Summary of November 2015, December 2015 and January 2016 Discussions of Draft Limitations and Conditions and Supplemental Information for the FULL SPECTRUM LOCA (FSLOCA) Evaluation Model (Non-Proprietary)

January 2016

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Summary of November 2015, December 2015, and January 2016 Discussions on Draft Limitations and Conditions and Supplemental Information for the FULL SPECTRUM LOCA (FSLOCA) Evaluation Model

In order to provide context for the discussion in this letter, the draft limitations and conditions proposed by the Nuclear Regulatory Commission (NRC) for the FULL SPECTRUM™ LOCA (FSLOCA™) evaluation model (EM) as discussed in the November 2015 meeting are included here in italics.

Draft Item #1

The FSLOCA EM applicability for performing PWR LOCA analyses is defined in terms of applicable accident transient phases so that the FSLOCA EM cannot be applied for analyzing the long-term core cooling phase of LOCA transients for the purpose of demonstrating compliance with the long-term core cooling requirement set forth in 10 CFR 50.46(b)(5). This limitation specifically addresses the condition that the FSLOCA EM does **[**

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Draft Item #2

The FSLOCA EM applicability for performing PWR LOCA analyses is defined in terms of applicable types of PWR plants so that the EM can be applied for LOCA analyses of Westinghouse designed three-loop and four-loop PWR plants only.

Draft Item #3

The coupled W̲COBRA/TRAC-TF2 and COCO codes will be applied to calculate the containment backpressure in PWR LOCA analyses for Region II so that a conservatively low, although not explicitly bounded, containment pressure will be predicted and used. For this purpose, the input to the COCO model and its prediction results will be based on appropriate plant-specific containment design parameters and initial conditions and will simulate accordingly engineered safety features and installed systems capable of affecting the containment pressure including their actuation, performance, and associated processes. The following specific limitations will apply for Region II analyses using the FSLOCA EM: **[**

]^{a,c} *(2) an acceptable plant-specific*

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initial containment temperature will be determined based on input from the utility for the purpose of modeling the containment pressure response with COCO; (3) unqualified or indeterminate coatings throughout containment and qualified coatings within the break jet zone-of-influence will not be credited for the purpose of modeling the containment pressure response using COCO consistent with the bounding treatment of this parameter (conservatively low containment pressure).

Draft Item #4

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Draft Item #5

The maximum assembly average burnup will be limited to [ ]^{a,c} and the maximum peak rod length-average burnup will be limited to [ ]^{a,c} within the FSLOCA EM.

Draft Item #6

In the FSLOCA EM applications for PWR LOCA analyses, an NRC approved version of the PAD 5.0 code will be used as a fuel performance code interfaced with <u>W</u>*COBRA/TRAC-TF2.*

Draft Item #7

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Draft Item #8

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Draft Item #9

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Draft Item #10

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<u>Draft Item #12</u>

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<u>Draft Item #13</u>

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<u>Draft Item #14</u>

Use of the Cathcart-Pawel correlation for oxidation will require the maximum local oxidation limit to be set at 13%.

Westinghouse had no comments regarding draft items 1, 2, 4, 5, 7, 8, 12, and 13. Discussion of draft items 3, 6, 9, 10, 11, and 14 follows.

<u>Draft Limitation and Condition #3</u>

The discussion in the November 2015 meeting was focused on the following aspect of the draft limitation and condition:

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In the meeting, Westinghouse agreed to provide supporting information regarding the removal of this aspect of the draft limitation and condition. That information is provided as follows.

LOTIC2 Code Version

When the Automated Statistical Treatment of Uncertainty Method (ASTRUM) EM [1] was approved, the LOTIC2 code version was 5.0. Due to maintenance of the code, there were two versions (6.0 and 7.0) that were released subsequent to the approval of the ASTRUM EM. The changes that were implemented in Versions 6.0 and 7.0 were reported to the NRC in LTR-NRC-12-37 [2] (LOTIC2 Error Corrections) and LTR-NRC-13-16 [3] (General Code Maintenance), and were estimated to have a negligible impact on peak cladding temperature (PCT) calculations.

The D. C. Cook Unit 2 ASTRUM analysis (transmitted to the NRC in AEP-NRC-2009-23 [4]) utilized LOTIC2 Version 5.0. The LOTIC2 calculation with Version 5.0 (shown on page 26 of Enclosure 2 to AEP-NRC-2009-23) was repeated with Version 7.0, with no changes to the input. The result is presented in Figure 3-1; it can be seen that the [

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Method to Determine Containment Pressure

For analyses with the ASTRUM EM, there was a step to perform a confirmatory study prior to executing the uncertainty analysis. The transient that resulted in the limiting configuration from the confirmatory study was referred to as the reference transient. The [

]^{a,c} For the D. C. Cook Unit 2 ASTRUM analysis, the <u>W</u>COBRA/TRAC reference transient input containment pressure and the associated LOTIC2-calculated containment pressure are shown in the figure on page 26 of Enclosure 2 to AEP-NRC-2009-23.

A flow map of the method to calculate the containment pressure for ice condenser containment designs is presented as Figure 3-2. The same method is used for ice condenser containment designs within the FULL SPECTRUM methodology. Since there is no confirmatory study or "reference transient" in the FSLOCA methodology, a representative transient is used as a surrogate for the ASTRUM reference transient, with key parameters set to minimize the mass and energy releases (hence the containment pressure). For example, the representative transient is based on a low vessel average temperature (less fluid energy) and a maximum steam generator tube plugging (less reactor coolant system (RCS) primary side fluid volume).

Review of Changes in COCO Modeling Assumptions Relative to LOTIC2

During the licensing of the FULL SPECTRUM LOCA EM, there was a Request for Additional Information (RAI) 46 regarding COCO, and several later clarifications regarding the RAI response that were transmitted to the NRC staff. As discussed in the RAI response and subsequent clarifications, a number of changes to the COCO code and modeling assumptions were made either due to the coupling with WCOBRA/TRAC-TF2 or as a result of the licensing process. These changes were reviewed to identify any differences relative to LOTIC2, which are discussed in the following paragraphs.

LTR-NRC-13-73 [5]: Several updates were made to the standalone COCO code in order to couple it with WCOBRA/TRAC-TF2 as described in the letter. The LOTIC2 code is not coupled with WCOBRA/TRAC-TF2 in any way; as such, no such changes were made to the standalone LOTIC2 code.

LTR-NRC-13-73: Generic values were determined for the *end-of-blowdown time* and *integral of break energy released to containment during blowdown* COCO inputs as described in the letter. No such values need be determined by the user for LOTIC2 because the blowdown calculation is different (refer to Sections 2 and 4.1 of the approved LOTIC2 topical report WCAP-8354-P-A, Supplement 1 [6]) and there are no corresponding inputs in LOTIC2.

LTR-NRC-13-73: Consistent with the prior approved best-estimate EMs, **[**

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LTR-NRC-14-60: The modeling of paint on containment structures and the initial containment temperature for LOTIC2 will follow the same approach described in LTR-NRC-14-60 for COCO.

LTR-NRC-14-60: The generic end-of-blowdown time and integral of break energy released to containment during blowdown are not applicable to LOTIC2 as discussed under LTR-NRC-13-73.

LTR-NRC-15-70 [8]: The **[**

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Example Ice Condenser Containment Pressure Calculation

The LOTIC2 code has no direct interface with the thermal-hydraulic code. The mass and energy releases from the thermal-hydraulic code (WCOBRA/TRAC for the ASTRUM EM or WCOBRA/TRAC-TF2 for the FSLOCA EM) are extracted by the analyst and then entered via tables into the LOTIC2 code. It was previously shown that the current version of LOTIC2 produces the [

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As previously mentioned, the D. C. Cook Unit 2 WCOBRA/TRAC reference transient input containment pressure and the associated LOTIC2-calculated containment pressure are shown in the figure on page 26 of Enclosure 2 to AEP-NRC-2009-23 for the ASTRUM analysis. This figure has been included herein as Figure 3-3.

The process previously outlined was used to determine an appropriate containment pressure boundary condition for WCOBRA/TRAC-TF2 within the FSLOCA EM. A WCOBRA/TRAC-TF2 transient with conditions as similar to the ASTRUM reference transient as reasonably achievable was used (recognizing that there will be some differences in the mass and energy releases from the ASTRUM case). A comparison of the assumed WCOBRA/TRAC-TF2 containment pressure boundary condition versus the LOTIC2-calculated containment pressure is given in Figure 3-4. It can be seen that [

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Additional Information from January 2016 Discussion

1) Initial Containment Pressure: The initial containment pressure for the results presented in Figure 3-4 was set to [ ]^{a,c} psia simply for consistency with the initial pressure analyzed in the ASTRUM analysis (presented in Figure 3-3). However, for analyses with the FSLOCA EM, the containment pressure will be initialized as described in Appendix A, Section A.1, Item I.A. of WCAP-8339 [21] (discussion is applicable for both COCO and LOTIC2 as identified at the beginning of the appendix). Specifically, the [
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2) Increase in Calculated Containment Pressure During Transient: It was observed that the LOTIC2-calculated containment pressure presented in Figure 3-4 based on WCOBRA/TRAC-TF2 (for the FSLOCA methodology) increases from about 40 to 80 seconds. This increase is primarily due to the injection of the accumulators. The accumulator injection is capable of pushing liquid into the bottom of the core, which then contacts the hot fuel rods and generates steam. This steam causes a re-pressurization in the reactor coolant system and results in additional mass and energy release into containment. Additionally, and perhaps even more

important, is that once the accumulators empty, the non-condensable cover gas enters into containment.

A sensitivity case was executed with LOTIC2 where the only difference from the result presented in Figure 3-4 was to not model the injection of the accumulator cover gas into containment (the mass and energy releases were not modified, as it is not easy to separate the contribution from the accumulators). The resulting LOTIC2-calculated containment pressures from the base case and the sensitivity study are compared in Figure 3-5. It can be seen that the LOTIC2-calculated containment pressure for the sensitivity study without the accumulator cover gas modeled does not show the same pressure increase that was observed in the base case, which supports the assertion that the increase in the calculated containment pressure is the result of accumulator injection.

3) <u>Convergence of Results</u>: There was a question during the discussion as to whether convergence has been obtained between the <u>W</u>COBRA/TRAC-TF2 and LOTIC2 codes. It was pointed out that the [

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Draft Limitation and Condition #6

In the November 2015 meeting it was discussed that there is an expectation that fuel performance codes would be updated over time to account for new data and potentially new phenomena that were not previously recognized. This draft limitation and condition (as currently written) would restrict the FULL SPECTRUM LOCA evaluation model to an NRC-approved version of the PAD5 code. The concern with the limitation is that it would not allow for the use of newer versions of the PAD fuel performance code which may be reviewed and approved by the NRC.

In the November 2015 meeting, the NRC took an action to modify the restriction in recognition that fuel performance codes will be updated over time. The updated language would allow the use of newer PAD versions which are reviewed and approved by the NRC.

In revising the draft limitation and condition, it is requested that implementation of the draft limitation and condition be considered from the perspective that review of plant-specific LOCA submittals as well as methodology topical reports can both span several years. As such, the limitation and condition should accommodate plant-specific analysis submittals which use a prior approved version of the PAD fuel performance code, should a newer PAD version be approved during the review of the plant analysis submittal.

Draft Limitation and Condition #9

In the November 2015 meeting, Westinghouse discussed that this draft limitation and condition should be removed based on supplemental information which would be provided to the NRC, and similarities of the effect of the parameters studied across various plant classes. The NRC noted that certain plant classes have unique features and questioned whether the information based on a Westinghouse-designed 3-loop pressurized water reactor (PWR) may be different for other plant classes. Upon further consideration, Westinghouse agrees that the draft limitation with respect to the model uncertainty contributors is appropriate for plant classes other than Westinghouse-designed 3-loop PWRs. As such, Westinghouse does not request the removal of this draft limitation and condition. Rather, Westinghouse proposes several modifications to the draft language [

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Break Area Sampling, Background

In order to provide context around the sensitivity studies that were executed regarding the break size sampling, some background is first provided regarding the break sampling approach within the FSLOCA EM.

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[1] The effect of sampling the break discharge coefficients was assessed because they directly influence the sampled break area, resulting in what is generally referred to as the "effective break area". The impact of sampling these uncertainties is described in 29.1.1 of WCAP-16996-P, Revision 1.

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Break Area Sampling, Sensitivity Studies

Given that background, additional break area sampling sensitivity studies were executed based on the Region I demonstration analysis in WCAP-16996-P, Revision 1 [12] (the same studies which were previously discussed in the context of the [

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The peak cladding temperature from the limiting transient for each sensitivity study with biased uncertainty parameters is shown in Figure 9-4, with the time scale shifted such that boiloff uncovery starts at the same time for all 4 transients. It can be seen that the [

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Less Prescriptive Means to Demonstrate Uncertainty Parameter Sensitivities

The current language in the draft limitation and condition is very prescriptive. It would preclude the use of parametric sensitivity studies, or other means of being able to assess the sensitivity of the uncertainty contributors individually. As such, it is requested that the language be written in a manner that is less prescriptive for how to demonstrate the desired sensitivities.

Conclusion

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The topical report will be updated prior to issuing the approved version to reflect this change.

Draft Limitation and Condition #10

The discussion in the November 2015 meeting focused on three different aspects of the draft limitation and condition.

1) First, it was discussed that this limitation and condition should not apply to Westinghouse-designed 3-loop plants since it was already demonstrated as part of the methodology licensing. Additional information is also provided herein relative to the three-loop Westinghouse designed plant.

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3) Third, Westinghouse requested [

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Draft Limitation and Condition #11

The following was proposed after the November 2015 discussion with the NRC.

The FSLOCA EM uncertainty methodology is described in Section 30 of the topical report (WCAP-16996-P, Revision 1). Following the submittal of Revision 1 of the topical report, and in part stemming from an October 7, 2015 meeting between Westinghouse and the NRC, adjustments to the uncertainty methodology were made to [

]^{a,c} The summary of the meeting and these updates were provided in LTR-NRC-15-88 [13].

In general, the FSLOCA EM uncertainty methodology relies on non-parametric order statistics, [

]^{a,c} The population of calculated results arises from the geometric model of the PWR being analyzed, the predictive tool (WCOBRA/TRAC-TF2), and the various uncertainty contributors and their associated distributions. Uncertainty contributors include the postulated accident scenario and boundary conditions, plant initial conditions, and code or model uncertainties.

Because it is impractical to fully resolve the population of predicted results, manageable sample sizes are used to make a bounding estimate of the 95th quantile. Assuring that this bounding estimate of the 95th quantile for each of the outcomes meets its acceptance criterion, and since the population of predictions known to be conservative relative to experimental benchmarks, "high probability" is assured that the acceptance criteria would be met in the event of an accident.

A consequence of making only a bounding prediction is that a confidence level must be specified. In the FSLOCA EM, consistent with prior licensed EMs, a 95% confidence level is used; in each analysis, it is assured with 95% confidence that the bounding prediction succeeds and bounds the true 95th quantile of the population of predicted results. The bounding predictor is referred to as the 95/95 predictor.

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The topical report will be also be updated prior to issuing the approved version to reflect this change.

In the January 2016 phone call, the NRC asked for a concise explanation of how Westinghouse would comply with this draft limitation and condition.

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Draft Limitation and Condition #14

In the November 2015 discussion, the NRC staff indicated that this limitation stemmed from the use of the Baker-Just correlation to convert the time-at-temperature into equivalent cladding reacted for the data which resulted in the current 10 CFR 50.46 oxidation criterion of 17%. The discussion in RIL 0202 [14] indicated that the use of Cathcart-Pawel considering the same data would result in a limit of approximately 13%. Westinghouse did not agree that this limitation and condition was appropriate for the FULL SPECTRUM LOCA evaluation model, and provided several supporting reasons in the November 2015 discussion. The NRC staff requested that Westinghouse provide those reasons for consideration, which is done in the following paragraphs.

1) <u>At beginning-of-life (BOL), NRC-sponsored research indicates that cladding ductility is maintained beyond 17% Cathcart-Pawel (CP) equivalent cladding reacted (ECR)</u>. The NRC has sponsored post-quench ductility (PQD) testing at Argonne National Laboratory (ANL) in support of the 10 CFR 50.46c rulemaking. A summary of the results from this testing is presented on page 40775 of the Federal Register [15]. It can be seen that at BOL, cladding ductility is maintained for data points up to roughly 20% CP-ECR. A ductile-to-brittle CP-ECR level was presented in Figure 2 of the update to RIL 0801 [16], which shows a transition of just over 18% at BOL. Finally, an acceptable analytical limit for CP-ECR presented in Figure 2 of a draft of RG 1.224 [17] is 18% CP-ECR at BOL.

2) <u>After beginning-of-life, the upper bound, steady-state corrosion accounted for in the FSLOCA EM is transparent to the correlation used to translate the LOCA transient time-at-temperature to an ECR</u>. Prior Westinghouse best-estimate LOCA EMs only accounted for the LOCA transient oxidation when comparing against the 17% acceptance criterion. However, for the FSLOCA EM, the sum of the LOCA transient oxidation and the upper bound steady-state corrosion is compared against the current 10 CFR 50.46 acceptance criterion of 17% consistent with the recommendation in IN 98-29 [18]. The contribution of the steady-state corrosion, which [ ]^{a,c} (e.g. Figure 31.4-6 of WCAP-16996-P, Revision 1), is transparent to the selection of the correlation used to convert the transient time-at-temperature to an ECR. The comparison of the total oxidation to anything other than a 17% acceptance criterion is inconsistent with the guidance in IN 98-29 regarding the treatment of the pre-existing corrosion.

3) <u>The current regulation (10 CFR 50.46) does not require the use of Baker-Just for best-estimate EMs, and regulatory guidance indicates the use of Cathcart-Pawel for best-estimate EMs is acceptable</u>. A review of the 10 CFR 50.46 regulation indicates that the use of Baker-Just is required for Appendix K EMs. However, there is no stated requirement to use the Baker-Just correlation for best-estimate EMs in the regulation. A review of associated Regulatory Guide (RG) 1.157 indicates that the use of Cathcart-Pawel is acceptable under certain conditions. As such, the regulatory guidance associated with LOCA analysis supports the use of the Cathcart-Pawel correlation.

4) The NRC has previously found acceptable and approved best-estimate LOCA EMs which use correlations such as Cathcart Pawel (or other correlations besides Baker Just) to convert the transient time-at-temperature into an ECR and then compare against a 17% oxidation criterion.

5) The 17% versus 13% is based on LOCA transient oxidation at 2,200°F. The use of 13% as mentioned in RIL 0202 versus the 17% acceptance criterion is believed to be specific to the conversion of LOCA transient time-at-temperature to ECR based on oxidation at 2,200°F. A comparison of the Baker-Just weight gain normalized to Cathcart-Pawel is presented in Figure 2 of an Argonne National Laboratory report from June 2002 [19]. At 2,200°F, the ratio of Baker-Just to Cathcart-Pawel weight gain is about 1.3 to 1 (17% / 1.3 = ~13%). As the oxidation temperature decreases from 2,200°F the two correlations begin to converge (i.e., the difference becomes smaller). The **[**

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Proposed Updates to Select Limitations and Conditions

This section contains the proposed updates to the draft limitations and conditions based on the previous discussion in this letter. Additions are shown in **blue, bolded text** and removals are shown in red text with strikeouts.

Draft Item #3

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Draft Item #6

NRC action

Draft Item #9

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Draft Item #10

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Draft Item #11

Propose replacement of draft limitation and condition with the following

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Draft Item #14

Propose replacement of draft limitation and condition with the following, which has the same intent as the NRC-proposed wording but more detail for completeness:

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References

1) WCAP-16009-P-A, "Realistic Large-Break LOCA Evaluation Methodology Using the Automated Statistical Treatment Of Uncertainty Method (ASTRUM)," January 2005.

2) LTR-NRC-12-37, "10 CFR 50.46 Annual Notification and Reporting for 2011," July 9, 2012.

3) LTR-NRC-13-16, "10 CFR 50.46 Annual Notification and Reporting for 2012," April 1, 2013.

4) AEP-NRC-2009-23, "License Amendment Request Regarding Large Break Loss-of-Coolant Accident Analysis Methodology," March 19, 2009 (ADAMs accession # ML090930453).

5) LTR-NRC-13-73, "Submittal of Westinghouse Responses to 'WCAP-16996-P, 'Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FULL SPECTRUM LOCA Methodology)' Request for Additional Information - RAIs 46 – 58, 75 and 77' (Proprietary/Non-Proprietary), Project 700, TAC No. ME5244," October 28, 2013.

6) WCAP-8354-P-A, Supplement 1, "Long Term Ice Condenser Containment Code – LOTIC Code," April 1976.

7) LTR-NRC-14-60, "Summary of August 2014 NRC Audit Part 1 of the FULL SPECTRUM LOCA (FSLOCA) Evaluation Model" (Proprietary/Non-Proprietary), Project 700, TAC No. ME5244," September 17, 2014.

8) LTR-NRC-15-70, "Summary of June 2015 NRC Audit Part 2 of the FULL SPECTRUM LOCA (FSLOCA) Evaluation Model (Proprietary/Non-Proprietary)," September 16, 2015.

9) LTR-NRC-13-70, "Summary of July 2013 NRC Code Workshop and August 2013 NRC Audit of the FULL SPECTRUM LOCA (FSLOCA) Evaluation Model (Proprietary/Non-Proprietary)," October 10, 2013.

10) WCAP-16996-P, Revision 0, "Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FULL SPECTRUM LOCA Methodology)," November 2010.

11) LTR-NRC-14-29, "Summary of May 2014 NRC Audit of the FULL SPECTRUM LOCA (FSLOCA) Evaluation Model (Proprietary/Non-Proprietary), Project 700, TAC No. ME5244," June 5, 2014.

12) WCAP-16996-P, Revision 1, "Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FULL SPECTRUM LOCA Methodology)," 2015.

13) LTR-NRC-15-88, "Summary of October 2015 NRC Audit of the FULL SPECTRUM LOCA (FSLOCA) Evaluation Model (Proprietary/Non-Proprietary)," October 12, 2015.

14) Research Information Letter 0202, "Revision of 10 CFR 50.46 and Appendix K," June 20, 2002.

15) Federal Register, Volume 74, Number 155, "Proposed Rules: Performance-Based Emergency Core Cooling System Acceptance Criteria," August 13, 2009.

16) Letter from B. W. Sheron to E. J. Leeds and M. R. Johnson, "Update to Research Information on Cladding Embrittlement Criteria in 10 CFR 50.46," December 29, 2011(ADAMS accession ML113050484).

17) RG 1.224 (Preliminary Draft), "Establishing Analytical Limits for Zirconium-Alloy Cladding Material," 2015 (ADAMS accession ML15281A192).

18) Information Notice 98-29, "Predicted Increase in Fuel Rod Cladding Oxidation," August 3, 1998.

19) Letter from M. C. Billone to H. H. Scott, "Steam Oxidation Kinetics of Zirconium Alloys," June 2002 (ADAMS accession ML021680052).

20) NUREG-1475, Revision 1, "Applying Statistics," March 2011.

21) WCAP-8339, "Westinghouse Emergency Core Cooling System Evaluation Model – Summary," June 1974.

22) WCAP-12610-P-A & CENPD-404-P-A, Addendum 2-A, "Westinghouse Clad Corrosion Model for *ZIRLO* and *Optimized ZIRLO*," October 2013.

23) LTR-NRC-15-82, "Summary of September 2015 NRC Audit of the FULL SPECTRUM LOCA (FSLOCA) Evaluation Model (Proprietary/Non-Proprietary)," September 28, 2015.

24) LTR-NRC-13-40, "Submittal of Westinghouse Responses to 'WCAP-16996-P, 'Realistic LOCA Evaluation Methodology Applied to the Full Spectrum of Break Sizes (FULL SPECTRUM LOCA Methodology)' Request for Additional Information' (Proprietary/Non-Proprietary), Project 700, TAC No. ME5244," June 13, 2013.

Figure 3-1: Comparison of Containment Pressure from LOTIC2 Version 5.0 and 7.0 with Identical Inputs

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Figure 3-2: Process for Calculating Containment Pressure for Ice Condenser Containment

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Figure 3-3: Figure 17 from AEP-NRC-2009-23, D. C. Cook Unit 2 ASTRUM Analysis Containment Pressure Comparison

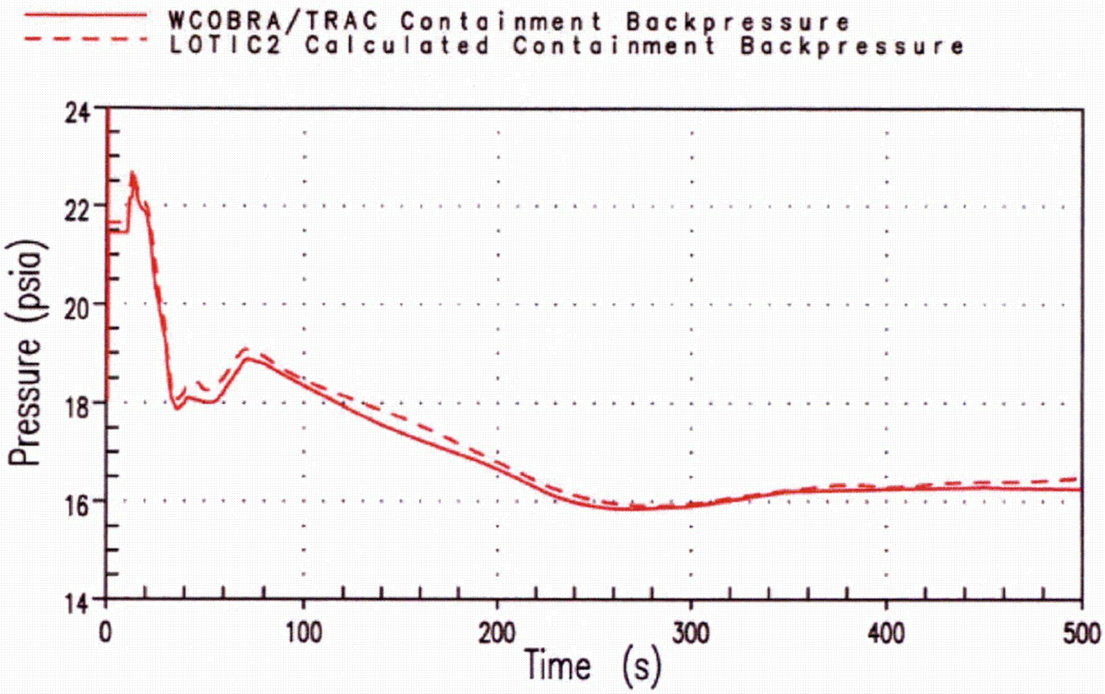

Figure 3-4: D. C. Cook Unit 2 Containment Pressure Comparison with Mass and Energy Releases from WCOBRA/TRAC-TF2

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Figure 3-5: Comparison of LOTIC2-Calculated Containment Pressure with and without Accumulator Cover Gas Modeled

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Figure 3-7: Comparison of WCOBRA/TRAC-TF2 Containment Pressure Boundary Condition and LOTIC2-Calculated Containment Pressure for All Three Iterations

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Figure 9-1: Figure 7.37 of NUREG-1829 V1

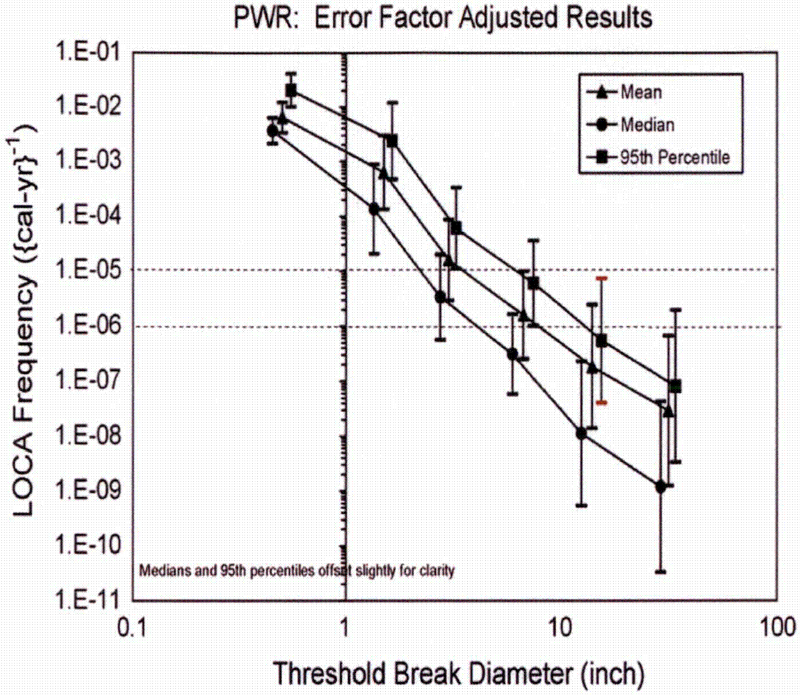

Figure 9-2: From Los Alamos National Lab presentation, May 9, 2012 ACRS transcripts

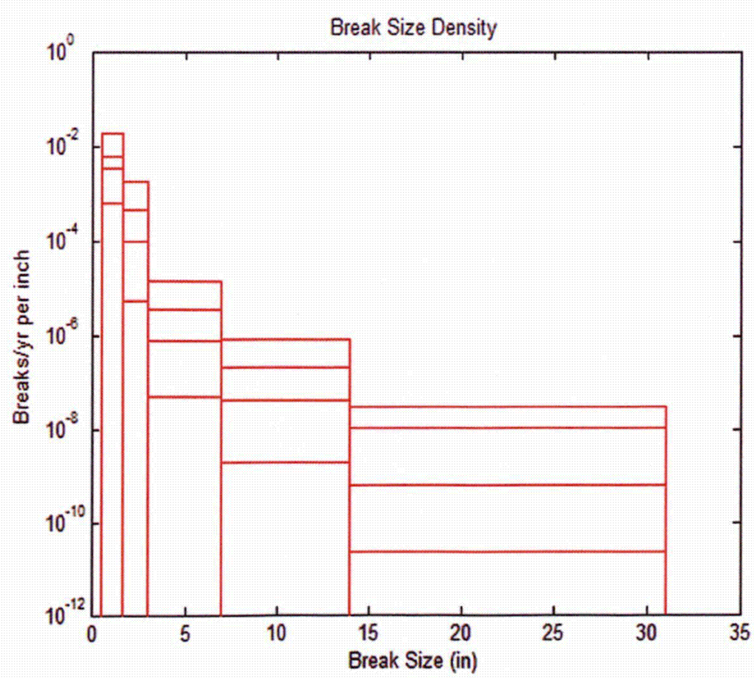

Figure 9-3A: Analysis Peak Cladding Temperature for Region I Studies with Different Break Area Sampling Ranges Compared to the Region I Break Spectrum Study

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Figure 9-3B: Average Transient Peak Cladding Temperature for Region I Studies with Different Break Area Sampling Ranges

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Figure 9-4: Peak Cladding Temperature for the Limiting Transient from Each Break Area Sampling Sensitivity Study with [

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Figure 10-1: Peak Cladding Temperature vs. Break Diameter (Figure 4-1 from LTR-NRC-14-29)

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Figure 10-2: Peak Cladding Temperature vs. Time for a Resonance Region Break and a Larger Diameter Break (Figure 4-2 from LTR-NRC-14-29)

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Figure 10-3: Peak Cladding Temperature vs. Effective Break Diameter from Demonstration Analysis

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Figure 10-4: Peak Cladding Temperature vs. Time for the Limiting Region I Break, Several Smaller Region II Breaks, and the Limiting Region II Large Break

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Figure 11-1: Illustration of Perceived Concern

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Figure 11-2: Result Not Demonstrating Compliance

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Figure 11-3: Result Demonstrating Compliance

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Figure 11-4 – Predicted [ ]^{a,c}

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