AUDIT REPORT RELATED TO WCAP-17202-P, 17203-P, 16747-P and 17116-P SAFETY EVALUATIONS

A. Background

By letters dated June 30, 2010, South Texas Project Nuclear Operating Company (STPNOC), now Nuclear Innovation North America, LLC (NINA), submitted topical reports (TRs) WCAP-17202-P and WCAP-17203-P for the U.S. Nuclear Regulatory Commission (NRC) staff review and approval. WCAP-17202-P, "Supplement 4 to BISON Topical Report RPA 90-90-P-A," describes new methods and models for the BISON code to extend its capability to model all limiting and non-limiting transients required for a first-time transient analysis application. WCAP-17203-P, Revision 0, "Fast Transient and ATWS Methodology," describes the Westinghouse methodology of the evaluation model for non-limiting and limiting anticipated operational occurrences (AOOs) including anticipated transients without scram (ATWS) and infrequent events.

By letter dated October 29, 2010, STPNOC, now NINA, submitted for the NRC staff review TR WCAP-16747-P, "POLCA-T: System Analysis Code with Three-Dimensional Core Model, Appendices C and D." WCAP-16747-P intends to provide qualification for applying the POLCA-T code to the Advanced Boiling Water Reactor design and boiling water reactors (BWR/2-6).

By letter dated September 30, 2009, STPNOC, now NINA, submitted WCAP-17116-P, Revision 0, "Westinghouse BWR ECCS Evaluation Model: Supplement 5 – Application to the ABWR," for NRC staff review and approval. This TR describes the basis for extending the applicability of the computer code GOBLIN to the ABWR and supports South Texas Project Units 3 and 4 Final Safety Analysis Report (FSAR) Section 6.3, "Emergency Core Cooling Systems."

The NRC's Office of Nuclear Reactor Regulation (NRR) and Office of New Reactors (NRO) and NRC/NRO contractor Energy Research, Inc. (ERI) are performing a technical review of these TRs to determine their adequacy using the guidelines and criteria delineated in NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition" (SRP), Chapter 15, "Transient and Accident Analysis." In the process, the staff prepared and submitted a round of requests for additional information (RAIs) to STPNOC/NINA on November 19, 2010, for WCAP-17203-P, and on April 12 and 18, 2011, for WCAP-17202-P.

NINA submitted responses to these RAIs in seven separate sets between January 18, 2011, and July 5, 2011. The NRC and ERI evaluated these responses and determined that several of the issues remained unresolved. The staff decided that an audit at the Westinghouse-Sweden site would be the best forum in which NRC/NRO and ERI could examine documents that would resolve these remaining open items.

On September 14-16, 2011, the audit team consisting of George Thomas and James Gilmer of NRC/NRO and Mohsen Khatib-Rahbar of ERI visited the Westinghouse offices in Västerås, Sweden and undertook an audit of the Westinghouse ABWR/BWR methodologies.

Enclosure

The staff inspected the NINA/Westinghouse quality assurance (QA) program in parallel with the regulatory audit as part of the vendor inspection. The results of the inspection are documented in the inspection report available at Agencywide Documents Access and Management System (ADAMS) Accession No. ML11300A148.

B. Regulatory Audit Bases

This audit was based on the following:

- 10 CFR 50.46, "Acceptance Criteria for Emergency Core Cooling Systems for Light-Water Nuclear Power Reactors"
- SRP Section 15.0.2, "Review of Accident and Accident Analysis Methods"
- Regulatory Guide 1.203, "Transient and Accident Analysis Methods"

C. Regulatory Audit Scope or Methodology

The staff is reviewing TRs WCAP-16747-P, WCAP-17116-P, WCAP-17202-P, and WCAP-17203-P against the guidelines in Standard Review Plan Section 15.0.2 for (a) documentation, (b) evaluation model, (c) accident scenario identification process, (d) code assessment, (e) uncertainty analysis, and (f) QA.

The focus of the audit was to discuss with NINA the RAIs and responses related to technical issues associated with the above TRs in future applications to the ABWR analyses. Section G of this audit report identifies these issues.

The NRC supplied the audit plan (ADAMS Accession No. ML112411278) to the applicant prior to the visit. The material presented during the audit was a direct response to the audit plan and addressed the elements as discussed below.

D. Logistics

The audit took place from September 14-16, 2011, at Westinghouse's Sweden office:

Location: Westinghouse Electric Sweden AB
SE-721 63 Västerås, Sweden

Audit Team Members: The following NRC staff members and contractors participated substantively in the audit:

- George Thomas, NRC/NRO Technical Reviewer
- James Gilmer, NRC/NRO Technical Reviewer
- Mohsen Khatib-Rahbar, ERI

E. Applicant Participants

The following applicant or applicant-supporting personnel participated in the audit:

- Jim Tomkins, NINA
- Mattias Lodin, Westinghouse
- Yonatan Dag, Westinghouse
- Patricia Quaglia, Westinghouse
- Johan Hallen, Westinghouse
- Nicole Brichacek, Westinghouse
- Björn Thörnstrom, Westinghouse
- Lena Olsson, Westinghouse
- Elisabeth Rudbäck, SSM
- Jan In de Betou, SSM (Swedish Radiation Safety Authority)
- Riku Mattila, STUK (Finnish Radiation and Nuclear Safety Authority)
- Jenni Laine, STUK
- P.M. Heinemann, Interpreter

F. Audit Items Status or Means of Resolution

The audit covered several technical items (each corresponding to an open item from inadequately resolved RAIs) and several NINA QA program items related to software development, software maintenance, software documentation, training, and software use. Westinghouse's presentations addressed each of the identified items sequentially and allowed time for auditor questions and feedback. Following the presentation and discussions, the NRC reviewers and NINA/Westinghouse agreed on the means by which most of the audit issues would be disposed and documented.

G. Overall Audit Summary

1. The applicant has not verified that the plant parameter inputs to three different computer codes (i.e., GOBLIN, BISON, and POLCA-T) are used in a consistent manner. The staff notes that it is desirable for different individuals and/or groups to use plant design parameters consistently across computer code domains. **The staff issued GOBLIN RAI-49 to close the issue.**

2. Follow-up of the safety evaluation report (SER) conditions and limitations as applicable to post-SER methodology use for safety analysis are not formalized at Westinghouse-Västerås and Westinghouse-Windsor even though the checklist included in the Westinghouse-Cranberry calculation notes verifies the NRC SER requirements. **The staff issued GOBLIN RAI-50 to close the issue.**

3. The staff expressed concerns regarding the technical approach Westinghouse used to address several RAIs. Westinghouse staff accepted the NRC audit team's concerns and agreed to address these concerns in the responses as part of the official submission. Examples include:

    - Steam Dome Condensation Model - This model is physically inadequate (as discussed in RAI 34 related to BISON) and lacks fundamental basis.

The current model is nothing more than a tuning of BISON results against integral plant tests at the Hamaoka-5 plant.

- Validation of GOBLIN ADS critical flow model against tests (e.g., Marviken or EPRI tests) is desirable; however, Westinghouse was not able to provide an English translation of an old report in Swedish that compares the GOBLIN homogeneous equilibrium model (HEM) against the Marviken data in time for the audit. Instead, Westinghouse showed a comparison of the HEM model against the Moody critical flow model that showed reasonable (and conservative in terms of ADS flow) agreement. The staff notes that 10 CFR Part 50, Appendix K requires use of the Moody critical flow model for LOCA calculations. On the other hand, since the use of HEM results in a slightly lower discharge flow through the ADS valves, Westinghouse argued this would result in a slightly slower depressurization, which both Westinghouse and the staff viewed as conservative.

4. Westinghouse demonstrated example calculations using BISON and POLCA-T, including processes used to modify default code inputs.

The text below summarizes the RAIs identified in the audit plan and their agreed-upon status discussed during the exit summary as presented by NRC.

Issues related to WCAP-17202-P (BISON)

1. Recirculation Pump Model Parameters and Validation Basis (RAI-15.00.02-5 and RAI 15.00.02-6)

RAI-15.00.02-5:

*Per Section 2.2 of WCAP-17202, the ability of the recirculation pump model to adequately represent the reverse flow appears to be determined by the **[[***

]]

a. *Discuss the physical basis that **[[***

]]

b. *Explain the basis for these inputs, including any plant-specific pump test data, to be applied to ABWR analyses. Explain how these parameters were selected for the Hamaoka 5 integral validation studies.*

RAI-15.00.02-6:

Section 2.3 of WCAP-17202 describes the validation of the recirculation pump model performed against data from the Hamaoka 5 plant.

a. *Consistent with the SRP Section 15.0.2.III.2.D guidance, please indicate if the recirculation pump model has been compared against manufacturer's curves or curves for pumps with similar specific speeds over the entire range* *of pump operation (including the energy dissipation regime where speed > 0 and flow < 0).*

b. Consistent with the SRP guidelines in Section 15.0.2.III.2.E related to the use of plant data for model validation, provide the uncertainty associated with the plant test data.

Resolution: Westinghouse clarified the statement on page 2-2 of WCAP-17202-P regarding the conditions for stopped pump, and stated that this clarification will be included in the pending response to RAI 15.00.02-5.

Westinghouse used the results of tests performed for the reactor internal recirculation pumps for the Oskarshamn nuclear power plant, which are very similar to those of ABWR, to define the pump characteristics in BISON for applications to ABWR. Westinghouse stated that the specific speed for the ABWR pump is comparable to that of the test data, justifying the applicability of the data to ABWR.

Westinghouse clarified that no separate test data are available for head versus flow characteristics. However, some limited manufacturer data are available over a limited pump operating range. Westinghouse extrapolated this data to other regimes and used it together with Oskarshamn test data to formulate the pump characteristics. Westinghouse then compared the model against the reactor internal pump trip test performed at Hamaoka Unit 5. The audit reviewers expressed concerns about the extrapolation approach and requested justification. This information, along with the available data, is expected to be provided as part of the response to RAI 15.00.02-6.

Westinghouse will present the pump characteristics based on measured data and will show that the measured data are applicable to the ABWR (and confirmatory benchmarking using the pump trip test performed at Hamaoka Unit 5 reactor) by discussing the similarity of these pumps, including the specific speeds for Oskarshamn, Hamaoka-5, and ABWR pumps.

Status: To document resolution of these RAIs, Westinghouse stated that they will provide supplementary information to these RAI responses consisting of documentation of the information presented during the audit, as well as the specific pump characteristic data and the specific speed for the tested pumps and the ABWR pump. If the supplementary information is not provided in a timely fashion, the staff will provide a follow-up RAI to request this information.

2. Advanced Control Rod Insertion Model: Pressure drop calculation under choked flow condition (related to RAI-15.00.02-10)

An extra linear term is included in the pressure drop equation for the gas flow between the gas and water tanks (Eq. 3-9 of WCAP-17202-P). In response to RAI-15.00.02-10, the applicant clarified that the linear term improves the numerical behavior at low flows where the contribution from the quadratic term is small. However, Equation 3-9 indicates that at critical flow condition, the quadratic term is dominant, and the contribution from the linear term is small. This does not appear to be an appropriate representation of the pressure drop at critical flow condition. At critical flow condition, the mass flow rate is independent of the downstream pressure. Equation 3-9 cannot be used for determination of pressure drop under choked flow condition. As part of the audit, the staff requested Westinghouse to discuss the applicability of Eq. 3-9 under critical flow conditions.

Resolution: Westinghouse presented arguments that the pressure differential between the gas and water tanks is not sufficient to result in critical gas flow through the connection pipe; therefore, the linear correction term added to Equation 3-9 for numerical reasons is not expected to affect the pressure drop calculations and the results of the control rod hydraulic insertion model. Furthermore, Westinghouse stated **[[**

]]

Status: The information Westinghouse discussed confirms the information in the docketed response to RAI-15.00.02-10, and the staff needs no additional information at this time.

3. Steam Dome Water Surface Condensation Model: Basis, Verification, and Validation (RAI-15.00.02-34)

In the Steam Dome Water Surface Condensation Model (WCAP-17202-P, Section 3.5.2), a second-degree polynomial equation is used to correlate the condensation rate on the pool surface to the water surface subcooling. RAI 15.00.02-34 requested the following:

- *Please provide the physical basis for the selection of the polynomial dependence used in the model. Comment on the generality of the purely empirical model for steam dome water surface condensation when applied to all possible ABWR related transient scenarios.*

- *Discuss the physical significance of each model parameter in Equation 3-49.*

- *Address the implications of having a finite amount of condensation for zero subcooling.*

- *Surface condensation is due to transfer of heat from vapors to subcooled liquid surface and the condensation rate is equivalent to the heat transfer rate divided by latent heat. Since the latent heat is function of pressure, the surface condensation rate is also pressure dependent. Discuss the pressure dependence of each model parameter in Equation 3-49.*

In addition, the staff requested to discuss the verification and validation bases of the model during the audit.

Resolution: The basis for including the dome surface condensation model was **[[**

]] The audit team explained, for example, film condensation rate on a flat surface is almost linear (i.e., $C \propto \Delta T^{3/4}$), not quadratic, in ΔT. Furthermore, the present empirical correlation does not account for pressure; the audit team noted that the film condensation rate is inversely proportional to latent heat, which is a function of pressure. In the present BISON model, both positive and negative ΔT produces condensation (and not evaporation). Westinghouse agreed that the present condensation model lacks any fundamental physical basis, and Westinghouse needs to reconsider the present empirical approach.

Status: Westinghouse is expected to reconsider their empirical approach and how best to arrive at a justification for the present condensation model. Therefore, this RAI is considered open and cannot be resolved until Westinghouse arrives at a more physical model that can adequately represent the pressure and temperature dependence of condensation rate over a subcooled water pool and is supported by experimental data.

4. Method for Cross-Section Collapsing: Biases and Uncertainties (RAI-15.00.02-22 and RAI-15.00.02-24)

RAI-15.00.02-22:

The results provided in Figures 3-4 through 3-8 of WCAP-17202 demonstrate reasonable agreement, but there are some discrepancies. Please explain how the biases and uncertainties indicated in Figures 3-4 through 3-8 are considered when utilizing BISON results from AOO transients or ATWS in determining whether the acceptance criteria for safety parameters have been satisfied.

RAI-15.00.02-24:

CENPD-390-P-A, "The Advanced PHOENIX and POLCA Codes for Nuclear Design of Boiling Water Reactors," provides comparisons of results demonstrating the degree of agreement between POLCA calculations and plant measurements. This is relevant to BISON because of the reliance upon POLCA for 3D information. Figures 5.33 through 5.38 of CENPD-390-P-A show some deviations from measured power distributions, and Figures 5.30 through 5.32 of CENPD-390-P-A indicate ***[[ ]]***

a. *Please describe whether, and if so, how, uncertainties and biases in power distribution and reactivity originating in POLCA are propagated into the BISON model* ***[[ ]]***

b. *Please describe how uncertainties and biases in analytical models determined from comparisons to measurements are considered when BISON results are used to confirm the acceptability of selected plant setpoints.*

Resolution: The staff explained the underlying concern as it pertains to the observed uncertainties and biases documented in other TRs. Westinghouse responded that they understand the question and will respond with a comprehensive explanation. In addition, Westinghouse explained that the uncertainty analysis, as it applies to plant setpoints, is handled in other processes and under other topical reports that are not the subject of this review. The staff stated that supplementary information to the RAI responses consisting of documentation of the statements that were made during the audit would be necessary to resolve these RAIs.

Status: The staff will review the supplementary information provided by Westinghouse when it becomes available.

Issues related to WCAP-17203-P (Fast Transient and ATWS Methodology)

1. RAI 17 and 17S01

RAI 17 inquired about the TR statements about some AOOs being more limiting at off-rated conditions. The response led to follow-up RAI 17 S01 with multiple parts dealing with a) how to determine the existence of such events for new plant designs such as ABWR, b) the desire to understand the evaluation process employed for them, and c) an inquiry about when analytical codes are required or when other methods can be used.

After providing a detailed response, Westinghouse then offered to disclose concrete examples during the previously announced audit. Although the staff found the response acceptable, the staff agreed that the audit was an ideal opportunity to observe and discuss examples to better understand the processes and methods.

Resolution: The Westinghouse analysts provided a demonstration and discussed the code usage and updating process, including:

- Selection of BISON code inputs
- Default parameters and guidance in their selection
- Code testing and execution
- Evaluation of results
- Documentation process
- Error identification and resolution process
- Revision control process for computer codes
- Categorization of software technology issues (STIs)
- STI categorization and resolution process

- Corrective action plan (CAP)
- Process used to address NRC-imposed limitations and conditions
- Consistency between plant design characterization inputs between various codes (e.g., BISON, GOBLIN) for common data

The code demonstration calculations were useful and showed a traceable and adequate process for code use, input selection, code execution, use of documentation, and revision control.

The code defaults are mostly numerical parameters; however, a few physical parameters are also set by default based on experimental benchmarking studies (e.g., pressure drop model, bubble rise velocity), which are documented. Westinghouse stated that the code defaults were established in 1980s, and even though the codes are evolving, the defaults do not change. Also, the model nodalization schemes are set based on plant integral testing experience.

Model improvements include model development, implementation of model into the code by qualified software engineers, and verification by two independent verifiers. Westinghouse subjects each new code version to several "regression tests" prior to release, and a manual accompanies each new version.

Westinghouse uses new compilers and platforms to test codes to ensure that the results and performance are consistent with legacy compilers and platforms. Furthermore, during code release, Westinghouse reviews and addresses a number of STIs. Westinghouse also evaluates the code changes and how they may affect the overall analysis methodology.

Westinghouse staff also presented their STI categorization and CAP process. The STI categories consist of:

Category A - An error with *significant* impact

Category B - An error that does not result in *significant* impact as per A above

Category C1 - Problems that do not prevent full use of program or technology documentation (e.g., typo in software display, problems with file name interface)

Category C2 - Request for enhancements (e.g., request for improvement of user interface to input data)

Category C3 - Non-functional issues (e.g., issues with programming standard such as inaccurate documentation or module that is too large)

Category D - Problems/conditions caused by factors external to program/document (e.g., network or system problems, user error, misinterpretation of user guide) - These are typically identified through verification

The audit team noted that the categorization process could result in inconsistencies because of the absence of clear and objective acceptance criteria. In addition, the audit team identified the absence of clear and objective acceptance criteria in validation and verification tests for BISON and POLCA-T codes as required by EP-310. Examples of documentation reviewed for earlier developed model tests include explicit numerical acceptance criteria in the test report. The audit team expects Westinghouse to address this shortcoming.

In addition, the staff determined that the follow-up of NRC SER conditions and limitations as applicable to post-SER methodology use for safety analysis are not formalized at Westinghouse-Västerås and Westinghouse-Windsor even though the checklist included in the Westinghouse-Cranberry calculation notes verifies the NRC SER requirements.

Status: The audit team expects Westinghouse to establish a set of objective acceptance criteria applicable to validation and verification tests for BISON and POLCA-T codes as required by EP-310. In addition, the staff wrote draft RAI-50, included later in this audit report, to address follow-up of SER conditions and limitations.

2. Multiple RAIs

There have been several RAIs regarding the uncertainty analysis as presented. With each set, the staff further understands this complex topic. However, it has been our experience that the staff observation of the initial concern and the resulting RAI often lead to a different concern after reviewing the response. This process of incremental understanding through RAIs is not efficiently leading to our understanding of the most important issues.

An example is RAI 19, which asked for clarification regarding parameters selected for statistical treatment. The response provided the basis for using the statistical treatment in general but without addressing the specific concerns in the RAI. This led to supplemental RAI 19 S01 regarding how these criteria are applied. In the response, the issues of “normality tests” and “statistical significance” were introduced to explain the process used. The second response then required another RAI, RAI 19 S02, requesting Westinghouse to explain how it uses the criteria in the response to ensure statistical significance and adequate sample size.

Resolution: Westinghouse and the audit team discussed the specific issues related to the follow-up RAIs including:

- The ranking of phenomenological issues
- The proposed uncertainty quantification methodology
- Definition of "leading parameters"
- The definition of "statistical significance"
- "Normality" test
- Adequacy of sample size

Based on the discussions with the audit team and the other NRC/NRR and ERI technical reviewers with the NINA/Westinghouse staff, Westinghouse plans to provide a comprehensive discussion of these issues to enable satisfactory closure of the RAI issues.

Status: The staff will review the related RAI responses when Westinghouse submits them.

<u>Other Issues related to WCAP-17203-P (Fast Transient and ATWS Methodology)</u>

In addition to the issues discussed above, the audit team discussed the RAIs and responses related to the WCAP-17203-P as listed below.

1. **RAI 9b S01**

[[

]] assigned in the BWR LOCA PIRT (NUREG/CR-6744). This phenomenon has been ranked [[

]] The rationale for lower ranking of this phenomenon provided in Table 5-2 of WCAP-17203 states that the effect of [[

]]

Resolution: Westinghouse presented the results of a sensitivity analysis demonstrating that the effect of **[[**

]]

Status: To document resolution of this open item, the audit team requested the information be provided in the follow-up RAI 9b S02, which was issued on July 21, 2011.

2. **RAI 19 S01**

(a) *Please describe the criteria used to separate parameters into the Relevant Parameter group.*

(b) *Please describe the criteria used to determine whether there has been a failure of a normality test.*

(c) *Please provide the criteria used to determine if a dataset is statistically significant.*

Resolution: The staff determined that the response to parts (a) and (b) was acceptable. The response to Part (c) did not adequately discuss the statistical significance of datasets to be used. In the audit, the staff expanded on what it means for data to be statistically significant. The staff noted that for cases with **[[**

]] Use of the uniform distribution merely assumes nothing is known about the underlying distribution. The need to address the quality of the data was also discussed. Westinghouse stated that it understood reviewers' concerns, would clarify its normality test, and would clarify how it assures statistical significance of data sets.

Status: To document resolution of this open item, the audit team requested the information be provided in the follow-up RAI 19 S02, which was issued on July 21, 2011.

3. RAI 20 S01

In response to RAI-20, Part (a), the applicant stated that medium "ranked parameters in PIRT ***[[*** ***]]****" However, there is no discussion of whether a combination of medium ranked independent phenomena could together have more than a moderate effect of the figure of merit.*

Please provide a more complete basis for why the ***[[*** ***]]***

Resolution: The staff determined that the response to part (a) was not acceptable. In the audit, the audit team further explained the concern that a series of moderately ranked parameters in the PIRT could, in total, have a non-trivial effect on a figure of merit. In addition, the audit team stated it could find no basis for the Westinghouse statement that treating medium-ranked parameters conservatively would be a cumbersome process. The audit team suggested that Westinghouse provide a table showing the actual effect of medium-ranked parameters on figures of merit by taking the ratio of the delta input (from the parameter to the model) to the delta output (from the model as it affects the figure of merit). Westinghouse agreed this would further illustrate the issue.

Status: To document resolution of this open item, the audit team requested the information be provided in the follow-up RAI 20 S02, which was issued on July 21, 2011.

4. RAI 25 S01

The response to Part (c) indicated that uncertainties in experimental databases are addressed in two ways.

1) "Parameters describing thermo-physical data … ***[[*** ***]]****" or,*

*2) "****[[*** ***]]***

However, the following aspects of the response to RAI 25 Part (c) are unclear. Please describe:

(a) *the criteria used to determine whether a parameter is a leading parameter,*

(b) *the method for determining whether there is a single leading parameter or set of leading parameters for an event to be analyzed,*

(c) *how experimental and modeling uncertainties and biases are mathematically combined into either single or multiple leading parameter(s) so that the resulting distribution of these parameter(s) reflects the total uncertainty,*

(d) *the situations in which you believe that a single leading parameter may be appropriate for analysis of AOO or ATWS events*

Resolution: The responses to Parts (b), (c), and (d) were acceptable. The response to Part (a), which stated that a leading parameter is one for which the comparison with the separate effects test data is performed, was not acceptable. In the audit, the reviewers further explained concerns about leading parameter selection and about the concept of a leading parameter.

The audit team noted that comparison to test data does not mean the comparison results are acceptable. The team also noted that Westinghouse did not justify why the use of a leading parameter(s) as a surrogate for other parameters that might affect a figure of merit is reasonable. Westinghouse agreed that there is a need to better explain how leading parameter are chosen and committed to documenting its selection process. The staff stated that an example of choosing a leading parameter and using it as surrogate for other parameters for a figure of merit would be extremely helpful, and Westinghouse agreed.

Status: To document resolution of this open item, the audit team requested the information be provided in the follow-up RAI 25 S02, which was issued on July 21, 2011.

<u>Issues related to WCAP-17116-P (GOBLIN)</u>

1. NRC/NRR requested a validation of the homogeneous equilibrium model (HEM) critical flow model used in GOBLIN for the automatic depressurization system (ADS) against experimental data (e.g., Marviken tests or EPRI data).

   Resolution: Westinghouse provided a comparison between the HEM and the Moody critical flow model to show that the two models produce very similar results, with HEM predicting a slightly lower flow compared to the Moody critical flow model (which Westinghouse considers conservative in terms of ADS flow). In addition, Westinghouse indicated that validation studies using Marviken data have been performed; however, due to the significant effort on the part of Westinghouse to provide an English translation of an old report in Swedish that compares the GOBLIN HEM against the Marviken data, Westinghouse is reluctant to provide such comparisons. The staff notes that 10 CFR Part 50, Appendix K requires use of the Moody critical flow model for LOCA calculations. The use of HEM results in a slightly lower discharge flow through the ADS valves. Westinghouse argued that this would result in a slightly slower depressurization, which the staff agrees is conservative.

Quality Assurance Issues

In an audit report issued on June 28, 2011 (ADAMS Accession No. ML111810561 [Contains Proprietary Information; not publicly available]), the staff indicated plans for continuation of the QA audit at Westinghouse's Sweden offices. Therefore, the staff continued its detailed review of QA procedures used by Westinghouse in Sweden, including identification of QA issues; the issue resolution and closure process related to various computer codes, including GOBLIN and BISON, to determine if the Westinghouse QA procedures meet the 10 CFR Part 50, Appendix B requirements for quality assurance; and fulfillment of the minimum requirements for design control, document control, software configuration control and testing, and corrective actions.

The audit team reviewed the processes used for QA of code design control, modification, configuration control, testing, code development, selection of inputs, file transfer processes, input modification, and model and documentation procedures and controls. Based on this audit, the staff generated the following draft RAIs:

1. DRAFT RAI-49

During the September 2011, audit in Sweden, the staff observed that no attempt has been made by Westinghouse to verify that the plant parameter inputs to three different computer codes (i.e., GOBLIN, BISON and POLCA-T) are used in a consistent manner. It is the staff position that plant design parameters are used consistently across computer code domains by different individuals and/or groups. Since the codes are used by numerous groups in different locations, there is a potential for generating errors in the running of the codes. Explain in detail how Westinghouse assures that the design-related input parameters are used in a consistent manner across various computer codes.

2. DRAFT RAI-50

During the September 2011, audit in Sweden, the staff observed that the staff SER "conditions" and "limitations" as applicable to post-SER methodology use for safety analysis are not formalized in Westinghouse-Västerås and in Westinghouse-Windsor, even though the checklist that is used in the Westinghouse-Cranberry calculation notes does include the SER conditions and limitations as an item. Explain in detail how Westinghouse plans to assure that the Westinghouse code users located at different locations follow the staff conditions and limitations consistently.