ENCLOSURE 2

GE-MNGP-AEP-3304R1, ENCLOSURE 2

GEH RESPONSE TO MELLLA+ RAI 2

NON-PROPRIETARY

12 pages follow

ROUND 3 RAI 2

Providing an ATWSI analysis is a MELLLA+ SER requirement per NEDC-33006P-A, Rev. 3, but the ATWSI analysis of record in the Safety Analysis Report (SAR) is based on the incorrect TRACG04 quench model. Provide documentation of the updated ATWSI analysis that includes assumptions, sequence of events, plots of relevant variables, and margin to acceptance criteria. Provide a justification for the assumptions used, with special emphasis on operator action timing (including actual timing values from simulator trials) and the type of initiating transient selection (i.e., Recirculation Pump Trip (RPT) versus Turbine Trip with Bypass (TTWBP)). A SAR revision or update would be adequate.

GEH Response

As discussed in the Round 1, RAI 5 revised response (Reference 2.1), GEH identified an error in the TRACG04 code that affects ATWSI results. With the corrected bottom reflood quench model, the bottom reflood quench is not as effective and potentially results in a higher value for the calculated Peak Cladding Temperature (PCT) for ATWSI scenarios. Note that there is no effect on the TRACG ATWS PCT results for the Main Steam Isolation Valve Closure PCT results presented in Table 9-4 and Figure 9-11 of Reference 2.2 because the quench model is not used in the calculations.

Analysis Assumptions

Consistent with the historical ATWS approach in References 2.3 and 2.4, the nominal input parameters are generally used for ATWS with instability analyses. The Monticello ATWSI cases are rerun with the corrected TRACG04 code. During these runs a few assumptions are changed to reduce the degree of conservatism in the analysis. The most significant conservatism was in the assumed time for manual operator action to lower reactor water level following Turbine Trip With Bypass (TTWBP). The assumption used in the Monticello ATWSI TTWBP scenario was to initiate reactor water level reduction at 250 seconds (Reference 2.1, See section 9.3.3). This is significantly later than the expected operator action time.

The updated ATWSI TTWBP analysis assumes that the operator will take action to lower reactor water level 90 seconds after the failure to scram. This value of 90 seconds is acceptable because it is based on an existing time critical operator action that Monticello operators are required to demonstrate, and it is consistent with operator action time assumed in ATWS events (e.g. MSIVC and PRFO) analysis discussed in Section 9.3.1.1 of Reference 2.2.

Another assumption that is changed is the hot rod peaking. In the original ATWSI TTWBP calculation the hot channel hot rod power in TRACG is peaked to the fuel design Linear Heat Generation Rate (LHGR) limit. This results in a very large hot rod peaking factor. The updated ATWSI TTWBP and 2RPT analysis is performed with 5% margin to the LHGR limit at BOC and MOC. At EOC the fuel is CPR limited; therefore, the hot rod LHGR in TRACG is set to the peak core LHGR when the core CPR is within 5% of the limit. EOC is typically not limiting for ATWSI analysis. This assumption remains conservative and appropriate for use in the beyond design basis ATWSI analysis, as the core is designed with more than 5% margin to the thermal limits (typically 10% for LHGR). The MNGP MELLLA+ core design evaluation includes at least 10% LHGR margin and for most of the cycle it is 15% or more.

Updated ATWSI Description

The discussion below supplements the Round 1, RAI 5 revised response, which includes the results of sensitivities on the Shumway Minimum Stable Film Boiling Temperature from the Two Recirculation Pump Trip (2RPT) event run with the corrected TRACG04 bottom reflood quench model. There were three sensitivity cases provided: 1) Shumway with no modification (void dependence included), 2) Modified Shumway without the void dependence term and 3) Modified Shumway without the void dependence term and using stainless steel material properties. The discussion is intended to provide the additional information that has been requested on both the TTWBP and 2RPT events. For the 2RPT cases presented in this RAI, the case 2 "Shumway – No Void" run is selected to provide the additional information.

Two event scenarios (TTWBP and 2RPT) are considered for ATWSI consistent with Reference 2.3. The TTWBP event is typically more limiting as all feedwater heating is lost resulting in a large increase in inlet subcooling which increases the power to flow ratio during the event and results in more severe oscillations. The 2RPT event does not result in a loss of all feedwater heating; however, the 2RPT event does not immediately result in an automatic reactor scram (unlike the TTWBP event). Due to the later time of scram (and assumed scram failure) the operator response is postulated to be delayed relative to the TTWBP event. The failure to scram is the key entry point to the plant Emergency Operating Procedures (EOPs).

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The results of the plant-specific TRACG ATWS instability calculation meet the ATWS acceptance criteria. Therefore, the Monticello response to an ATWS with core instability event initiated in the MELLLA+ operating domain is acceptable. Monticello EOP actions, including boron injection and water level control strategy, effectively mitigate an ATWS event with large power oscillations in the MELLLA+ operating domain.

Section 9.3.3, Table 9-5, and Figures 9-12, 9-13, 9-14, and the relevant references section of Reference 2.2 are updated based on the discussion above. Table 9-5b and c are added to provide the sequence of events for the ATWSI scenarios. Figures 9-14b and c are added to provide additional figures. The relevant revised sections are included as Enclosure 2.

Table 2-1 Key Results for ATWS with Core Instability Analysis from MELLLA+ Operating Domain

ATWS Acceptance Criteria	TTWBP	2RPT	Design Limit	Margin
Peak Vessel Pressure (psig) [1]	[[	Not limiting	1500	189
Peak Suppression Pool Temperature (°F)		Not limiting	281	145
Peak Containment Pressure (psig)	]]	Not limiting	56.0	53
Peak Cladding Temperature (°F)	Not limiting	[[	2200	1378
Peak Local Cladding Oxidation (%) [2]	Not limiting	]]	17	Note 2

Notes:

1. The TRACG calculation of peak vessel pressure is based on one SRV OOS. The assumption of one SRV OOS is conservative. See NEDC-33435P, Rev. 1, section 9.3.1.1 for further information.
2. [[

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Table 2-2 Sequence of Events for ATWS with Core Instability Analysis from MELLLA+ Operating Domain - TTWBP

Event	Time (sec)
Turbine trip	0
Reactor water level reduction begins	90
SLCS is initiated	120
Boron solution enters reactor pressure vessel	[[ ]]

Table 2-3 Sequence of Events for ATWS with Core Instability Analysis from MELLLA+ Operating Domain – 2RPT

Event	Time (sec)
Two recirculation pump trip	0
Manual scram fails	~60
SLCS is initiated	280
OPRM scram fails	[[
Core power oscillation amplitude reaches 25%	
Reactor water level reduction is initiated	
Boron solution enters reactor pressure vessel	]]

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Figure 2-1 TTWBP BOC Regional Oscillations – Relevant Parameters

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Figure 2-2 2RPT BOC Regional Oscillations – Relevant Parameters

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Figure 2-3 2RPT BOC Regional Oscillations – Reactor Power

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Figure 2-4 2RPT BOC Regional Oscillations – Channel Average Power

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Figure 2-5 2RPT BOC Regional Oscillations – PCT

References:

2.1. GEH Letter L King (GEH) to J Bjorseth (NSPM), "GEH Response to MELLLA Plus Requests for Additional Information," GE-MNGP-AEP-3299R1, Enclosure 3 (GEH Proprietary), dated August 12, 2013.

2.2. GE Hitachi Nuclear Energy, "Safety Analysis Report for Monticello Maximum Extended Load Line Limit Analysis Plus," NEDC-33435P, Revision 1, December 2009.

2.3. GE Nuclear Energy, "ATWS Rule Issues Relative to BWR Core Thermal-Hydraulic Stability," NEDO-32047-A, June 1995, (SER includes approval for: "Mitigation of BWR Core Thermal-Hydraulic Instabilities in ATWS," NEDO-32164, December 1992.).

2.4. GE Nuclear Energy, "Mitigation of BWR Core Thermal-Hydraulic Instabilities in ATWS," NEDO-32164, December 1992.

2.5. R. W. Shumway, EGG-RST-6781, "TRAC-BWR HEAT TRANSFER: ASSESSMENT OF TMIN," January 1985.