 8, and per section 15 and Appendix J.

**References for Appendix I**

I-1. *Applicability of GE Methods to Expanded Operating Domains, NEDC-33173P-A, Revision 4, November 2012.*

I-2. *Applicability of GE Methods to Expanded Operating Domains, NEDC-33173P-A, Revision 1, September 2010.*

I-3. *Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*, NEDE-32906P, Supplement 3-A, Revision 1, April 2010.

I-4. *General Electric Boiling Water Reactor Maximum Extended Load Line Limit Analysis Plus, NEDC-33006P-A, Revision 3, June 2009.*

I-5. *Supplemental Reload Licensing Report for Monticello Reload 26 Cycle 27 Extended Power Uprate (EPU)*, 0000-0146-5423-SRLR-R3, October 2013.

# Appendix J
# MELLLA+ Supplementary Information

The pressurization transients are generally limiting at high core flow conditions. However, the transients were performed at both the minimum MELLLA+ flow (80%) and the maximum ICF flow (105%). This ensures that the pressurization transient results bound MELLLA, MELLLA+ and ICF operating conditions. Additionally, the loss of feedwater heating (LFWH) transient, which is more limiting at low core flow, was performed at the minimum MELLLA+ flow. Therefore, the limiting subcooling transient bounds MELLLA, MELLLA+ and ICF operating conditions. Single loop operation (SLO) will not be allowed in conjunction with operation in the MELLLA+ domain.

**NEDC-33173P-A Revision 4 Limitations/Conditions**

The safety evaluation in licensing topical report NEDC-33173P-A Revision 4 (*Applicability of GE Methods to Expanded Operating Domains*) concluded that the application of GEH/GNF methods to expanded operating domains was acceptable subject to certain limitations and conditions. Several of these conditions request that additional, application-specific information be provided. The limitations/conditions for MELLLA+ have already been addressed in Appendix I.

**NEDC-32906P Supplement 3-A Limitations/Conditions**

The safety evaluation in licensing topical report NEDC-32906P Supplement 3-A (*Migration to TRACG04/PANAC11 from TRACG02/PANAC10 for TRACG AOO and ATWS Overpressure Transients*) concluded that the application of TRACG04 methods to AOO and overpressure transient analyses were acceptable subject to certain limitations and conditions. The limitations/conditions for MELLLA+ have already been addressed in Appendix I.

**NEDC-33006P-A Revision 3 Limitations/Conditions**

The safety evaluation in licensing topical report NEDC-33006P-A Revision 3 (*General Electric Boiling Water Reactor Maximum Extended Load Line Limit Analysis Plus*) concluded that plant-specific MELLLA+ applications were acceptable subject to certain limitations/conditions. Several of these conditions request that additional, application-specific information be provided. These limitations/conditions are addressed in Appendix I.

# Appendix K
# List of Acronyms

| Acronym | Description |
|---|---|
| ΔCPR | Delta Critical Power Ratio |
| Δk | Delta k-effective |
| 2RPT (2PT) | Two Recirculation Pump Trip |
| ABSP | Automated Backup Stability Protection |
| ADS | Automatic Depressurization System |
| ADSOOS | Automatic Depressurization System Out of Service |
| AOO | Anticipated Operational Occurrence |
| APRM | Average Power Range Monitor |
| ARTS | APRM, Rod Block and Technical Specification Improvement Program |
| BOC | Beginning of Cycle |
| BSP | Backup Stability Protection |
| BWROG | Boiling Water Reactor Owners Group |
| CDA | Confirmation Density Algorithm |
| COLR | Core Operating Limits Report |
| CPR | Critical Power Ratio |
| DIRPT | Delta MCPR over Initial MCPR for a two-Recirculation Pump Trip |
| DIVOM | Delta CPR over Initial MCPR vs. Oscillation Magnitude |
| DR | Decay Ratio |
| DSS-CD | Detect and Suppress Solution – Confirmation Density |
| DS/RV | Dual Mode Safety/Relief Valve |
| ECCS | Emergency Core Cooling System |
| ELLLA | Extended Load Line Limit Analysis |
| EOC | End of Cycle (including all planned cycle extensions) |
| EOR | End of Rated (All Rods Out 100%Power / 100%Flow / NFWT) |
| EPU | Extended Power Uprate |
| ER | Exclusion Region |
| FFWTR | Final Feedwater Temperature Reduction |
| FMCPR | Final MCPR |
| FOM | Figure of Merit |
| FWCF | Feedwater Controller Failure |
| FWHOOS | Feedwater Heaters Out of Service |
| FWTR | Feedwater Temperature Reduction |
| GESTAR | General Electric Standard Application for Reactor Fuel |
| GETAB | General Electric Thermal Analysis Basis |
| GSF | Generic Shape Function |
| HAL | Haling Burn |
| HBB | Hard Bottom Burn |
| HBOM | Hot Bundle Oscillation Magnitude |
| HCOM | Hot Channel Oscillation Magnitude |
| HFCL | High Flow Control Line |

| Acronym | Description |
|---|---|
| HPCI | High Pressure Coolant Injection |
| HTSP | High Trip Set Point |
| ICA | Interim Corrective Action |
| ICF | Increased Core Flow |
| IMCPR | Initial MCPR |
| ITSP | Intermediate Trip Set Point |
| IVM | Initial Validation Matrix |
| Kf | Off-rated flow dependent OLMCPR multiplier |
| Kp | Off-rated power dependent OLMCPR multiplier |
| L8 | Turbine Trip on high water level (Level 8) |
| LCF | Low Core Flow |
| LHGR | Linear Heat Generation Rate |
| LHGRFACf | Off-rated flow dependent LHGR multiplier |
| LHGRFACp | Off-rated power dependent LHGR multiplier |
| LOCA | Loss of Coolant Accident |
| LPRM | Local Power Range Monitor |
| LRHBP | Load Rejection with Half Bypass |
| LRNBP | Load Rejection without Bypass |
| LTR | Licensing Topical Report |
| LTSP | Low Trip Set Point |
| MAPFACf | Off-rated flow dependent MAPLHGR multiplier |
| MAPFACp | Off-rated power dependent MAPLHGR multiplier |
| MAPLHGR | Maximum Average Planar Linear Heat Generation Rate |
| MCPR | Minimum Critical Power Ratio |
| MCPRf | Off-rated flow dependent OLMCPR |
| MCPRp | Off-rated power dependent OLMCPR |
| MELLLA | Maximum Extended Load Line Limit Analysis |
| MELLLA+ | MELLLA Plus |
| MOC | Middle of Cycle |
| MRB | Maximal Region Boundaries |
| MSF | Modified Shape Function |
| MSIV | Main Steam Isolation Valve |
| MSIVOOS | Main Steam Isolation Valve Out of Service |
| MSR | Moisture Separator Reheater |
| MSROOS | Moisture Separator Reheater Out of Service |
| MTU | Metric Ton Uranium |
| MWd | Megawatt day |
| MWd/ST | Megawatt days per Standard Ton |
| MWd/MT | Megawatt days per Metric Ton |
| MWt | Megawatt Thermal |
| N/A | Not Applicable |
| NBP | No Bypass |
| NCL | Natural Circulation Line |
| NFWT | Normal Feedwater Temperature |
| NOM | Nominal Burn |

| Acronym | Description |
|---|---|
| NTR | Normal Trip Reference |
| OLMCPR | Operating Limit MCPR |
| OOS | Out of Service |
| OPRM | Oscillation Power Range Monitor |
| Pbypass | Reactor power level below which the TSV position and the TCV fast closure scrams are bypassed |
| Pdome | Peak Dome Pressure |
| Psl | Peak Steam Line Pressure |
| Pv | Peak Vessel Pressure |
| PCT | Peak Clad Temperature |
| PHE | Peak Hot Excess |
| PLHGR | Peak Linear Heat Generation Rate |
| PLU | Power Load Unbalance |
| PLUOOS | Power Load Unbalance Out of Service |
| PRFDS | Pressure Regulator Failure Downscale |
| PROOS | Pressure Regulator Out of Service |
| Q/A | Heat Flux |
| RBM | Rod Block Monitor |
| RC | Reference Cycle |
| RCF | Rated Core Flow |
| RDF | Recirculation Drive Flow |
| RFWT | Reduced Feedwater Temperature |
| RPS | Reactor Protection System |
| RPT | Recirculation Pump Trip |
| RPTOOS | Recirculation Pump Trip Out of Service |
| RTP | Rated Thermal Power |
| RV | Relief Valve |
| RVM | Reload Validation Matrix |
| RWE | Rod Withdrawal Error |
| $S_{AD}$ | Amplitude Discriminator Setpoint |
| SC | Standard Cycle |
| SL | Safety Limit |
| SLMCPR | Safety Limit Minimum Critical Power Ratio |
| SLO | Single Loop Operation |
| SRLR | Supplemental Reload Licensing Report |
| S/RV (SRV) | Safety/Relief Valve |
| SRVOOS | Safety/Relief Valve(s) Out of Service |
| SS | Steady State |
| SSV | Spring Safety Valve |
| STP | Simulated Thermal Power |
| STU | Short Tons (or Standard Tons) of Uranium |
| TBV | Turbine Bypass Valve |
| TBVOOS | Turbine Bypass Valves Out of Service |
| TCV | Turbine Control Valve |
| TCVOOS | Turbine Control Valve Out of Service |

| Acronym | Description |
|---|---|
| TCVSC | Turbine Control Valve Slow Closure |
| $T_{FW}$ | Temperature of Feedwater |
| TLO | Two Loop Operation |
| TRF | Trip Reference Function |
| TSIP | Technical Specifications Improvement Program |
| TSV | Turbine Stop Valve |
| TSVOOS | Turbine Stop Valve Out of Service |
| TT | Turbine Trip |
| TTHBP | Turbine Trip with Half Bypass |
| TTNBP | Turbine Trip without Bypass |
| UB | Under Burn |