



FRAMATOME ANP

An AREVA and Siemens company

FRAMATOME ANP, Inc.

February 28, 2003
NRC:03:013

PROJ 728

Document Control Desk
ATTN: Chief, Planning, Program and Management Support Branch
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

2002 - 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, 2002 to December 31, 2002.

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: D. G. Holland (w/enclosures)
Project 728

TO DO
Y601

Add: Drew Holland

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. 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. 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.

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.

Attachment B
Annual Reporting of Framatome ANP LOCA Evaluation Model
Changes and Error Corrections (2002)

Power Measurement Uncertainty – Generic Change

The NRC has modified Appendix K to 10 CFR 50 to allow two options for defining the reactor power level for LOCA applications. It allows the power to be modeled as: (1) at least 1.02 times the licensed power level (to allow for instrumentation error), or (2) an alternate power level (not less than the licensed power level), provided the proposed alternative value has been demonstrated to account for uncertainties due to power level instrumentation error. The Framatome ANP LOCA evaluation models were written prior to this modification and specified the use of a power level at least 1.02 times the rated power level. The EM change reported herein simply acknowledges the change in the regulations and allows current or future EM analyses to be performed with either of the Appendix K prescribed options. This change is applicable to all of the 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.

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.

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

CRAFT2 PWR Large Break LOCA Evaluation Model

This model is applicable to all B&W designed pressurized water reactors for large break LOCA analyses. 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 2002.

CRAFT2 PWR Small Break LOCA Evaluation Model

This model is applicable to all B&W designed pressurized water reactors for small break LOCA analyses. 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 2002.

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 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 2002. An evaluation model change is described below.

Approval of RELAP5/MOD2-B&W Topical Report Revision

The NRC, by letter dated April 9, 2002, approved Revision 4 of the RELAP5/MOD2-B&W topical report, BAW-10164, and its use with the once-through steam generator large break and small break LOCA evaluation models, BAW-10192P-A. The RELAP5 revision for large break analyses allows (i) modeling of the hot fuel assembly as a hot pin and a hot bundle, each with their own heat structure, (ii) improvements to the TACO3-based, steady state, fuel temperature uncertainties, and (iii) automation of the BEACH (BAW-10166P-A) blockage limitation. The RELAP5 revision for small break analyses allows an automation of the void-dependent cross-flow model. Material was also added to the RELAP5 topical report revision reflecting prior approvals for M5TM cladding (BAW-10227P-A) applications with the once-through steam generator evaluation model.

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 error corrections made during 2002. An evaluation model change is described below.

Approval of RELAP5/MOD2-B&W Topical Report Revision

The NRC, by letter dated April 9, 2002, approved Revision 4 of the RELAP5/MOD2-B&W topical report, BAW-10164, and its use with the re-circulating steam generator large break LOCA evaluation model. Prior to the approval of this RELAP5 topical report revision, the hot channel contained the hot fuel assembly, represented by a single heat structure. The RELAP5 revision allows (i) modeling of the hot fuel assembly as a hot pin and a hot bundle, each with their own heat structure, (ii) improvements to the TACO3-based, steady state, fuel temperature uncertainties, and (iii) automation of the BEACH (BAW-10166) blockage limitation. Material was also added to the RELAP5 topical report revision reflecting its and the re-circulating steam generator evaluation model prior approvals for use with M5™ cladding (BAW-10227).

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.

The error corrections and model changes to the LBLOCA Evaluation Model implemented during this reporting period are described below.

TOODEE2 Clad thermal Expansion

The code TOODEE2 uses a correlation for determining clad thermal expansion with three ranges--Alpha phase, Beta phase, and a transition region between the Alpha and Beta phases. The formulation for the Beta phase was programmed with an incorrect constant coefficient of 2.9E-6 instead of 3.2E-6. This introduced a discontinuity between the transition region and the Beta region and caused all clad thermal expansion calculations at temperatures above 1773 °F to be underpredicted. The coding was revised to use the correct coefficient.

The impact of this change on the PCTs for those plants for which Framatome ANP performs LBLOCA analyses using this evaluation model was estimated to be -1 °F.

Incorrect Pump Junction Area Used in RELAP4 LBLOCA Blowdown Analysis

For the SEM/PWR-98 evaluation model, the junction area that should be used for the recirculation pump junctions is the connecting pipe area. The LBLOCA guideline was not specific on the definition of this junction area. The LBLOCA guideline was changed to require the use of the full connecting pipe area.

The impact of this change on the PCTs for those plants for which Framatome ANP performs LBLOCA analyses using this evaluation model was estimated to be between -10 and +10 °F.

Errors Discovered during RFPAC V&V

Framatome ANP (formerly Siemens Power Corporation) committed (in response to the NRC 1997 inspection at SPC) to perform additional V&V and to update or create user's manuals, theory manuals, and programmer's manuals for Framatome ANP's primary codes. One of the primary codes was the RFPAC code. The RFPAC code performs the refill and reflood calculations for the LBLOCA event in the SEM/PWR-98 evaluation model. A number of minor errors were identified and corrected as a result of the additional V&V activities. Examples of the errors identified and corrected are:

- An array was dimensioned too small
- An inconsistent pressure drop calculation
- The use of instantaneous vs. effective flooding rate in the calculations of some parameters

The impact of this change on the PCTs for those plants for which Framatome ANP performs LBLOCA analyses using this evaluation model was estimated to be less than 50 °F.

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.

The code or methodology changes to this Evaluation Model implemented during this reporting period are described below.

TOODEE2 Clad Thermal Expansion

The code TOODEE2 uses a correlation for determining clad thermal expansion with three ranges--Alpha phase, Beta phase, and a transition region between the Alpha and Beta phases. The formulation for the Beta phase was programmed with an incorrect constant coefficient of $2.9E-6$ instead of $3.2E-6$. This introduced a discontinuity between the transition region and the Beta region and caused all clad thermal expansion calculations at temperatures above 1773°F to be underpredicted. The coding was revised to use the correct coefficient.

The impact of this change on the PCTs for those plants for which Framatome ANP performs SBLOCA analyses using this evaluation model was estimated to be -1°F .

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.

Revised SBLOCA Guideline

The S-RELAP5 guideline incorporated increased modeling detail and several changes relative to the sample problem in the NRC approved topical report EMF-2328(P)(A). Changes included more detailed modeling of the cold legs and steam generator to be consistent with automation input deck tools and non-LOCA and Realistic LOCA models.

The impact of this change on the PCTs for those plants for which Framatome ANP performs SBLOCA analyses using this evaluation model was estimated to be less than +70 °F.