



February 1, 2017  
NRC:17:007

U.S. Nuclear Regulatory Commission  
Document Control Desk  
11555 Rockville Pike  
Rockville, MD 20852

**2016 - Annual Reporting of Changes and Errors in Emergency Core Cooling Systems (ECCS) Evaluation Models**

Ref. 1: Letter, Gary Peters (AREVA Inc.) to Document Control Desk (NRC), "2015 - Annual Reporting of Changes and Errors in Emergency Core Cooling Systems (ECCS) Evaluation Models," NRC:16:003, February 12, 2016.

Attached is a summary report of changes and error corrections implemented in the AREVA Inc. (AREVA) Emergency Core Cooling Systems (ECCSs) evaluation models for the period of January 1, 2016 to December 31, 2016. Reference 1 provided reporting for the previous year.

AREVA considers the Boiling Water Reactor (BWR) and Pressurized Water Reactor (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 loss of coolant accident (LOCA) evaluation model changes and errors are reported on a plant specific basis by AREVA to the affected licensees. The licensees have the obligation under 10 CFR 50.46 to report the nature of changes and errors affecting PCT. The report in this letter is provided for information only.

If you have any questions related to this information, please contact Mr. Alan B. Meginnis, Product Licensing Manager, by telephone at (509) 375-8266, or by e-mail at [Alan.Meginnis@areva.com](mailto:Alan.Meginnis@areva.com)

Sincerely,

A handwritten signature in cursive script that reads "Gary Peters".

Gary Peters, Director  
Licensing & Regulatory Affairs  
AREVA Inc.

cc: J. G. Rowley  
Project 728

**Attachments:**

1. Attachment A- Listing of AREVA LOCA Evaluation Models
2. Attachment B- Annual Reporting of AREVA LOCA Evaluation Model Changes and Error Corrections (January 1, 2016- December 31, 2016)

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**AREVA INC.**

**Attachment A**  
**Listing of AREVA LOCA Evaluation Models**

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, Revision 0.

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, Revision 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, Revision 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, Revision 0. The NRC has approved this evaluation model for M5™ clad fuel in BAW-10227PA, 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, Revision 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, Revision 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, Revision 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, Revision 0.

Realistic PWR Large Break LOCA Model

This model is applicable to Westinghouse designed 3 and 4 loop pressurized water reactors and Combustion Engineering 2x4 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 AREVA LOCA Evaluation Model Changes and Error Corrections (January 1, 2016- December 31, 2016)

#### 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, Revision 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.

The following evaluation model changes or error corrections were made during the reporting period:

#### 1. Computer Platform Change

Analyses based on the NRC approved topical report (EMF-2361 PA, Revision 0) have been performed on a DEC ALPHA computer platform. New analyses have been qualified on a LINUX based computer platform. The impact of the change in platforms was estimated to have an insignificant impact on PCT. Therefore, the 10 CFR 50.46 reportable impact is estimated as 0 °F.

#### 2. Grouping of Rods in the Heatup Calculation Computer Platform Change

Previous versions of the heatup code HUXY used in the Reference 1 methodology allowed a limited number of different rod types to be modeled. The method grouped rods that had similar local peaking histories. HUXY has been revised to no longer have a limited number of rod groupings. This change in rod grouping was estimated to have an insignificant impact on PCT. Therefore, the 10 CFR 50.46 reportable impact is estimated as 0 °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 clad fuel. The NRC approved topical report for this evaluation model is BAW-10104PA, Revision 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 TAC03) 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 the reporting period.

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, Revision 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) THETA 1-B to determine the hot pin thermal response for the entire transient. An NRC-approved fuel code (currently TAC03) 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 the reporting period.

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, Revision 0. The NRC has approved this evaluation model for M5™ clad fuel in BAW-10227PA, Revision 0.

The large break LOCA Evaluation Model consists of four computer codes:

- (1) BAW-10164PA, RELAP5/MOD2-B&W to compute the system, core, and hot rod response during blowdown.
- (2) BAW-10171PA, REFLOD3B to calculate the time for refill of the lower plenum and core reflood rate.
- (3) BAW-10095A, CONTEMPT to compute the containment pressure response, and
- (4) BAW-10166PA, 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-10164PA, RELAP5/MOD2-B&W to compute the system, core, and hot rod response during the transient, and
- (2) BAW-10095A, CONTEMPT to compute the containment pressure response, if needed. An NRC-approved fuel code (currently BAW-10162PA, TAC03 or BAW-10184PA, 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 safety evaluation report on BAW-10227PA.

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

#### 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, Revision 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:

- (1) RELAP5/MOD2 B&W to compute the system, core and hot rod response during the transient. A NRC-approved fuel code (currently TAC03 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, Revision 0.

The SEM/PWR-98 large break LOCA 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, Revision 1, Supplement 1.

The ANF-RELAP small break LOCA 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, Revision 0.

The S-RELAP5 PWR Small Break LOCA Evaluation Model consists of two primary computer codes:

- (1) S-RELAP5 to compute the system and hot channel response, and
- (2) 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.

Realistic PWR Large Break LOCA Model

This model is applicable to Westinghouse designed 3 and 4 loop pressurized water reactors and Combustion Engineering 2x4 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 PWR Large Break LOCA Model consists of three primary computer codes:

- (1) S-RELAP5 to compute the system and hot channel response,
- (2) RODEX3A to determine the rod conditions at the start of the transient, and
- (3) ICECON to determine the containment conditions.

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