AREVA

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2005 – Annual Reporting of Changes and Errors in ECCS Evaluation Models

Attached is a summary report of the changes and error corrections implemented in the AREVA NP ECCS evaluation models for the period of January 1, 2005 to December 31, 2005.

AREVA NP considers the BWR and PWR ECCS evaluation models to include both the codes and the methodology for using the codes. Changes to inputs that result from fuel or plant changes and that are treated according to the methodology are not considered model changes and, therefore, are not reported in the attachment. Changes in peak cladding temperatures (PCTs) due to changes to LOCA evaluation models and input changes are reported on a plant specific basis by AREVA NP to affected licensees. The licensees have the obligation under 10 CFR Part 50.46 to report the nature of changes and errors affecting PCT. This report is provided for information only.

Sincerely,

Ronnie L. Gardner

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Enclosures

cc: G.S. Shukla
Project 728

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Attachment A

Listing of AREVA NP LOCA Evaluation Models

EXEM BWR Large and Small Break LOCA Evaluation Model

This model is applicable to all boiling water reactors for both large and small break LOCA analyses. The NRC approved topical report for this evaluation model is ANF-91-048PA Supplements 1 and 2.

EXEM BWR-2000 Large and Small Break LOCA Evaluation Model

This model is applicable to jet-pump boiling water reactors for both large and small break LOCA analyses. The NRC approved topical report for this evaluation model is EMF-2361PA Rev 0.

CRAFT2 PWR Large Break LOCA Evaluation

This model is applicable to all B&W designed pressurized water reactors for large break LOCA analyses of zircaloy clad fuel. The NRC approved topical report for this evaluation model is BAW-10104PA Rev 5.

CRAFT2 PWR Small Break LOCA Evaluation Model

This model is applicable to all B&W designed pressurized water reactors for small break LOCA analyses of zircaloy clad fuel. The NRC approved topical report for this evaluation model is BAW-10154PA Rev 0.

RELAP5/MOD2-B&W Once Through Steam Generator Large and Small Break LOCA Evaluation Model

This model is applicable to all B&W designed pressurized water reactors for large and small break LOCA analyses of zircaloy or M5 clad fuel. The NRC approved topical report for this evaluation model is BAW-10192PA Rev 0. The NRC has approved this evaluation model for M5 clad fuel in BAW-10227PA Rev 0.

RELAP5/MOD2-B&W Re-Circulating Steam Generator Large and Small Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 3 and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for large and small break LOCA analyses. The NRC approved topical report for this evaluation model is BAW-10168PA Rev 3.

SEM-PWR-98 PWR Large Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 3 and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for large break LOCA analyses. The NRC approved topical report for this evaluation model is EMF-2087PA Rev 0.

ANF-RELAP PWR Small Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 2, 3, and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for small break LOCA analyses. The NRC approved topical report for this evaluation model is XN-NF-82-49PA Rev 1 Supplement 1.

S-RELAP5 PWR Small Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 2, 3, and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for small break LOCA analyses. The NRC approved topical report for this evaluation model is EMF-2328PA Rev 0.

Realistic PWR Large Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 3 and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for large break LOCA analyses. The NRC approved topical report for this evaluation model is EMF-2103PA Rev 0.

Attachment B

Annual Reporting of AREVA NP LOCA Evaluation Model Changes and Error Corrections (2005)

EXEM BWR Large and Small Break LOCA Evaluation Model

This model is applicable to all boiling water reactors for both large and small break LOCA analyses. The NRC approved topical report for this evaluation model is ANF-91-048PA Supplements 1 and 2.

The Evaluation Model consists of four computer codes: (1) RELAX to compute the system and hot channel response during blowdown, (2) FLEX to calculate the time for refill of the lower plenum and reflood of the core, (3) HUXY to calculate the heatup of the peak power plane, and (4) RODEX2 to determine the rod conditions at the start of the transient.

There were no code or methodology error corrections or changes implemented during the reporting period.

EXEM BWR-2000 Large and Small Break LOCA Evaluation Model

This model is applicable to jet-pump boiling water reactors for both large and small break LOCA analyses. The NRC approved topical report for this evaluation model is EMF-2361PA Rev 0.

The Evaluation Model consists of three computer codes: (1) RELAX to compute the system and hot channel response during blowdown and to calculate the time for refill of the lower plenum and reflood of the core, (2) HUXY to calculate the heatup of the peak power plane and (3) RODEX2 to determine the rod conditions at the start of the transient.

Error in the SPCB Critical Power Correlation

The SPCB correlation is used by RELAX to calculate critical heat flux (CHF). If the actual heat flux exceeds CHF, RELAX switches to post-CHF heat transfer coefficients that result in reduced heat transfer. SPCB is only used when fluid conditions are within the range of applicability of the correlation. The range of the SPCB correlation is exceeded early in a LOCA analysis and after that time, other CHF correlations are used by RELAX. The SPCB correlation has no effect on LOCA analysis results unless CHF is exceeded before the transfer to other correlations. An error was found in the coding used to implement the SPCB correlation in the RELAX computer code.

The impact of the code error was assessed for all plants that AREVA NP has performed LOCA analyses for using the BWR EXEM-2000 methodology. The impact on PCT was 0°F for the LOCA analyses supporting normal operation for all plants. A PCT change of -19°F occurred for the analysis supporting single recirculation loop operation for one plant.

Error in Hydraulic Characteristics for Bypass to Lower Plenum Leakage Flow

During a BWR LOCA, water flows from the bypass region into the lower plenum through various leakage paths in the core support plate, through the flow holes in the assembly lower tie plate, and through the fuel channel and lower tie plate interface. In LOCA analyses, these flow paths are modeled as one equivalent flow path in the RELAX computer code. In the EXEM BWR-2000 methodology, an automation code is used to calculate the flow characteristics for the equivalent flow path. The calculations by the automation code for the flow characteristics of the equivalent flow path contained an error.

The impact of the code error was assessed for all plants that AREVA NP has performed LOCA analyses for using the BWR EXEM-2000 methodology. For some plants, the impact in PCT was greater than 50°F. For those plants, new LOCA analyses were performed with corrected input for RELAX. For all new analyses, all 10 CFR 50.46 criteria continued to be met without changes to the LOCA MAPLHGR limit.

CRAFT2 PWR Large Break LOCA Evaluation Model

This model is applicable to all B&W designed pressurized water reactors for large break LOCA analyses of zircaloy clad fuel. The NRC approved topical report for this evaluation model is BAW-10104PA Rev 5.

The Evaluation Model consists of five computer codes: (1) CRAFT2 to compute the system and core response during blowdown, (2) REFLOD3 to calculate the time for refill of the lower plenum and core reflood rate, (3) CONTEMPT to compute the containment pressure response (4) FLECSET to calculate the hot pin heat transfer coefficients, and (5) THETA1-B to determine the hot pin thermal response for the entire transient. An NRC-approved fuel code (currently TACO3) is used to supply the fuel rod steady-state conditions at the beginning of the transient.

There were no evaluation model changes or error corrections made during 2005.

CRAFT2 PWR Small Break LOCA Evaluation Model

This model is applicable to all B&W designed pressurized water reactors for small break LOCA analyses of zircaloy clad fuel. The NRC approved topical report for this evaluation model is BAW-10154PA Rev 0.

The Evaluation Model consists of three computer codes: (1) CRAFT2 to compute the system and core response during blowdown, (2) FOAM2 to calculate the core mixture level and average channel steaming rate, and (3) THETA1-B to determine the hot pin thermal response for the entire transient. An NRC-approved fuel code (currently TACO3) is used to supply the fuel rod steady-state conditions at the beginning of the transient.

There were no evaluation model changes or error corrections made during 2005.

RELAP5/MOD2-B&W Once Through Steam Generator Large and Small Break LOCA Evaluation Model

This model is applicable to all B&W designed pressurized water reactors for large and small break LOCA analyses of zircaloy and M5 clad fuel. The NRC approved topical report for this evaluation model is BAW-10192PA Rev 0.

The large break LOCA Evaluation Model consists of four computer codes: (1) BAW-10164P-A, RELAP5/MOD2-B&W to compute the system, core, and hot rod response during blowdown, (2) BAW-10171P-A, REFLOD3B to calculate the time for refill of the lower plenum and core reflood rate, (3) BAW-10095-A, CONTEMPT to compute the containment pressure response, and (4) BAW-10166P-A, BEACH (RELAP5/MOD2-B&W reflood heat transfer package) to determine the hot pin thermal response during refill and reflood phases. The small break LOCA Evaluation Model consists of two codes: (1) BAW-10164P-A, RELAP5/MOD2-B&W to compute the system, core, and hot rod response during the transient and (2) BAW-10095-A, CONTEMPT to compute the containment pressure response, if needed. An NRC-approved fuel code (currently BAW-10162P-A, TACO3 or BAW-10184P-A, GDTACO) is used to supply the fuel rod steady-state conditions at the beginning of the small or large break LOCA. These codes are approved for use with M5 cladding via the SER on BAW-10227P-A.

There was one generic evaluation model change and zero error corrections made during 2005.

1. EM Change for BHTP CHF Correlation Implementation for SBLOCA

The BHTP CHF correlation was conservatively implemented in the RELAP5/MOD2-B&W code as dictated by Section 4.3.4.8 of the EM for use in LBLOCA applications. This EM change was previously reported via 50.46 as part of the 2003 annual report[1]. As originally implemented, the flow-direction dependent terms of the BHTP correlation were excluded from the calculation of the CHF for LBLOCA applications. This causes a conservative reduction in the BHTP CHF prediction, which was specifically intended only for LBLOCA applications. The EM is changed such that for SBLOCA applications, the BHTP CHF correlation is adjusted to specifically account for these flow-dependent terms since the flow direction does not change for these smaller break sizes and the conservatism in the implementation is not necessary. The SBLOCA EM has been generically modified to include the impact of these terms for analysis and evaluation of the Mark-B-HTP fuel.

The affect of this SBLOCA EM change on the plant-specific evaluations and analyses related to the Mark-B-HTP fuel is reported in the plant-specific submittals. The maximum break size for the SBLOCA spectrum is defined in the BWNT LOCA EM based on the CHF performance, specifically that the heat flux should not exceed the CHF during the first several seconds of the SBLOCA transient. The extent of this EM change is to confirm that the correct EM (transition LBLOCA versus SBLOCA) is utilized to analyze the transient. However, this change does not affect the limiting SBLOCA PCT for any of the B&W plants. Therefore, the PCT change associated with this SBLOCA EM change is 0°F.

[1] Letter, James F. Mallay (Framatome ANP) to Document Control Desk (NRC), "2003-Annual Reporting of Changes and Errors in ECCS Evaluation Models," NRC:04:014, March 15, 2004.

RELAP5/MOD2-B&W Re-Circulating Steam Generator Large and Small Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 3 and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for large and small break LOCA analyses. The NRC approved topical report for this evaluation model is EAW-10168PA Rev 3.

The large break LOCA Evaluation Model consists of three computer codes: (1) RELAP5/
MOD2-B&W to compute the system, core and hot rod response during blowdown, (2) REFLOD3B to calculate the time for refill of the lower plenum and core reflood rate, and (3) BEACH (RELAP5/MOD2-B&W reflood heat transfer package) to determine the hot pin thermal response during refill and reflood phases. The small break LOCA Evaluation Model consists of one code: RELAP5/MOD2-B&W to compute the system, core and hot rod response during the transient. A NRC-approved fuel code (currently TACO3 or GDTACO) is used to supply the fuel rod steady state conditions at the beginning of the small or large LOCA transient.

There were no evaluation model changes or error corrections made during the reporting period.

SEM/PWR-98 PWR Large Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 3 and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for large break LOCA analyses. The NRC approved topical report for this evaluation model is EMF-2087PA Rev 0.

The SEM/PWR-98 LBLOCA Evaluation Model consists of four primary computer codes: (1) RELAP4 to compute the system and hot channel response, (2) RFPAC to compute the containment pressures, reflood rates, and axial shape factors, (3) TOODEE2 to calculate the hot rod heatup, and (4) RODEX2 to determine the rod conditions at the start of the transient.

There were no evaluation model changes or error corrections made during the reporting period.

ANF-RELAP PWR Small Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 2, 3, and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for small break LOCA analyses. The NRC approved topical report for this evaluation model is XN-NF-82-49PA Rev 1 Supplement 1.

The ANF-RELAP SBLOCA Evaluation Model consists of three computer codes: (1) ANF-RELAP to compute the system response, (2) TOODEE2 to calculate the hot rod heatup, and (3) RODEX2 to determine the rod conditions at the start of the transient.

There were no evaluation model changes or error corrections made during the reporting period.

S-RELAP5 PWR Small Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 2, 3, and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for small break LOCA analyses. The NRC approved topical report for this evaluation model is EMF-2328PA Rev 0.

There were no evaluation model changes or error corrections made during the reporting period.

Realistic PWR Large Break LOCA Evaluation Model

This model is applicable to Westinghouse designed 3 and 4 loop pressurized water reactors and Combustion Engineering designed pressurized water reactors for large break LOCA analyses. The NRC approved topical report for this evaluation model is EMF-2103PA Rev 0.

There was one evaluation model error correction made during the reporting period. An error was identified in the determination of the break flow when the break flow un-choked. The specific break area is not used when the break un-chokes. Instead, the minimum of the upstream and downstream break junction connecting volume areas is used as the break flow area. An appropriate k-factor needs to be input to adjust the un-choked break flow rate. As part of this error correction the containment modeling was changed to model the containment volume area as equal to the upstream volume flow area. This provides for a continuous break flow when transitioning from choked-to-un-choked flow.

The issue's effect on existing RLBLOCA analyses was evaluated relative to change in peak clad temperature (PCT). For affected plants, the absolute value of the PCT impact was less than 30°F.