

# CEOG COMBUSTION ENGINEERING OWNERS GROUP

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Westinghouse Electric Company LLC Calvert Cliffs Nuclear Power Plant, Inc. Entergy Operations, Inc. Korea Hydro & Nuclear Power Company Omaha Public Power District  
Calvert Cliffs 1, 2 ANO 2 WSES Unit 3 YGN 3, 4 Ulchin 3,4 Ft. Calhoun

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Arizona Public Service Co. Consumers Energy Co. Florida Power & Light Co. Dominion Nuclear Connecticut, Inc. Southern California Edison  
Palo Verde 1, 2, 3 Pallsades St. Lucie 1, 2 Millstone 2 SONGS 2,3

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December 13, 2002  
CEOG-02-256

Project No. 692

Document Control Desk  
U. S. Nuclear Regulatory Commission  
Washington, DC 20555-0001

ATTN: Chief, Information Management Branch  
Division of Program Management

**Subject: Submittal of Combustion Engineering Owners Group Reports:  
WCAP-15996-P, (Proprietary) and WCAP-15996-NP, (Non-Proprietary),  
entitled "Technical Description Manual for the CENTS Code"**

**[Enclosures 1-P and 2-P Contain Westinghouse Proprietary Class 2 Information]**

- References: 1. WCAP-15996-P, Rev. 0, Volumes 1 - 3, "Technical Description Manual for the CENTS Code", December, 2002
2. CENPD-282-P-A, Rev. 0, "Technical Description Manual for the CENTS Code",
3. Letter, M. J. Virgilio (NRC) to S. A. Toelle (ABB-CE), "Acceptance for Referencing of Licensing Topical Report CENPD-282-P, Technical Manual for the CENTS Code" (TAC No. MB2718)", March 17, 1994
4. Letter, R. C. Jones (NRC) to S. A. Toelle (ABB-CE), "Acceptance for Referencing of Licensing Topical Report CE-NPD 282-P, Vol. 4, "Technical Manual for the CENTS Code" (TAC No. M85911)", February 25, 1995

By this letter, the CE Owners Group (CEOG) is submitting WCAP-15996-P, Rev. 0, Volumes 1 - 3, "Technical Description Manual for the CENTS Code" (Reference 1), prepared by Westinghouse Electric Co. LLC (Westinghouse), for Nuclear Regulatory Commission (NRC) review and approval. WCAP-15996-P is an update of CENPD-282-P-A (Reference 2) which was reviewed and approved for application to CE designed pressurized water reactors (PWRs) by the NRC March, 1994 (Reference 3). In February, 1995 (Reference 4) the NRC extended its approval for CENTS for application to PWRs designed by Westinghouse. Consistent with its prior approvals, the CEOG requests that the NRC review and approve WCAP-15996-P, Rev. 0 for continued application to both CE and Westinghouse designed PWRs. The CEOG plans to submit WCAP-15996-P, Rev. 0, Volume 4, which contains the results of the benchmark test cases, in January, 2003.

WCAP-15996-P (Enclosure 1-P) documents changes made to the CENTS methodology and incorporates a number of minor changes to clean-up and clarify the methodology. Following NRC approval of WCAP-15996-P, it will be employed in licensing applications by Westinghouse and members of the CEOG. To supplement WCAP-15996-P and assist the NRC in its review, Westinghouse has prepared a 'Roadmap' (Enclosure 2-P) which provides an overview of the changes made to the original topical report, CENPD-282-P-A, where the changes were made, the nature of the change and a recommendation as to whether or not the changes need to be reviewed by the NRC. Since WCAP-15996-P includes a re-format of the original CENPD-282-P-A, it is hoped that the 'Roadmap' will help direct the NRC reviewer(s) to those sections of the topical report that would represent the major component of their review effort. Along

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these lines, a Record of Revision table has also been incorporated in the topical report to provide a cross-reference between section numbers in WCAP-15996-P and the corresponding subject matter section numbers in CENPD-282-P-A.

The CEOG requests that the NRC complete the review of WCAP-15996-P, Rev. 0, by June 30, 2003. To this end, Entergy is employing the currently approved CENTS methodology (i.e., CENPD-282-P-A) in support of their upcoming power uprate project for the Waterford Steam Electric Station, Unit 3. Approval of WCAP-15996-P by the requested date will allow use of the updated CENTS methodology, should it be needed. Further, both Arizona Public Service Company and Southern California Edison are also planning to use the updated CENTS methodology described in WCAP-15996-P in future licensing actions for the Palo Verde Nuclear Generating Stations Units 1, 2 and 3 and the San Onofre Nuclear Generating Station Units 2 and 3, respectively.

Consistent with the Office of Nuclear Reactor Regulation, Office Instruction LIC-500, "Processing Request for Reviews of Topical Reports," the CEOG requests that the NRC provide an estimate of the review hours, and target dates for any Request(s) for Additional Information (RAIs) and for completion of the Safety Evaluation for WCAP-15996-P, Rev. 0. For NRC planning purposes, Westinghouse plans to provide responses to RAIs in an expeditious manner so as not to delay the review.

Westinghouse has determined that the information contained in WCAP-15996-P, Rev. 0 (Enclosure 1-P) and the 'Roadmap' (Enclosure 2-P) are proprietary in nature. Consequently, it is requested that this information be withheld from public disclosure in accordance with the provisions of 10 CFR 2.790 and that copies of this information be appropriately safeguarded. The reasons for the classification of this information as proprietary are delineated in the affidavit provided in Enclosure 3. Enclosure 4 provides a non-proprietary version of the topical report while Enclosure 5 provides a non-proprietary version of the 'Roadmap'.

The information transmitted herewith bears a Westinghouse copyright notice. The NRC is permitted to make the number of copies of the information contained in these reports which are necessary for its internal use in connection with generic and plant-specific reviews and approvals as well as the issuance, denial, amendment, transfer, renewal, modification, suspension, revocation, or violation of a license, permit, order, or regulation subject to the requirements of 10 CFR 2.790 regarding restrictions on public disclosure to the extent such information has been identified as proprietary by Westinghouse, copyright protection notwithstanding. With respect to the non-proprietary version of this report, the NRC is permitted to make the number of copies beyond those necessary for its internal use which are necessary in order to have one copy available for public viewing in the appropriate docket files in the public document rooms as may be required by NRC regulations if the number of copies submitted is insufficient for this purpose. Copies made by the NRC must include the copyright notice in all instances and the proprietary notice if the original was identified as proprietary.

Invoices associated with the review of WCAP-15996-P, Rev. 0 should be addressed to:

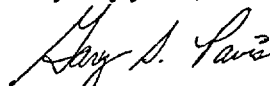
Mr. Gordon Bischoff  
Manager, Owners Group Program Management Office  
Westinghouse Electric Company  
2000 Day Hill Road  
Windsor, CT 0095-0500

All correspondence related to this matter should be addressed to:

Mr. Gary S. Pavis  
Chairman, Combustion Engineering Owners Group  
Constellation Energy Group  
Calvert Cliffs Nuclear Power Plant, Inc.  
P.O. Box 1635  
Lusby, MD 20657-4702

If you have any questions regarding this matter, please do not hesitate to call me or Chuck Molnar of Westinghouse's Licensing staff at (860) 731-6286.

Very truly yours,



Gary S. Pavis, Chairman  
CE Owners Group

Enclosure(s): As stated

xc: F. M. Akstulewicz (NRC, w/o enclosures)  
A. C. Attard ((NRC, w/enclosures)  
S. Dembek (NRC, w/o enclosures)  
G. S. Shukla (NRC, w/enclosures)  
G. C. Bischoff, Westinghouse (1L)  
S. Dederer, Westinghouse (1L)  
V. Paggen, Westinghouse (1L)  
H. A. Sepp, Westinghouse (1L)  
K. J. Vavrek, Westinghouse (1L)  
CEOG Analysis Subcommittee Representatives (1L)  
CEOG Library Task 2027  
CEOG Management Committee (1L)

**WESTINGHOUSE ELECTRIC COMPANY LLC**

**PROPRIETARY AFFIDAVIT**

**FOR**

**WCAP-15996-P, TECHNICAL DESCRIPTION  
MANUAL FOR THE CENTS CODE**

Proprietary Affidavit

I, Ian. C. Rickard, depose and say that I am the Licensing Project Manager, Windsor Nuclear Licensing, of Westinghouse Electric Company LLC (WEC), duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and described below.

I am submitting this affidavit in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations for withholding this information. I have personal knowledge of the criteria and procedures utilized by WEC in designating information as a trade secret, privileged, or as confidential commercial or financial information.


The information for which proprietary treatment is sought, and which documents have been appropriately designated as proprietary, is contained in the following:

WCAP-15996-P, Revision 0, "Technical Description Manual for the CENTS Code", December, 2002

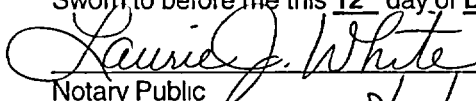
Enclosure 2-P to CEOG-02-256, "Roadmap for WCAP-15996-P, Technical Description Manual for the CENTS Code", December, 2002

Pursuant to the provisions of Section 2.790(b)(4) of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information included in the documents listed above should be withheld from public disclosure.

- i. The information sought to be withheld from public disclosure is owned and has been held in confidence by WEC. It consists of information concerning enhanced safety analysis methodologies for the evaluation of non-LOCA transients.
- ii. The information consists of test data or other similar data for the design, development and implementation of enhanced safety analysis methodologies for the evaluation of non-LOCA transients, the application of which results in substantial competitive advantage to WEC.
- iii. The information is of a type customarily held in confidence by WEC and not customarily disclosed to the public.
- iv. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.
- v. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements that provide for maintenance of the information in confidence.
- vi. Public disclosure of the information is likely to cause substantial harm to the competitive position of WEC because:
  - a. A similar product is manufactured and sold by major competitors of WEC.
  - b. WEC invested substantial funds and engineering resources in the development of this information. A competitor would have to undergo similar expense in generating equivalent information.
  - c. The information consists of enhanced safety analysis methodologies for the evaluation of non-LOCA transients, the application of which provides a competitive economic advantage. The availability of such information to competitors would enable them to design their product to better compete with WEC, take marketing or other actions to improve their product's position or impair the position of WEC's product, and avoid developing similar technical analysis in support of their processes, methods or apparatus.
  - d. In pricing WEC 's products and services, significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included. The ability of WEC's competitors to utilize such information without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.
  - e. Use of the information by competitors in the international marketplace would increase their ability to market a competing product, reducing the costs associated with their technology development.

  
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Ian. C. Rickard  
Licensing Project Manager  
Westinghouse Electric Company LLC

Sworn to before me this 12<sup>th</sup> day of December, 2002

  
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Notary Public  
My commission expires: 8/31/04

WESTINGHOUSE NON-PROPRIETARY CLASS 3

Enclosure 4 to CEOG-02-256

# **WESTINGHOUSE ELECTRIC COMPANY LLC**

## **NON-PROPRIETARY WCAP-15996-NP TECHNICAL DESCRIPTION MANUAL FOR THE CENTS CODE**

**WESTINGHOUSE ELECTRIC COMPANY LLC**

**NON-PROPRIETARY ROADMAP FOR  
WCAP-15996-P TECHNICAL DESCRIPTION  
MANUAL FOR THE CENTS CODE**

## Roadmap for WCAP-15996-P, Technical Description Manual for the CENTS Code

### 1.0 Purpose

WCAP-15996-P, Rev. 0, "Technical Manual for the CENTS Code", provides an updated description of the CENTS code which was originally submitted by Combustion Engineering and subsequently approved by the Nuclear Regulatory Commission (NRC) under topical report number CENPD-282-P-A, Rev. 0. For the most part, the changes which have been made to CENTS are consistent with the code description given in CENPD-282-P-A Volumes 1 and 2. However, in a few cases the changes disagree with the detailed model descriptions given in CENPD-282-P-A Volumes 1 and 2. Also, new capabilities have been added to the CENTS code which are not described in CENPD-282-P-A.

The CENTS technical descriptions in WCAP-15996-P have been updated to describe the current CENTS code and the documentation has been improved to describe the models more completely and accurately. The new code description replaces CENPD-282-P-A Volumes 1 and 2. In addition, a new benchmarking study has been performed which quantifies the effect of the changes. The study compares the results of the latest version of CENTS to the approved version for a standard set of cases. This study supplements the benchmarking reported in CENPD-282-P-A Volumes 3 and 4.

The purpose of this 'Roadmap' is to highlight changes made in the CENTS code since its original review and approval. This is being done to help maximize the efficiency of the NRC review. The changes can be broken down into four (4) categories as follows:

- e. **Clarifications** – No change was made to the methodology as approved by the NRC in CENPD-282-P-A, however, the topical report discussion was updated to clarify the original description.
- f. **Editorial** – No change was made to the methodology as approved by the NRC in CENPD-282-P-A, however, the text was updated to correct typographical and grammatical errors.
- g. **New** – This is a completely new section not contained in CENPD-282-P-A and, therefore, not previously reviewed by the NRC. Depending on the intended use of the new material, changes falling into this category may or may not require NRC review and approval.
- h. **Updated** – A change was made to the methodology as approved by the NRC in CENPD-282-P-A and, therefore, new material is presented not previously reviewed by the NRC. In two (2) instances the change was not made to the coded methodology but to the model description instead. In these cases the coded model was correct and the description incorrect. However, in essence the NRC did not review and approve the model actually coded (although the coded model represented the correct formulation and was used for the original benchmark cases presented). Depending on the intended use of the new material, changes falling into this category may or may not require NRC review and approval.

In consideration of the above categorizations, Sections 3.0 and 4.0 below respectively discuss changes made which did not require prior NRC review and approval and those changes for which prior NRC review and approval is required before they can be implemented in licensing applications, such as Chapter 15 safety analyses.

### 2.0 Introduction

CENTS is a computer code for the simulation of PWR transient behavior under normal and abnormal conditions. CENTS provides an interactive capability for simulating the standard NSSS components and may be used to determine the transient thermal-hydraulic conditions in the primary and secondary systems and the transient core power. CENTS is intended to be used for prediction of plant behavior for conditions ranging from normal plant operation to operational and licensing transients.

CENPD-282-P-A, "Technical Manual for the CENTS Code", was originally submitted to the NRC for review in October 1991. Final approval was received in February 1995.

A number of changes have been made to the CENTS code since NRC approval was obtained. These changes have been made consistent with the guidance provided in 10 CFR 50.59. Generally, these changes have not invalidated the descriptions given in CENPD-282-P-A. However, in a few cases the



changes did affect the CENPD-282-P-A descriptions, although the actual code results remained essentially the same.

The updated CENTS code topical report (i.e., WCAP-15996-P, Rev. 0, Volumes 1 – 3) being submitted to the NRC at this time incorporates these existing changes as well as additional changes for which NRC review and approval is required (see Section 4.0 below). Volume 4, which contains the results of the benchmark test cases, will be submitted in January, 2003.

The CENTS technical description has been updated to describe the current state of the CENTS code and the documentation has been improved to describe the models more completely and accurately. The new code description, WCAP-15996-P Volumes 1, 2 and 3, replaces in their entirety CENPD-282-P-A Volumes 1 and 2.

In addition, a new benchmarking study has been performed which quantifies the effect of the changes. The study compares the results of the latest version of CENTS to the previously NRC approved version for a standard set of cases. This study supplements the benchmarking originally provided in CENPD-282-P-A Volumes 3 and 4. Although the benchmarking provided in CENPD-282-P-A Volumes 3 and 4 remains applicable, WCAP-15996-P Volume 4 provides the benchmarking conducted for the latest version of the CENTS code.

Because WCAP-15996-P includes a few changes which require NRC review and many minor changes which do not, this 'Roadmap' discussion is provided to facilitate the review. Additionally, a Record of Revision table has been added to the topical report itself which provides a cross-reference between section numbers in WCAP-15996-P and CENPD-282-P-A. The table also delineates those sections of CENPD-282-P-A which have been deleted.

### **3.0 Previous CENTS Code Changes Which Did Not Require Prior Review And Approval**

All revisions to the CENTS code since the original NRC submittal were evaluated using the guidance provided by 10 CFR 50.59. A screening process was employed to establish which CENTS modifications could be used without prior NRC review, and which changes would require licensee's to obtain NRC review and approval prior to being used. Following this process, it was determined that the following categories of changes to the CENTS do not require prior NRC review and approval:

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9. *CEA Ejection Accident SER Restriction Clarification*

The Nuclear Regulatory Commission (NRC) Safety Evaluation Report (SER) for CENPD-282-P-A contains the following restriction:

“...CENTS is not approved for performing CEA ejection licensing analyses. The CEA ejection analyses should be performed with the NRC approved ABB-CE methods of Reference-10 (Section-3.3).”

As stated this restriction is ambiguous with respect to exactly how CENTS may be used in regard to CEA ejection evaluations. Westinghouse believes this restriction meant that CENTS could not be used to evaluate the fuel failure aspect of the CEA ejection accident. This portion of the event was to be analyzed using the STRIKIN-II computer code as described in the quoted SER reference. However, CENTS could be used to analyze the NSSS thermal hydraulic response aspects of the event. This NSSS response information determined by CENTS is then used as input to the fuel failure analysis performed by STRIKIN-II in conformance with the quoted SER reference.

In support of this approach, Westinghouse notes that its response to RAI No. 3 ABB-CE stated:

“The CESSAR analysis of the CEA ejection event used CESEC to determine the NSSS response. However, this portion of the analysis is not limiting. The STRIKIN-II program was used to calculate the hot rod fuel temperature, heat flux, and the number of fuel rods which experience DNB. ABB-CE methods for the CEA ejection analysis are described in Reference 3.1.”

In further support of this usage, Westinghouse notes that the NRC has specifically approved such application of the CENTS code to CEA ejection analyses for the Arizona Public Service Company, Palo Verde Nuclear Generating Station Units 1, 2 and 3 in an SER issued on October 15, 2001<sup>1</sup>. In this SER, the NRC indicates that a benchmarking study was performed by APS to demonstrate that the predictions of the NSSS response by the CESEC and CENTS codes for the CEA ejection event are comparable, and that CENTS can replace CESEC in accident analyses to predict the NSSS response.

A detailed NRC review is not being requested for regarding the application of CENTS to the NSSS response portion of a CEA ejection event. Rather, Westinghouse is requesting that the NRC provide a clear statement of the acceptable application of this restriction when the SER for WCAP-15996-P, Rev. 0 is issued.

#### **4. Code Changes Requiring Prior Review and Approval**

Several methodology changes have been made to the CENTS code which require prior NRC review and approval prior to their using in licensing applications. These changes are being made to more accurately model the plant systems and transient behavior.

a. *Changes to the Main Steam Line Header Model*

Description

The revised CENTS header model is described in WCAP-15996-P, Volume 1, Section 5.6. The original model is described in CENPD-282-P-A, Section 5.6.

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<sup>1</sup> Letter, L. R. Wharton (NRC) to G. R. Overbeck (APS), “Palo Verde Nuclear Generating Station, Units 1, 2, and 3 - Issuance of Amendments re: Various Administrative Controls (TAC Nos. ME1668, MB1669, and MB1670)”, October 15, 2001

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*b. Steam Generator Tube Nodalization*

Description

The improved steam generator nodalization is described in WCAP-15996-P, Volume 1, Section 5.3. The original model is described in CENPD-282-P-A, Section 5.3.

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*c. Reactor Pressure Vessel Nodalization*

Description

The detailed primary side nodalization is described in WCAP-15996-P, Volume 1, Section 4.1. The original model is described in CENPD-282-P-A, Section 4.1.

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d. *SG Tube Rupture Model*

Description

The improved model is described in WCAP-15996-P, Volume 1, Section 5.7. The original model

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] is described in GENPD-282-P-A, Section 7.5.2

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e. *Dose Model*

Description

The new model is described in WCAP-15996-P, Volume 1, Section 5.8. [

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f. *Detailed Main Feedwater / Auxiliary Feedwater Model*

Description

The new model is described in WCAP-15996-P, Volume 1, Section 5.5. The original model is described in CENPD-282-P-A, Section 5.5.

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g. *Bubble Rise Velocity Used for Heat Transfer Coefficient for Bubble Condensation*

Description

The original model is described in CENPD-282-P-A, Section 4.6.3 where it is stated that the bubble rise velocity ( $V_D$ ) used in the calculation of the heat transfer coefficient for bubble condensation is assumed to be 2 ft/sec. However, this description is incorrect in that the coded bubble rise velocity is calculated as a function of the bubble radius. The model employed is one that was used in

RELAP4 Mod 7 and the CE Small Break LOCA Realistic Evaluation Model (this methodology has not been reviewed and approved by the NRC). The as coded model is the one now described in WCAP-15996-P, Volume 1, Section 4.6.3, in order to bring the description and the coding into congruence. In addition, the definitions of the terms used in the calculation of the heat transfer coefficient were clarified.

#### Reason for Change

The original topical report description was incorrect and inconsistent with the equation actually coded for use (which was itself correct).

#### Effect on Results

Since CENTS was always using the correct formulation, there is no effect on previous results. The only effect is on the correction of the topical report description of the model.

#### Planned use of this modification

The as coded model, correctly described in WCAP-15996-P, Volume 1, Section 4.6.3, will continue to be used in design basis accident analyses. NRC review and approval is requested.

### *h. Annulus Bubble Release Rate*

#### Description

The model description is given in WCAP-15996-P, Volume 1, Section 4.8.3. The original description is given in CENPD-282-P-A, Section 4.8.3. The governing equation was found to be incomplete as typed in CENPD-282-P-A in that the divisor was omitted. The equation for the bubble release rate from the annulus was presented as:

$$W_{\text{rele}} = 2 V_D \rho_g A \alpha$$

But should have included a divisor term as shown below:

$$W_{\text{rele}} = 2 V_D \rho_g A \alpha / (1 - \alpha)$$

#### Reason for Change

The original topical report description was incorrect and inconsistent with the equation actually coded for use (which was itself correct).

#### Effect on Results

Since CENTS was always using the correct formulation, there is no effect on previous results. The only effect is on the correction of the topical report description of the model.

#### Planned use of this modification

The as coded model now, correctly described in WCAP-15996-P, Volume 1, Section 4.8.3, will continue to be used in design basis accident analyses. NRC review and approval is requested.

### *i. RCS Line Break Models*

Previously, CENTS modeled all leaks from the RCS as a simple hole. An explicit model of a break in a branch line has been added. Also, an explicit model has been added to support the analysis of the letdown line break event. The new models are described in WCAP-15996-P, Volume 1, Section 4.21.1.

#### Reason for Change

The new models provide more detail and accuracy.

#### Effect on Results

CENTS is not used for loss-of-coolant accident (LOCA) calculations for the evaluation of regulatory compliance to 10 CFR 50.46 ECCS performance. Therefore, the improved model does not gain margin to these limits.

CENTS is used to analyze the letdown line break accident. However, this is not typically a limiting event. The new model is not expected to gain margin to regulatory limits.

Planned use of this modification

The improved model will be used in design basis accident analyses. NRC review and approval is requested.

*J. Feed Line Break Model*

Description

As discussed in CENPD-282-P-A, Volume 3, Sections 2.3.2 and 3.3.2, the analysis of the feedwater line break assumed that the fluid exiting the steam generator through the break consisted of only liquid water. This was accomplished by artificially locating (by input specification) the feedring at the top elevation of the tubesheet. This assumption is unnecessarily overly conservative for the analysis of plants which do not have economizer steam generators.

WCAP-15996-P, Volume 4, Section 3.4.2 describes a more realistic approach for analyzing this event for plants which do not have economizer steam generators. Specifically, the feedring is simply modeled (by input specification) to be at its actual physical elevation so that a steam blowdown commences when the steam generator downcomer water level drops below the feedring elevation. This change did not require a modification to CENTS algorithms since the feedring elevation is an input parameter.

Reason for Change

The previous modeling of the steam generator blowdown was non-physical and overly conservative.

Effect on Results

The effect of the change is discussed in section WCAP-15996-P, Volume 4, Section 3.4.2.1.

Planned use of this modification

This change in feedring modeling will be used in design basis accident analyses. NRC review and approval is requested.