FRAMATOME ANP

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FRAMATOME ANP, Inc.

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2003 - Annual Reporting of Changes and Errors in ECCS Evaluation Models

Attached is a summary report of the changes and error corrections implemented in the Framatome ANP ECCS evaluation models for the period of January 1, 2003 to December 31, 2003.

FANP 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 FANP 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.

Very truly yours,

James F. Mallay, Director
Regulatory Affairs

Enclosures

cc: M. C. Honcharik (w/ enclosures)
Project 728

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Attachment A
Listing of Framatome ANP 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 zicaloy 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. 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-10227P-A Revision 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 Revision 0.

Attachment B
Annual Reporting of Framatome ANP LOCA Evaluation Model
Changes and Error Corrections (2003)

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.

An error correction made during the reporting period is described below.

Data Transfer Between RELAX and HUXY

The PREHUXY code is used to transfer data from RELAX analysis results to the HUXY computer code. In some analyses, the last value of RELAX coolant temperature output by PREHUXY is at the time of rated spray (TSPRAY) or slightly beyond depending on the RELAX hot channel output data edit frequency. Coolant temperature data of 212°F is added by PREHUXY at a time slightly greater than TSPRAY. Due to the small time steps used in HUXY, the first HUXY time step at or following TSPRAY may occur before the coolant temperature is set to 212°F. In these situations, the HUXY interpolated temperature will be greater than 212°F. If the interpolated temperature is high enough (~500°F) after TSPRAY, HUXY may predict immediate quenching of the fuel rods. This is an error in the application of the HUXY quenching model.

The impact of this error on the PCTs for those plants for which Framatome ANP performs LOCA analyses using this evaluation model is estimated to be 0°F.

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.

A number of error corrections and evaluation model changes made during the reporting period are described below.

Data Transfer Between RELAX and HUXY

The PREHUXY code is used to transfer data from RELAX analysis results to the HUXY computer code. In some analyses, the last value of RELAX coolant temperature output by PREHUXY is at the time of rated spray (TSPRAY) or slightly beyond depending on the RELAX hot channel output data edit frequency. Coolant temperature data of 212°F is added by PREHUXY at a time slightly greater than TSPRAY. Due to the small time steps used in HUXY, the first HUXY time step at or following TSPRAY may occur before the coolant temperature is set to 212°F. In these situations, the HUXY interpolated temperature will be greater than 212°F. If the interpolated temperature is high enough (~500°F) after TSPRAY, HUXY may predict immediate quenching of the fuel rods. This is an error in the application of the HUXY quenching model.

The impact of this error on the PCTs for those plants for which Framatome ANP performs LOCA analyses using this evaluation model is estimated to be 0°F.

Units Conversion Factor in Change in RELAX

Following approval of the EXEM BWR-2000 topical report (EMF-2361(P)(A) Rev 0), a change to a code internal energy units conversion factor was made to improve the consistency between the RELAX code and steady state automation tools. This change was made before the EXEM BWR-2000 methodology was used to perform a LOCA licensing analysis for any plant.

The impact of this change on the PCTs for those plants for which Framatome ANP performs LOCA analyses using this evaluation model is estimated to be 0°F.

Revised Transition Void Fraction in RELAX Slip Model

Following approval of the EXEM BWR-2000 topical report (EMF-2361(P)(A) Rev 0), a change to a tighter value for the slip model selection logic was implemented to improve numerical stability. This change was made before the EXEM BWR-2000 methodology was used to perform a LOCA licensing analysis for any plant.

The impact of this change on the PCTs for those plants for which Framatome ANP performs LOCA analyses using this evaluation model is estimated to be -10°F.

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 cald 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 2003.

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 2003.

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 were no evaluation model error corrections made during 2003. An evaluation model change is described below.

Change to RELAP5/MOD2-B&W for Mark-B-HTP Fuel

The BHTP CHF correlation from BAW-10241P (BHTP DNB Correlation Applied with LYNXT) was implemented into RELAP5/MOD2-B&W for analysis of Mark-B-HTP fuel. This change is in accordance with Section 4.3.4.8 of Volume 1 of BAW-10192P-A, which states that the LOCA analyses will use the same CHF correlation that is used for the fuel pin DNB analyses.

The impact of this error on the PCTs for those plants for which Framatome ANP performs LOCA analyses using this evaluation model is estimated to be +3°F.

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.

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 2003.

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 2003.

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 2003.

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.

An evaluation model change is described below.

Revised Steam Generator U-tube Primary Side Hydraulic and Heat Structure Modeling

The S-RELAP5 SBLOCA guideline was revised to change the steam generator U-tube primary side hydraulic and heat structure modeling in the bend region. The revised modeling more accurately represents the U-tube volume and heat transfer to the secondary side.

The ΔPCT impact for the plants for which Framatome ANP performs SBLOCA analyses using this evaluation model was estimated to be -15°F.

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 Revision 0.

The Realistic large break LOCA (RLBLOCA) evaluation model was not the analyses of record for any plant for 2003. Thus there are no changes or error corrections to the evaluation model to report for 2003.