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Enclosure 2

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AREVA Report ANP-3435NP

Non-Proprietary

AREVA Responses to RAI-8 and RAI-32 from SRXB and SNPB on MNGP EFW LAR

Revision 2

July 2016

21 pages follow

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Nature of Changes

Item	Pages	Description and Justification
1.	1-2	Added Section 1.2 to discuss benchmarking issues.
2.	1-3	Added References 5 and 6
3.	2-1	Updated discussion of TTWB results
4.	2-4, 2-5, 2-7, and 2-8	Updated Figures 8-5 through 8-8
5.	2-9	Updated Reference 8-1
6.	2-11	Updated results of the 2RPT event
7.	2-12	Updated Figure 32-3

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Nomenclature

Acronym	Definition
2RPT	2 Recirculation Pump Trip
ATWS	Anticipated Transient Without Scram
ATWSi	ATWS with instability
BOC	Beginning-of-Cycle
BWR	Boiling Water Reactor
CPR	Critical Power Ratio
DBA	Design Basis Accident
EFW	Extended Flow Window
EOC	End-of-Cycle
EOIII	Enhanced Option III (Stability)
EPU	Extended Power Uprate
MELLLA	Maximum Extended Load Line Limit Analysis
MELLLA+	Maximum Extended Load Line Limit Analysis Plus
MNGP	Monticello Nuclear Generating Plant
TTWBP	Turbine Trip with Bypass

1.0 Introduction

In Reference 1, Northern States Power Company - a Minnesota corporation, doing business as Xcel Energy, submitted a license amendment request (LAR) for the Monticello Nuclear Generating Plant (MNGP). The application was supplemented by Reference 2. The amendment would revise the Technical Specifications and approve certain AREVA analytical methods to support plant operation in the expanded power-flow domain described as the Extended Flow Window (EFW).

The U.S. Nuclear Regulatory Commission (NRC) staff in the Reactor Systems Branch (SRXB) and Nuclear Performance and Code Review Branch (SNPB) has reviewed the application and concluded that additional information is necessary to complete its review. Draft Requests for Additional Information (RAI) were provided as an attachment to Reference 3. AREVA responses to all of these RAI except RAI-8 and RAI-32 were documented in Reference 4. The RAI and the AREVA responses for RAI-8 and RAI-32 are attached.

The analysis of Anticipated Transient Without Scram – Instability (ATWSi) described herein should be recognized as the licensee's analysis of record supporting the proposed amendment to allow operation in the EFW domain. [

]

Following submittal of Revision 0 of this document, two issues have been discovered within MICROBURN-B2. A description of these issues is found in the following section, and the results in Section 2.0 have been updated with corrected results for these issues.

These responses are provided so Xcel Energy can provide a complete set of responses to the NRC by combining the AREVA responses with the responses being prepared by Xcel Energy.

1.1 *Description of MICROBURN-B2 Issues*

The identified issues within MICROBURN-B2 are described in detail below, but it is noted that both are only a concern in regard to low flow calculations.

The first issue that was identified within MICROBURN-B2 was that at some low flow conditions (i.e., below 50% rated core flow), the MICROBURN-B2 code hydraulic convergence might not be sufficient to ensure the accuracy of the resulting solutions.

A new version of the MICROBURN-B2 code has been issued with a revised low flow convergence scheme that addresses this non-convergence issue. This new version of the code has been used in the revised calculations discussed later in this document.

The second issue within MICROBURN-B2 identifies that the current implementation of the void quality correlation used within MICROBURN-B2 includes by default [ ]. Investigations that have been carried out revealed that the correlation produces some potentially non-physical results at very low mass fluxes and high flow qualities, which is part of the reason for the implementation of the [ ] into the correlation in MICROBURN-B2. This default behavior for MICROBURN-B2 was implemented in 2011.

The non-physical behavior is inherent in the formulation of the correlation and is not an implementation issue within the MICROBURN-B2 code. Investigation has determined that the correlation behaves in an expected manner for the following range of conditions*:

[ ]

All versions of the MICROBURN-B2 code since 2011 have included a default [ ]. While this appears to have mitigated the correlations non-physical behavior it has been determined [ ].

Revised calculations were performed eliminating the [ ] with an existing MICROBURN-B2 input. The analyses were then reviewed to confirm that all cases fall within [ ] behavior is as expected.

1.2 *Description of Benchmarking Issues*

[ ] The calculations were revised to [ ]

* The range of applicability has been defined in a conservative manner. Falling outside this range does not mean that the void-quality correlation will provide a non-physical result; instead it indicates that the potential exists. Analyses inside of this range of conditions produce the expected result.

References

1. License Amendment Request for AREVA Extended Flow Window, October 3, 2014, MNGP L-MT-14-044, ML14283A119.

2. License Amendment Request for AREVA Extended Flow Window Supplement to Response to NRC Staff Questions (TAC No. MF5002), January 9, 2015, MNGP L-MT-14-103, ML15022A165 and ML15022A167.

3. Monticello Nuclear Generating Plant – Request for Additional Information (SRXB/SNPB) re: AREVA Extended Flow Window Licence Amendment Request (TAC No MF5002) - email from Terry Beltz (NRC) to Glenn Adams (Xcel Energy), August 5th, 2015.

4. ANP-3434P Revision 1, *AREVA Responses to RAI from SRXB and SNPB on MNGP EFW LAR*, AREVA, August 2015.

5. ANP-3274P Revision 2, *Analytical Methods for Monticello ATWS-I*, July 2016.

6. ANP-3284P Revision 1, *Results of Analysis and Benchmarking of Methods for Monticello ATWS-I*, July 2016.

2.0 RAIs and Responses

2.1 *RAI-8: Mitigated ATWSI Calculations*

ATWSI calculations in the Monticello LAR are for unmitigated (i.e., no operator actions) assumptions.

a) *Provide realistic Anticipated Transient Without Scram with Instability (ATWSI) calculations under the expected conditions crediting operator actions. Provide sensitivity results for later operator action time.*

b) *Provide a discussion of uncertainty treatment (e.g., hGap, inlet friction).*

c) *Describe the methodology used by AISHA to excite the oscillation when the decay ratio (DR) is close to 1.0.*

AREVA Response

a) *Provide realistic Anticipated Transient Without Scram with Instability (ATWSI) calculations under the expected conditions crediting operator actions. Provide sensitivity results for later operator action time.*

The case that produced the maximum clad temperature excursion without operator action was repeated while crediting the operator action of lowering the water level. As is demonstrated below, the operator action [

] and the transient is demonstrated to be uneventful. The operator action was delayed by increasing time periods in a series of runs to examine the sensitivity of the action timing. It was found that a delayed action [

]

The sensitivity runs were made with operator action initiated at 90 seconds and at larger values with incremental steps of 10 seconds. [

] The sensitivity to operator action timing is illustrated in the following figures. In some of the figures, only the results of representative runs are shown to avoid crowding of data so the trends are more clearly seen.

Two modifications were made to the original runs in order to properly model the mitigated cases. [

]

[

]

Figure 8-2 shows the inlet mass flow rate as a function of time for several cases with differing operator action times. [

]

Figure 8-3 shows the limiting bundle power for the cases represented in Figure 8-2.

Figure 8-4 shows the clad temperature excursion for selected cases with differing operator action timing. [ ]

Figure 8-5 depicts the peak clad temperature that is reached in the different simulations with different operator action timing. The figure shows clearly that [

]

[ ]

Figure 8-1 Core Inlet Subcooling Versus Time For Various Operator Intervention Times

[ ]

Figure 8-2 Hot Bundle Inlet Flow Versus Time For Various Operator Intervention Times

[ ]

Figure 8-3 Hot Bundle Power Versus Time For Various Operator Intervention Times

[ ]

Figure 8-4 Clad Temperature Versus Time For Various Operator Intervention Times

[ ]

Figure 8-5 Peak Clad Temperature Versus Operator Intervention Time

b) Provide a discussion of uncertainty treatment (e.g., hGap, inlet friction).

The mitigated cases as described in item a) above were performed again while varying certain parameters. These parameters have been identified as being of higher importance and also represent a higher level of calculational uncertainty. These parameters include

- The gap conductance was [ ]
- The inlet orifice resistance was [ ]
- [ ]

As shown in Figure 8-6 through Figure 8-8, the effect of these parameter variations on the Peak Clad Temperature (PCT) is [ ]

It is important to note that the range of parameter variation imposed on the simulation is larger than the uncertainty for these parameters.

Figure 8-6 Gap Conductance Effect on Peak Clad Temperature Versus Operator Intervention Time

Figure 8-7 Orifice Loss Coefficient Effect on Peak Clad Temperature Versus Operator Intervention Time

[ ]

Figure 8-8 [ ] Effect on Peak Clad Temperature Versus Operator Intervention Time

c) *Describe the methodology used by AISHA to excite the oscillation when the decay ratio (DR) is close to 1.0.*

[

]

References for RAI-8

8-1. ANP-3274P Revision 2, "Analytical Methods for Monticello ATWS-I," July 2016.

2.2 ***RAI-32: 2RPT ATWS***

The ATWSI analysis of record in the LAR is Turbine Trip with Bypass (TTWBP). When operator actions are credited, the TTWBP does not show significant power oscillations and the limiting ATWSI transient becomes the 2RPT with failure to scram.

Provide the results of 2RPT event with failure to scram. Describe the basis for boundary conditions and operator actions assumed for the analysis.

AREVA Response

The Two Recirculation Pump Trip (2RPT) differs from the Turbine Trip With Bypass (TTWBP) event in that turbines are not isolated and the steam flow to the feedwater heaters is not interrupted. The 2RPT transient results in a much smaller feedwater temperature transient, as the feedwater temperature decreases to a new equilibrium value determined by the final power level. [

]

The results are shown in Figure 32-1 through Figure 32-3. Figure 32-1 shows the limiting bundle power as function of time, and Figure 32-2 shows the corresponding inlet flow rate. Figure 32-3 shows the peak

powered rod clad temperature at different axial nodes. The maximum clad temperature of [
]

[ ]

Figure 32-1 Bundle Power Versus Time For [ ]

[ ]

Figure 32-2 Bundle Inlet Flow Versus Time For [ ]

[

]

Figure 32-3 Clad Temperature Versus Time For [ ]