

September 26, 2003

APPLICANT: Westinghouse Electric Company

PROJECT: AP1000 Standard Plant Design

SUBJECT: SUMMARY OF APRIL 3, 2003, CATEGORY 1 MEETING WITH  
WESTINGHOUSE ELECTRIC COMPANY TO DISCUSS UNRESOLVED  
STRUCTURAL ISSUES ASSOCIATED WITH THE AP1000 DESIGN  
CERTIFICATION REVIEW

On April 3, 2003, a public meeting was held between the U.S. Nuclear Regulatory Commission (NRC) and representatives of Westinghouse Electric Company (Westinghouse), at the Westinghouse Energy Center, Monroeville, PA. The purpose of this meeting was to discuss issues associated with the structural design for the AP1000 design certification, including requests for additional information (RAIs) that were sent to Westinghouse via letter dated September 19, 2002. A list of meeting attendees is included in Enclosure 1.

Westinghouse presented information on the overall AP1000 seismic and structural review, AP1000 shield building vertical stresses, effects of basemat lift-off on response spectra, and lift-off finite element model analysis of the basemat. The presentation materials are provided in enclosures to this meeting summary as specified below. In addition, Westinghouse provided a telephone call conference summary that was previously sent to the NRC in a letter dated March 13, 2003 (ADAMS Accession No. ML030760701) to facilitate discussions with the staff. The telephone conference call summary is included in Enclosure 6.

The staff discussed with Westinghouse several unresolved issues associated with requests for additional information (RAIs) in the areas of structural and seismic design. These unresolved issues were previously transmitted to Westinghouse via electronic mail and are included in Enclosures 3 and 5. Also included in Enclosure 3 are several clarifications that were provided to and discussed with Westinghouse during the April 3, 2003, public meeting. A summary of actions associated with these RAIs and clarifications is included in Enclosure 8.

In conjunction with this public meeting, the NRC staff and its consultants conducted an audit of the AP1000 analysis report and design calculations in the areas of structural and seismic design. The information reviewed during the audit was identified by Westinghouse as containing propriety information. A review was performed by the NRC staff which concluded that the information reviewed during the audit was proprietary and therefore the meeting was closed to the public. This determination is documented in a memorandum dated March 31, 2003 (ADAMS Accession No. ML030790528). A list of the calculations reviewed during the audit is included in Enclosure 9.

Enclosures 2, 4, 7, and 10 contain the Westinghouse meeting handouts which can be accessed through the Agencywide Documents Access and Management System (ADAMS). This system provides text and image files of NRC's public documents. The handouts mentioned above may be accessed through the ADAMS system under Accession No. ML031040260. If you do not have access to ADAMS or if there are problems in accessing the handouts located in ADAMS, contact the NRC Public Document Room (PDR) reference staff at 1-800-397-4209, 301-415-4737 or by e-mail to [pdrr@nrc.gov](mailto:pdrr@nrc.gov).

Please direct any inquiries concerning this meeting to Joseph Colaccino at 301-415-2753, or [jxc1@nrc.gov](mailto:jxc1@nrc.gov).

**/RA/**

Joseph Colaccino, Senior Project Manager  
New, Research and Test Reactors Program  
Division of Regulatory Improvement Programs  
Office of Nuclear Reactor Regulation

Docket No. 52-006

- Enclosures:
1. List of attendees
  2. Overall AP1000 seismic and structural review
  3. Status of RAI Responses and additional clarifications
  4. AP1000 shield building vertical stresses
  5. RAI 230.020 (included in letter to Westinghouse dated May 20, 2003, ADAMS Accession No. ML030900588)
  6. Telephone call conference summary included in letter to the NRC dated March 13, 2003 (ADAMS Accession No. ML030760701)
  7. Effects of basemat lift-off on response spectra and lift-off finite element model analysis of basemat
  8. Summary of public meeting discussions concerning unresolved RAIs and clarifications
  9. List of calculations reviewed during April 2-4, 2003, structural audit
  10. Draft DCD, Revision 4, Page 3H-19, 3H-39, 3H-40, and 3H-41 (ADAMS Accession No. ML031040228)

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Joseph Colaccino, Senior Project Manager  
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ADAMS ACCESSION NUMBER: ML031040266

OFFICE	PM:RNRP	EMEB	SC:RNRP
NAME	JColaccino:cn	TCheng	LDudes
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JColaccino

LDudes

E-Mail:

JDyer

RBorchardt

JCraig

BSheron

TMcGinty

RNRP Group

ACRS

OPA

RBarrett

GImbro

DTerao

KManoly

TKing

MEI-Zeftawy, ACRS

PBoehnert, ACRS

TCheng

SPSekerak

GBagchi

FEltawila, RES

BBateman

JCalvo

SCoffin

ALund

TChan

EMarinos

ESullivan

JColaccino

JStarefos

JSegala

SBajorek

JFlack

SRubin

CAder

OGC

bhupinder.singh@hq.doe.gov

tom.miller@hq.doe.gov

NRC Public Meeting Attendance List  
AP1000 Structural Design Issues  
April 3, 2003

<u>Name</u>	<u>Organization</u>
J. Colaccino	U. S. Nuclear Regulatory Commission (NRC)
J. Braverman	Brookhaven National Laboratory (BNL)
R. Morante	BNL
E. Cummins	Westinghouse Electric Company (Westinghouse)
R. Orr	Westinghouse
M. Corletti	Westinghouse
W. LaPay	Westinghouse
C. Constantino	Carl J. Constantino & Associates
G. Bagchi	NRC
G. Harstead	Carl J. Constantino & Associates
T. Cheng	NRC
Y. Takeahi	Obayashi
L. Tuñón-Sanjur	Westinghouse
N. Prasad	Westinghouse

Requests for Additional Information (RAIs)  
AP1000 Standard Design Certification

Series 230 - Seismology and Seismic Design

RAI 230.020

Section 3.7.2.3 - Procedure Used for Modeling:

In discussions with Westinghouse regarding the development of the Nuclear Island (NI) dynamic model, the Nuclear Regulatory Commission (NRC) staff identified instances in which this complex finite element model, which was developed by multiple organizations in different countries, has not produced acceptable results. The NRC staff is concerned as to the process used by Westinghouse to ensure the adequacy of the structural model. Specific examples where the model did not produce acceptable results include:

1. During a public meeting in November 2002, the NRC staff requested that Westinghouse select a simple shear wall section from its model to compare the lateral deflection of the selected wall predicted by the computer analysis against the result of hand calculation. The model results were not consistent with the hand calculation.
2. The seismic analysis result of the Auxiliary and Shield Building (ASB) shows net tension in the shield building wall. This suggests that during seismic excitation parts of the basemat will lift up from the rock surface resulting in changes in the basemat stresses.

During a conference call on January 21, 2003, Westinghouse agreed to inform the NRC staff of its intentions regarding how Westinghouse plans to address the issues of (1) peer review of its AP1000 design models and (2) stiffness reduction of shear wall models. In a submittal dated March 13, 2003, Westinghouse provided its response. The response was not adequate for the following reasons:

1. Westinghouse has indicated its intention to conduct the peer review by a single expert who is already involved in the AP1000 design process. Although a peer review is not a requirement per the regulations, a review of the model to determine its adequacy by an individual who is associated with the development of the model does not appear to provide an independent review of the model.
2. Westinghouse stated that it has incorporated quality in its modeling and analysis of the NI in all of its activities conducted so far; however, the NRC identified that the seismic analysis result of the ASB shows net tension in the shield building wall. This suggests that during seismic excitation parts of the basemat will lift up from the rock surface resulting in changes in the basemat stresses. This result does not suggest that the model is of sufficient quality.
3. Westinghouse has accepted the recommendation to adopt the criteria in Federal Emergency Management Agency (FEMA) documents for the stiffness of reinforced concrete shear wall structures. However, Westinghouse would only use it when

Enclosure 5

performing new analysis. It claims that this effect will be covered by a peak broadening of +10 percent and -20 percent. The reduction in stiffness of shear walls has two effects: one, on the design of the structure itself, and two, on the structures, systems, and components (SSCs) supported by the structure. On the design of the structure, Westinghouse asserts that a reduction in frequency of about 7 percent will occur, based on some Japanese tests cited in NUREG/CR-6241. The NRC notes that the FEMA recommendations are most current, and based on a scrutiny of a broad base of test results. Using the FEMA recommendation, the reduction in natural frequency can be as much as 60 percent of those calculated without the stiffness reduction. The respective order and the fundamental natural frequency change can lead to significant changes in the seismic load, hence the member forces. On the response of supported SSCs, the ordering of respective dominant frequencies and higher significant modes of response can result in unpredictable shapes of response spectra. Therefore, it is essential that the response spectra at several critical locations be developed and compared against those obtained from the original analysis using higher stiffness properties.

In light of the inadequacies cited above, Westinghouse should provide further information as to how the NI dynamic model and related calculations used for design certification satisfy the requirements of 10 CFR Part 50, Appendix A.

## **Summary of Public Meeting Discussions**

### **Request For Additional Information (RAI) Unresolved Issues:**

Westinghouse provided responses to the Series 220, 230, 240, and 241 RAIs in the following letters:

October 4, 2002 (ADAMS Accession No. ML022830632)  
October 18, 2002 (ADAMS Accession No. ML022980577)  
November 1, 2002 (ADAMS Accession No. ML023080378)  
November 8, 2002 (ADAMS Accession No. ML023170535)  
November 26, 2002 (ADAMS Accession No. ML023360097)  
December 2, 2002 (ADAMS Accession No. ML023400058)

The NRC staff provided unresolved issues on certain RAIs in an electronic mail. Each of these RAIs were discussed in the public meeting. A summary is provided below.

#### **RAI 220.001**

The NRC audit team (the team) stated that WCAP-15603 would be reviewed to determine if the issues associated with this RAI had been addressed. No additional information is needed at this time.

#### **RAI 220.003**

Westinghouse stated that they would revise the RAI response to address procurement and post weld heat treatment issues and provide sharp test data for the containment vessel.

#### **RAI 220.005**

The team stated that they would review the calculations related to the Westinghouse response to this RAI to ensure that the response addressed the unresolved issues. Westinghouse also stated that they may revise the RAI response based on the team's review.

#### **RAI 220.007**

Westinghouse stated that they would revise the RAI response to add a description of the attached figure. In addition, the design control document (DCD) Tier 2, Figure 3.8.3-7 would also be revised.

#### **RAI 220.008**

The team will review proprietary calculations to determine if the issues associated with this RAI have been addressed.



RAI 220.009

The team will review proprietary calculations to determine if the issues associated with this RAI have been addressed.

RAI 220.010

The team will review proprietary calculations to determine if the issues associated with this RAI have been addressed.

RAI 220.013

Westinghouse provided the staff with a presentation on this issue (See Enclosure 4).

In response to this RAI, Westinghouse took exception to certain requirements in American Concrete Institute (ACI)-349. The staff has not identified any issues with the previous response. The NRC staff stated that it was not acceptable to take exception to ACI-349. In addition, the current response is not acceptable because of the discreditation of the model. Westinghouse stated that they would revise the RAI response to address the NRC staff's concerns.

RAI 220.015

Westinghouse stated that they would revise the RAI response to address the staff's concerns. The team will review proprietary calculations to determine if the issues associated with this RAI have been addressed.

RAI 220.017

This RAI was discussed during the November audit at Westinghouse (Reference response to RAI 241.001 where Table 3.8.5-3 was intended to be changed to be designated as Tier 2\*). Westinghouse expressed concern with designated portions of the DCD as Tier 2\* where there are no backup calculations. After further discussion, Westinghouse stated that they would revise their RAI response to designate portions of figure as Tier 2.\* In addition, the DCD would be revised as appropriate.

RAI 230.018

The team will review proprietary calculations to determine if the issues associated with this RAI have been addressed.

During the public meeting, the team discussed with Westinghouse a number of issues which were described as clarifications from the November audit and the review of DCD, Revision 3 (See pages 3-4 of Enclosure 3). A number of these clarifications were determined to be significant issues impacting the safety review of the AP1000 design certification. The following is a list of each clarification with a summary of the discussion during the public meeting.

1. The team will review proprietary calculations to determine if the issues associated with this clarification have been addressed.

2. This clarification is related to RAI 230.018. The team will review proprietary calculations to determine if the issues associated with this RAI have been addressed.
3. The team stated that with respect to the modal time history analysis, the DCD only had modal properties to 33 Hz. The team questioned why all 200 modes were not included in the DCD. Westinghouse stated that they would revise the DCD to include all 200 modes. Westinghouse also stated that they would revise Section 3.7.2 of the DCD to describe the process to develop the finite element model from the stick model.
4. The team will review proprietary calculations to determine if the issues associated with this clarification have been addressed.
5. Both of these clarification questions are related to RAI 230.020, which was transmitted to Westinghouse prior to the meeting via electronic mail. The RAI is included as Enclosure 5 to this meeting summary (Reference NRC letter dated May 20, 2003, ADAMS Accession No. ML030900588). Westinghouse provided a telephone conference call summary from its letter dated March 13, 2003 (ADAMS Accession No. ML030760701) during the public meeting and is included as Enclosure 6.

RAI 230.020 requests that Westinghouse provide further information as to how the nuclear island (NI) dynamic model and related calculations used for design certification satisfy the requirements of 10 CFR Part 50, Appendix A. Westinghouse agreed to inform the NRC staff of its intentions after a conference call dated January 21, 2003 (Reference Call Summary dated February 6, 2003, ADAMS Accession No. ML030280305) to address the issues of (1) peer review of its AP1000 design models and (2) stiffness reduction of shear wall models. This response was provided in the March 13, 2003, letter, the relevant portion of which is included as Enclosure 6. After the team and Westinghouse discussed the RAI and the Westinghouse telephone conference call response, Westinghouse stated that they would further discuss the RAI internally and provide a response to the NRC.

6. The team will review proprietary calculations to determine if the issues associated with this clarification have been addressed.
7. Westinghouse stated that they may add an interface item to address this issue.
8. & 9. This clarification issue is related to the Westinghouse response to RAI 241.001. The team stated that the main issue that needed to be addressed was the relation between the shear wave velocity vs. the bearing capacity and the spring stiffness. Westinghouse stated that the wording of the combined operating license (COL) action item would be revised. Possible language would state that the COL must demonstrate allowable for safe shutdown earthquake (SSE) loads. The team noted that the word "allowable" was important to include in this COL action item. The team will also review proprietary calculations to determine if the issues associated with this clarification have been addressed.

To facilitate discussions on Items 10-14, Westinghouse made two presentations to the team: Effects of basemat lift-off on response spectra and lift-off finite element model analysis of basemat. The presentation materials are included as Enclosure 7.

10. The team will review proprietary calculations to determine if the issues associated with this clarification have been addressed.
11. The team stated that there was a fundamental problem with the use of the JEAG analysis. The team believes the results from the analysis are adequate and that it may effect the evaluation of the response spectrum. In addition, the simplified model used by Westinghouse is not adequate because of the use of several assumptions and omits characteristics important to the lift-off model. The team will review proprietary calculations to determine if the issues associated with this clarification have been addressed.
12. See Clarification Issue 8 above.
13. A new RAI (230.021) was generated to request that Westinghouse update the DCD to be consistent with rulemaking in 1977 related to Standard Review Plan (SRP) Chapter 2.5.1-2.5.3 (Reference NRC letter dated May 20, 2003, ADAMS Accession No. ML030900588).

The team also provided Westinghouse a second set of clarifications (see pages 5-6 of Enclosure 3). Westinghouse agreed, with one exception, to revise Revision 4 of the DCD to reflect the proposed clarifications. With regard to Clarification 14, the team will discuss this issue further during the audit.

List of Calculations Reviewed During the April 2-4, 2003, Structural Audit

APP-1000-S2C-034, Revision 1	Finite Element Shell Model of Containment Internal Structures (CIS)
APP-1100-S2C-001, Revision 0	Static Analysis of CIS - Dead Load and Live Load
APP-1100-S2C-002, Revision 1	Static Analysis - Seismic Equivalent Accelerations
APP-1100-S2C-003, Revision 1	Static Analysis - Pressures
APP-1100-S2C-004, Revision 0	Temperature Distribution Through Wall
APP-1100-S2C-005, Revision 1	Static Analysis - Thermal Analyses
APP-1100-S2C-006, Revision 1	Static Analysis - Load Combinations
APP-1100-S2C-007, Revision 0	Required Steel Area Calculations of Main IRWST [in-containment refueling water storage tank] Concrete Filled Module Walls
APP-1100-S2C-008, Revision 0	IRWST Steel Wall and Main Operating Floor Columns Verifications
APP-1200-S2C-001, Revision 0	Seismic equivalent static analysis of auxiliary/shield building (ASB), finite element model
APP-1100-S2C-004, Revision 0	Temperature Distribution Through Wall
APP-1100-S2C-005, Revision 1	Static Analysis - Thermal Analyses
APP-1200-S2C-002, Revision 0	ASB Exterior Walls Thermal and Earth Pressure Analyses
APP-GW-S1-009, Revision 0	Design Guide for Thermal Effects on Concrete Structures
APP-SSAR-GSC-529, Revision 0	APP1000 MSIV [main steam isolation valve] Compartment Temperature Response Following MSLB [main steam line break] in Support of the Equipment Qualification

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cc:

Mr. W. Edward Cummins  
AP600 and AP1000 Projects  
Westinghouse Electric Company  
P.O. Box 355  
Pittsburgh, PA 15230-0355

Mr. H. A. Sepp  
Westinghouse Electric Company  
P.O. Box 355  
Pittsburgh, PA 15230

Lynn Connor  
Doc-Search Associates  
2211 SW 1<sup>ST</sup> Ave - #1502  
Portland, OR 97201

Barton Z. Cowan, Esq.  
Eckert Seamans Cherin & Mellott, LLC  
600 Grant Street 44<sup>th</sup> Floor  
Pittsburgh, PA 15219

Mr. Ed Rodwell, Manager  
Advanced Nuclear Plants' Systems  
Electric Power Research Institute  
3412 Hillview Avenue  
Palo Alto, CA 94304-1395

Charles Brinkman, Director  
Washington Operations  
Westinghouse Electric Company  
12300 Twinbrook Parkway, Suite 330  
Rockville, MD 20852

Mr. R. Simard  
Nuclear Energy Institute  
1776 I Street NW  
Suite 400  
Washington, DC 20006

Mr. Thomas P. Miller  
U.S. Department of Energy  
Headquarters - Germantown  
19901 Germantown Road  
Germantown, MD 20874-1290

Mr. David Lochbaum  
Nuclear Safety Engineer  
Union of Concerned Scientists  
1707 H Street NW, Suite 600  
Washington, DC 20006-3919

Mr. Paul Gunter  
Nuclear Information & Resource Service  
1424 16th Street, NW., Suite 404  
Washington, DC 20036

Mr. Tom Clements  
6703 Guide Avenue  
Takoma Park, MD 20912

Mr. James Riccio  
Greenpeace  
702 H Street, NW, Suite 300  
Washington, DC 20001

Mr. James F. Mallay, Director  
Regulatory Affairs  
FRAMATOME, ANP  
3315 Old Forest Road  
Lynchburg, VA 24501

Mr. Ed Wallace, General Manager  
Projects  
PBMR Pty LTD  
PO Box 9396  
Centurion 0046  
Republic of South Africa

Mr. Vince Langman  
Licensing Manager  
Atomic Energy of Canada Limited  
2251 Speakman Drive  
Mississauga, Ontario  
Canada L5K 1B2

Mr. Gary Wright, Manager  
Office of Nuclear Facility Safety  
Illinois Department of Nuclear Safety  
1035 Outer Park Drive  
Springfield, IL 62704

Dr. Gail H. Marcus  
U.S. Department of Energy  
Room 5A-143  
1000 Independence Ave., SW  
Washington, DC 20585

Mr. Paul Leventhal  
Nuclear Control Institute  
1000 Connecticut Avenue, NW  
Suite 410  
Washington, DC 20036

Mr. Jack W. Roe  
SCIENTECH, INC.  
910 Clopper Road  
Gaithersburg, MD 20878

Patricia Campbell  
Winston & Strawn  
1400 L Street, NW  
Washington, DC 20005

Mr. David Ritter  
Research Associate on Nuclear Energy  
Public Citizens Critical Mass Energy  
and Environmental Program  
215 Pennsylvania Avenue, SE  
Washington, DC 20003

Mr. Michael M. Corletti  
Passive Plant Projects & Development  
AP600 & AP1000 Projects  
Westinghouse Electric Company  
P. O. Box 355  
Pittsburgh, PA 15230-0355