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UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

August 10, 2000

MEMORANDUM TO: ACRS Members

FROM: Sam Duraiswamy

SUBJECT: PRE-APPLICATION (PHASE 1) REVIEW OF THE AP1000 STANDARD PLANT DESIGN

Attached are the status report and relevant documents associated with the pre-application (Phase 1) review of the AP1000 Standard Plant Design. This matter is scheduled for discussion by the Committee during its August 29 -September 1, 2000 meeting. If you have any questions, please call me at (301) 415-7364.

cc: J. Larkins
H. Larson
N. Dudley
P. Boehnert

AP1000

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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
475TH MEETING
PRE-APPLICATION (PHASE 1) REVIEW OF THE AP1000 DESIGN
AUGUST 29, 2000

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Cognizant ACRS Member: Tom Kress
Cognizant ACRS Staff: Sam Duraiswamy

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
475TH MEETING
PRE-APPLICATION (PHASE 1) REVIEW OF THE AP1000 DESIGN
AUGUST 29, 2000

- PROPOSED SCHEDULE -

	TOPICS	PRESENTER	TIME	ACTUAL TIME
1.	Introduction	T. S. Kress, ACRS	5 Min.	1:00 - 1:05 p.m.
2.	Results of the AP1000 Pre-Application Review - Phase 1	J. Wilson, NRR	30 Min.	1:05 - 1:35 p.m.
3.	Committee Caucus		10 Min.	1:35 - 1:45 p.m.

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
475TH MEETING
PRE-APPLICATION (PHASE 1) REVIEW OF THE AP1000 DESIGN
AUGUST 29, 2000

- STATUS REPORT -

PURPOSE

The purpose of this session is to discuss the results of the NRC staff's pre-application (phase 1) review of the Westinghouse AP1000 standard plant design.

BACKGROUND

Westinghouse proposes to increase the power rating of the AP600 design, which has been certified by the NRC, to 1000MWe and seeks NRC feedback on the scope and cost for review and certification of the AP1000 design. Westinghouse goal is to minimize the changes to the AP 600 design and retain the objectives, design detail, licensing basis, and risk basis. A comparison of the key parameters of the AP600 and AP1000 designs are provided below.

Parameter	AP600	AP1000
Net electric output, MWe	600	1000
Reactor power, MWt	1933	2993
Hot leg temperature, °F	600	615
Number of fuel assemblies	145	157
Type of fuel assembly	17x17	17x17
Active fuel length, ft	12	14
Core loading, MTU	66.90	84.50
Linear heat rating, kw/ft	4.10	5.03
Average power density, kw/liter	78.82	96.6
Reactor coolant pump flow, gpm	51,000	65,000
Pressurizer, ft^3	1600	1800

The NRC and Westinghouse have agreed to a 3-phase review approach as noted below.

Phase 1

- Identify the review assumptions and issues that need to be evaluated in Phase II.

- Identify the information that the NRC will need to evaluate these assumptions and issues.

- Estimate the schedule and resources needed to perform the Phase II review.

Phase II

- Determine the scope of the AP1000 design certification review.

- Estimate the schedule and resources needed to perform the Phase III review.

- Request Commission approval of Phase II evaluation.

Phase III

- Perform design certification review.

PRE-APPLICATION REVIEW ITEMS PROPOSED BY WESTINGHOUSE AND THE NRC STAFF'S RESPONSE TO WESTINGHOUSE PROPOSAL.

In a letter dated May 31, 2000 (pages 7-15), Westinghouse has identified five fundamental assumptions, noted below, for evaluation by the staff during the Phase II pre-application review of the AP1000 design. In letter dated July 27, 2000, the NRC staff provided the results of its assessment of the Westinghouse proposal (pages 16-25). Staff's response to Westinghouse proposal is also included under each item.

1. The AP1000 Design Certification Application will reference sections of the AP600 Design Control Document (DCD) that do not change for AP1000.

Westinghouse will submit a Table of Contents of DCD for the AP1000 design for review by the NRC. At the conclusion of the Phase II review, Westinghouse expects to reach an agreement with the NRC on the Table of Contents for the DCD, including a determination of the sections that can be retained from the AP600 DCD that will not be subject to re-review.

The staff states that in order to determine which sections of AP600 DCD will not require re-review for AP1000, Westinghouse should provide a description of its proposed design changes containing a level of detail comparable to that provided in Section 1.2 of the AP600 DCD and a rationale for why changes are not needed in certain sections of the AP600 DCD.

2. The AP1000 design certification will not require additional tests to be performed by the applicant.

Westinghouse will submit AP1000 Analysis Plan and Scaling Assessment of AP600 Test Program. The NRC should determine whether the AP600 Test Program meets the requirements of 10 CFR Part 52 for the AP1000 design.

3. **The AP1000 Design Certification can utilize the AP600 analysis codes with limited modifications. Westinghouse will submit AP1000 Analysis Plan and Scaling Assessment of AP600 Test Program and AP1000 Passive Core Cooling System Design Margins Assessment. Westinghouse will provide an assessment of the applicability of each code and will identity code changes to address the most significant comments documented in NUREG-1512 "Final Safety Evaluation Report Related to Certification of AP600 Standard Design." The NRC should determine whether the AP600 analysis codes, including the proposed changes are adequate for analyzing the AP1000 design.**

For items 2 and 3, the staff states that in order to determine whether the AP600 Test Program (including test matrices) and code validation are sufficient for AP1000, Westinghouse must develop a Phenomena Identification and Ranking Table (PIRT) for AP1000, identify key thermal-hydraulic phenomena and parameter ranges, and identify any new phenomena or differences from the AP600 PIRTs for large- and small-break LOCAs and non-LOCA transients. In addition, the staff requests Westinghouse to provide necessary information on various thermal-hydraulic tests and codes for use by the staff to determine whether additional tests and code changes are needed for AP1000. For example:

- Westinghouse must demonstrate that the existing separate effects tests on the passive residual heat removal system heat exchanger, automatic depressurization system, and core makeup tank sufficiently cover the range of key thermal-hydraulic phenomena and parameters or acquire additional test data.

- Westinghouse must submit a scaling report for the integral system tests, such as OSU/APEX and SPES-2 (high pressure, full vertical scale) for AP1000 and demonstrate that the test matrices of OSU/APEX and SPES-2 provided adquate coverage of the break sizes and locations to address important system-related phenomena identified in the AP1000 design. It is possible that additional integral system tests may be required, especially for validation of the NOTRUMP code for small-break LOCA analysis and the WCOBRA/TRAC code for long-term cooling analysis.

- Westinghouse will have to either provide justification on the acceptability of the WRB-2 CHF correlation to the new fuel design by demonstrating that sufficient test data exist to cover the geometrical and thermal-hydraulic conditions of the new fuel design or acquire additional CHF data to cover the new fuel design and thermal-hydraulic conditions and demonstrate that the WRB-2 correlation adequately predicts new data, or develop a new CHF correlation (including WRB-2 modification).

- Westinghouse needs to explain how LOFTRAN code has been or will be changed to model AP1000 and why these changes are appropriate.

- The limitations and restrictions, identified in NUREG-1512, of the WGOTHIC code model on the AP600 evaluation need to be justified or modified accordingly for AP1000.

4. **The AP1000 Design Certification Application can utilize the AP600 PRA Supplemented with a Sensitivity Study to meet the requirements for a plant-specific PRA.**

Westinghouse will submit the Table of Contents for the AP1000 PRA Sensitivity Study and AP1000 Level 1 PRA LOCA Success Sequences Analysis Report. The NRC should determine whether the AP600 PRA supplemented with a suitable Sensitivity Study meets the requirements for the AP1000 plant-specific PRA.

The staff states that Westinghouse should provide the following Level 1 PRA information:

- A detailed description of the approach that will be followed to confirm the validity of the success criteria for both systems and operator actions. In the AP600 PRA, the success criteria were determined by a risk-based margins approach that used conservative assumptions for key thermal-hydraulic parameters, such as decay heat. This process resulted in success criteria that are sequence dependent and take into account thermal-hydraulic uncertainties. Westinghouse should discuss how the proposed design changes will affect the implementation of the margins approach for AP1000. If it is proposed that some portion of the AP600 margins approach implementation be retained, Westinghouse should provide documentation showing that this action will not compromise the robustness of the success criteria (for both systems and human actions) used in the AP1000 PRA models.

- A list of changes in the AP600 design with an explanation of why such changes would not introduce additional hardware failure mechanisms or increases in hardware failure rates. Both power operation and shutdown operation need to be addressed.

5. **The AP1000 Design Certification Application can defer selected design activities to the Combined License (COL) Applicant.**

Westinghouse proposes to include less design detail in the AP1000 Design Certification Application than that included in the AP600 application. The general arrangement, structural configuration, equipment and piping layout are substantially the same. However, qualification analyses will be deferred to the COL applicant. Westinghouse requests that the NRC provide feedback on the level of design detail to be included in the AP1000 application.

The NRC staff states that Westinghouse should provide necessary information for the staff to determine whether Westinghouse can use design acceptance criteria (DAC) instead of detailed design information for the AP1000 seismic analysis, structural design, and piping design. Also, Westinghouse should demonstrate several things, including the:

- Dynamic stability of the nuclear island (sliding and overturning).

- Adequacy of the 6-foot thick foundation mat (in the balance of plant area) under the increased design loads (dead loads and seismic loads).

- Design adequacy of the sub-compartment walls to withstand higher pressures resulting from the increased size of NSSS components.

- AP1000 steel containment will continue to meet the containment performance requirement for severe accidents (withstand the internal pressure at 24 hours after the start of an accident at ASME Service Level C limits)

ISSUES IDENTIFIED BY THE ACRS

During its June 2000 meeting, the ACRS considered the AP1000 pre-application and identified several issues that need to be addressed in the review of the AP1000 design (pages 26-27). These issues stem from the ACRS review of the AP600 design. The staff has incorporated most of the ACRS issues in its response to Westinghouse proposal for Phase II review of the AP1000 design, with the exception of certain issues associated with the integrity of the containment. These issues will be addressed during the design review (Phase III).

EXPECTED COMMITTEE ACTION

The Committee needs to decide and provide feedback on whether the staff has identified all significant issues for Phase II pre-application review of the AP1000 design.

Westinghouse
Electric Company

Advanced Plant Development Unit

Box 355
Pittsburgh Pennsylvania 15230-0355

DCP/NRC1463
May 31, 2000

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

ATTENTION: J. N. WILSON

SUBJECT: AP1000 PRE-APPLICATION REVIEW ITEMS

Dear Mr. Wilson:

Per the request in your letter on May 10, 2000, we have identified five fundamental assumptions to be evaluated in phase two of the Nuclear Regulatory Commission's (NRC) pre-application review of the AP1000 standard plant design. These items are summarized below and are deemed critical to the determination of whether to submit a design certification application for the AP1000 design in the near future. In addition, a summary description of the information (i.e. report, analysis, etc.) that Westinghouse plans to provide to the NRC during the phase two review is identified for each of the five items along with Westinghouse's expectations related to each item.

Item 1 —The AP1000 Design Certification Application will reference sections of the AP600 Design Control Document (DCD) that do not change for the AP1000.

To reach agreement on this item, Westinghouse and the NRC should agree on the scope of the AP600 DCD that can be retained for the AP1000. This will determine the scope of the NRC review of the AP1000 DCD submitted for Design Certification. It is expected that at the conclusion of phase two, the NRC and Westinghouse will agree on the revised Table of Contents for the DCD and delineate the sections that can be retained from the AP600 DCD.

W Deliverable: Table of Contents of AP1000 Design Control Document

W Expectation: Agreement on the Table of Contents for the DCD, including a determination of the sections that can be retained from the AP600 DCD that will not be subject to re-review. It is our expectation that the NRC will also agree that corresponding portions of NUREG-1512, "Final Safety Evaluation Report Related to Certification of the AP600 Standard Design" will not change materially.

Item 2 —The AP1000 Design Certification Application will not require additional tests to be performed by the applicant.

In NUREG-1512, "Final Safety Evaluation Report Related to Certification of the AP600 Standard Design," the NRC states that the requirements of 10 CFR Part 52 have been interpreted to require that a passive plant vendor must develop and perform design certification test programs of a sufficient scope. This includes both separate-effects and integral-systems experiments to provide data to assess the computer codes used to analyze plant behavior over the range of normal operating conditions, transient conditions, and accident sequences.

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It is our position that the AP600 test program meets the requirements of 10 CFR Part 52 for the AP1000. Westinghouse proposes to provide a report to the NRC staff to permit the NRC staff to evaluate this conclusion. The AP1000 Analysis Plan and Scaling Assessment of AP600 Test Program is a single report that will be provided to the NRC staff for their review. Its format will be based on WCAP-14141, AP600 Test and Analysis Plan. Its scope and content is described in more detail in Attachment 1.

W Deliverable: AP1000 Analysis Plan and Scaling Assessment of AP600 Test Program

W Expectation: NRC determination whether the AP600 test program meets the requirements of Part 52 for the AP1000.

Item 3 — The AP1000 Design Certification Application can utilize the AP600 analysis codes with limited modifications.

As part of the design certification application for the AP600, Westinghouse performed extensive code development and validation activities to develop analysis tools suitable for performing Chapter 15 accident analyses for the AP600. The NRC and the Advisory Committee on Reactor Safeguards (ACRS) have performed extensive reviews of the code development and validation programs for each of the computer codes developed for the AP600. It is our position that these codes are suitable for use in performing accident analyses for the AP1000. It is recognized that certain limitations of the codes were identified in NUREG-1512. In these cases, the acceptability of the codes for the AP600 is based, in part, on the large safety margins provided by the AP600. Westinghouse will address the limitations identified in NUREG-1512 for the AP600 computer codes used for safety analysis and will demonstrate the appropriateness of their use for the AP1000. Westinghouse will provide an assessment of the applicability of each code and will identify code changes to address the most significant comments documented in NUREG-1512. This assessment will be provided as part of the AP1000 Analysis Plan and Scaling Assessment of AP600 Test Program Report discussed under item 2.

In addition, to assist the staff in their consideration of this item, Westinghouse will provide a report that assesses the AP1000 passive core cooling system design margins with respect to safety injection performance characteristics. The relative margin between the performance of the AP600 and the AP1000 passive core cooling system features will be assessed during the minimum core inventory time period at the start of IRWST injection following a small LOCA. This assessment will address the relative performance margins in the IRWST injection paths and the ADS stage 4 vent paths. The line resistances of these paths will be used together with consistent boundary conditions to provide a simple calculation of the comparative injection and venting flow rates. The purpose of this evaluation is to provide a simple estimate of the relative margin of the AP1000 as compared to the AP600. The report will present the important inputs, boundary conditions and calculated results and will discuss the meaning and significance of the results. This report is not meant to replace any of the Chapter 15 accident analyses that would be provided as part of the AP1000 Application for Design Certification. It is provided for informational purposes to assist the staff and ACRS to assess the margin of safety that will be provided by the AP1000 passive safety systems for the particular phase of the LOCA events that is most sensitive to the code limitations outlined in NUREG-1512.

W Deliverable: AP1000 Analysis Plan and Scaling Assessment of AP600 Test Program (See Item 2)
AP1000 Passive Core Cooling System Design Margins Assessment

W Expectation: NRC determination that the AP600 analysis codes including the proposed changes are adequate for analyzing the AP1000.

Item 4 — The AP1000 Design Certification Application can utilize the AP600 PRA supplemented with a sensitivity study to meet the requirements for a plant-specific PRA.

The Code of Federal Regulations specifies in 10 CFR Part 52.47 that an application for design certification must contain a design-specific probabilistic risk assessment. It is our position that the probabilistic risk assessments performed for the AP600, supplemented with a sensitivity study, is sufficient to meet the requirements of 10CFR52.47(a)(1)(v) for the AP1000 Design Certification Application.

The objective for this issue is to provide the NRC with sufficient information such that the staff can conclude that the Westinghouse approach with regards to satisfying the requirements of 10CFR52.47(a)(1)(v) is acceptable. Westinghouse proposes that the scope of the PRA sensitivity study that will be submitted as part of the AP1000 Application for Design Certification should be agreed to during the phase two review. Westinghouse will propose a Table of Contents for this study and an explanation of what will be included in the study. Attachment 2 provides a description of the elements proposed to be included in the AP1000 PRA.

One of the goals of the AP1000 PRA sensitivity study is to demonstrate that the AP1000 success criteria are the same or similar to the AP600. Toward this end, an analysis of LOCA accident sequences that were determined to reflect the broad spectrum of phenomena important to the AP600 success in the level 1 PRA will be completed for the AP1000. Westinghouse proposes that, in phase two, the analyses from the MAAP4 Benchmarking Report (WCAP-14869) will be performed for the AP1000 using the MAAP4 code with the intent of demonstrating that the AP1000 plant response to these sequences is similar to the AP600 response. These analyses will provide a level of confidence to the NRC that the PRA level 1 success criteria for LOCA are achieved at the increased power level of the AP1000.

W Deliverable: Table of Contents for the AP1000 PRA Sensitivity Study
AP1000 Level 1 PRA LOCA Success Sequences Analysis Report

W Expectations:

1) NRC determination that the AP600 PRA supplemented with a suitable sensitivity study meets the requirements for the AP1000 plant-specific PRA; and
2) Agreement that the analysis results provided in the AP1000 Level 1 PRA LOCA Success Sequences Analysis Report are sufficient to conclude that the AP1000 Level 1 success criteria for LOCA is the same as for the AP600.

Item 5 — The AP1000 Design Certification Application can defer selected design activities to the COL applicant.

The AP1000 Design Certification application will include less design detail than that provided in the AP600 Design Certification application. The General Arrangement, structural configuration, equipment and piping layout are substantially the same; However, qualification analyses will be deferred to the Combined License applicant. This affects the design detail available during Design Certification in the following areas:

Seismic analyses	(DCD Sections 2 and 3.7)
Structural design	(DCD Section 3.8)
Piping design	(DCD Section 3.6 and 3.9)

The objective in phase two for this issue is for Westinghouse and NRC to agree on the level of detail necessary for Westinghouse to provide in an application for Design Certification for the AP1000. In phase two, Westinghouse will provide markups of the above listed sections of the AP600 DCD. These markups will show the level of information proposed for the AP1000 DCD. The AP1000 DCD will retain the methodology and design criteria for the COL applicant that references an AP1000 plant. Where the AP600 DCD contained results of analyses, the AP1000 DCD will identify information to be provided by the Combined License applicant. COL requirements will be proposed similar to those employed in the DCD for other certified standard plant designs (i.e. System 80+).

Attachment 3 summarizes the Westinghouse approach to the level of detail that will be provided in the applicable sections of the DCD and the items to be included in the phase two reviews.

W Deliverables:

Draft DCD Sections 2, 3.6, 3.7, 3.8, and 3.9 and the seismic analysis for hard rock. These drafts will be markups of the AP600 SSAR showing changes in strike out / redline format. It is expected that these sections would be nearly the final form for the AP1000. The changes from AP600 would primarily be items deferred to the COL applicant.

W Expectations:

1) NRC concurrence with the level of detail to be included in the AP1000 application.
2) Identification of significant issues to be addressed during Design Certification.
3) NRC agreement on the scope and content of the new COL commitments.

Finally, at the conclusion of the phase two review effort, Westinghouse seeks an estimate of the lead times, schedule milestone intervals and fee estimates of the review effort for an AP1000 Design Certification Application.

We would like to discuss these five fundamental assumptions and our planned deliverables with the key NRC staff reviewers at the June 5, 2000 meeting at the NRC. At that meeting, the cognizant Westinghouse engineers will describe our plan for each item, so that the NRC staff can provide feedback as to the acceptability of this plan. Subsequent to that meeting, Westinghouse requests the NRC to provide a milestone schedule and fee estimate for the phase two review effort. Note also the this schedule and estimate should include interactions with the ACRS necessary to receive their approval of these five items discussed in this letter.

Please contact me if you have any questions concerning this request.

Very truly yours,

Michael M. Corletti

M. M. Corletti
Advanced Plant Safety & Licensing

cc: W. E. Cummins – Westinghouse
J. W. Winters – Westinghouse
H. A. Sepp – Westinghouse
R. A. Matzie – Westinghouse
H. J. Bruschi – Westinghouse
[redacted] – Westinghouse

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Attachment 1 to DCP/NRC1463

AP1000 Analysis Plan and Scaling Assessment of AP600 Test Program Report

The AP1000 Analysis Plan and Scaling Assessment of AP600 Test Program Report is a single report that will be provided to the NRC staff for their review. Its format will be based on WCAP-14141, AP600 Test and Analysis Plan. The following is a description of the proposed AP1000 report:

I. Background/Purpose

- Description of process to support application of analysis codes currently approved for 600 Mw (i.e. AP600) passive plant design for 1000 MW uprating.

II. AP1000 Design

- Brief description of AP1000 design.
- Summary of major differences (i.e. core power, containment height, reactor vessel length, pressurizer etc.) in physical scale between AP600 and AP1000.
- Sketches/Layout drawings highlighting key physical dimensions to support PIRT and scaling assessments.

III. Important Thermal-Hydraulic Phenomena for Modeling AP1000 Performance

- Brief summary of important (i.e. high ranked) AP600 phenomena by transient and phase of transient.
- Results of expert reviews of AP600 PIRTs for application to AP1000.
- Reconciliation of expert review comments for AP1000.
- PIRT tables for AP1000 and summary of high ranked phenomena.
- Discussion and assessment of differences (if any) between AP600 and AP1000 PIRTs.

IV. Testing

- Brief summary of AP600 test program.
- SBLOCA, LBLOCA, Non-LOCA Transient
  - OSU, SPES-2, CMT, ADS, and PRHR Tests.
- Containment
  - LST, SST, Air Flow, Water Distribution, Water Film Formation, Wind Tunnel, Heated Flat Plate, and Univ. of Wisconsin Condensation Tests.
- Discussion of sufficiency of existing data bases for code validation of high ranked phenomena for AP1000. Sources of test data will be identified for important phenomena.
- Describe approach that no new testing is required as scaling analysis will justify application of AP600 test database to AP1000.

V. Scaling

- Approach of scaling effort for AP1000.
  - SBLOCA scaling will focus on ADS and transition to IRWST injection phases of transient. These phases were most important and unique to AP600. Therefore, they will receive the most scaling attention in AP1000.
  - AP600 LBLOCA behaves as conventional plant for which code validation exists; passive features do not play an important role. The break provides the depressurization and the accumulators recover the plant. AP1000 is expected to behave similarly and therefore; as with AP600, testing and scaling are not required.
  - Containment scaling will focus on limiting large break event (steam line break or cold leg LOCA).
  - Non-LOCA transient scaling will focus on the CMT and PRHR as they are unique to the passive plant design.

- Results in matrix or tabular format of high ranked phenomena, key scaling groups addressing this phenomena, numerical scaling ratios of test facility relative to AP600 and AP1000.
- Discussion of differences in scaling results relative to AP600 and AP1000.
- Identify where important phenomena are adequately scaled and suitable for code validation and identify where scaling is distorted and therefore not adequate for code validation without compensating conservative treatment.
- Document scaling equations, derivation of scaling groups, and key reference values used to numerically evaluate scaling groups for AP1000 in an Appendix. In an effort to improve scaling efficiency and usefulness in some cases, scaling equations from AP600 may be recast or combined to reduce the number of scaling groups that are needed to be evaluated.

VI. Code/Model/Correlation Validation

- Approach to code validation effort. Validate only new or re-ranked phenomena based upon AP1000 PIRT.
- Summary of models, correlations to address important phenomena.
  - NOTRUMP
  - WCOBRA-TRAC
  - WGOTHIC
  - LOFTRAN
- Results of code validation effort. Identify where test database is not adequate for code validation purposes and bounding/conservative modeling approach taken.
- Document models, correlations, and code comparison tests in Appendix.

AP1000 Probabilistic Risk Assessment Development Process

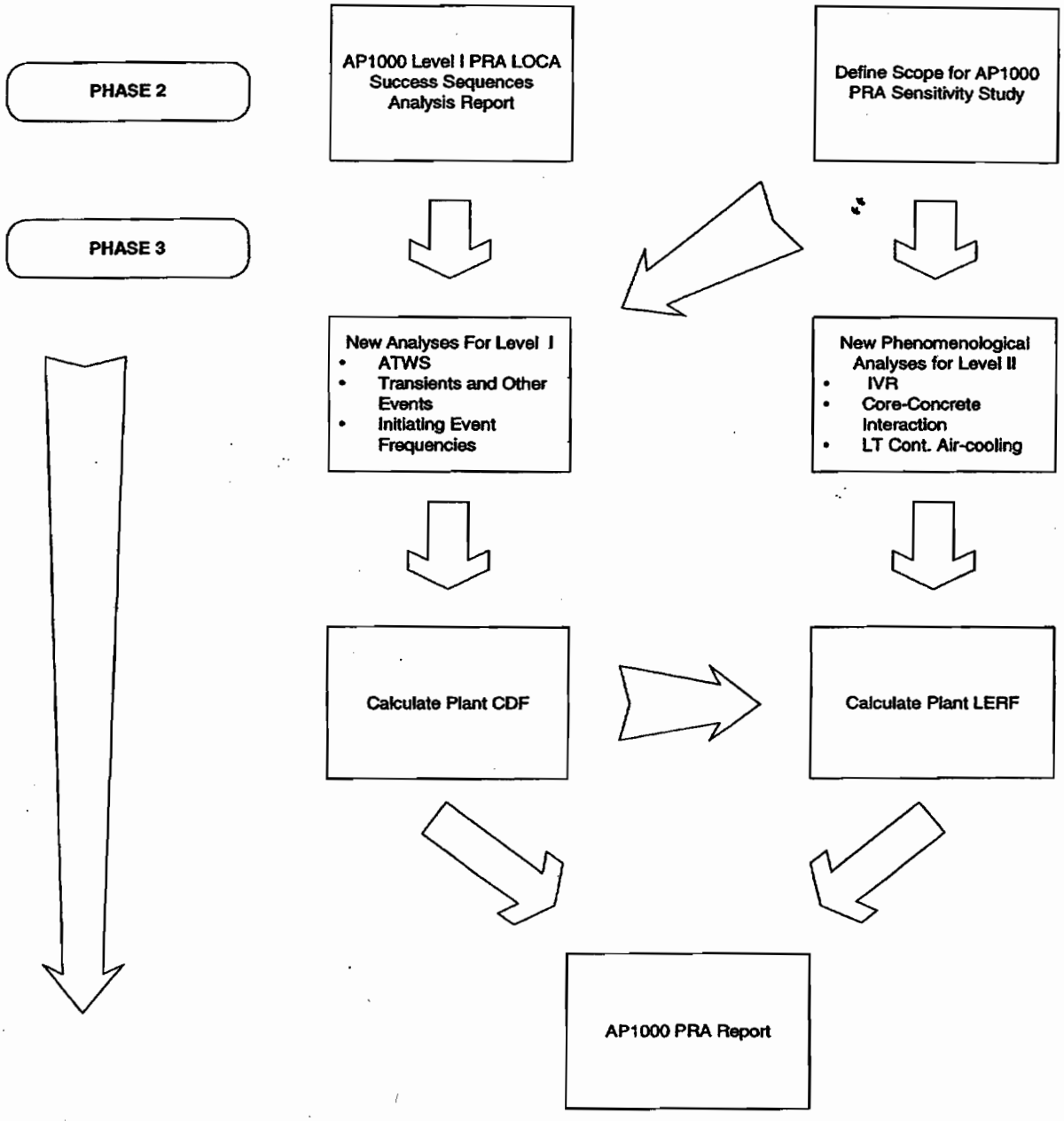

Figure 1. AP1000 PRA Analysis Approach

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Attachment 3 to DCP/NRC1463

Summary of Level of Detail in AP1000 Design Control Document

Seismic Analyses (DCD Sections 2 and 3.7)

10CFR52 requires identification of site parameters for the design and an analysis and evaluation of the design in terms of these parameters. Westinghouse will identify the site parameters for the AP1000 to the same level of detail as identified for AP600 in DCD Chapter 2 and in ITAAC 5.0.

The AP1000 DCD will include key structural dimensions for the AP1000 similar to those included in Figure 3.7.2-12 for AP600.

The AP1000 DCD will defer seismic analyses of the nuclear island to the COL applicant. Chapter 2 Appendices 2A, 2B and 2C of the AP600 Design Certification which included the results of parametric analyses to justify selection of four design soil profiles will not be included in the AP1000 DCD. Analyses and evaluation will be provided in phase two for a hard rock site. The results of these analyses are intended in phase two to provide NRC with an understanding of the effect of the AP1000 configuration changes on the seismic results previously provided for the AP600. Additional review of these analyses may be deferred to the review of the AP1000 Design Certification Application.

Structural Design (DCD Section 3.8)

Structural design criteria and methodology will be the same as for AP600. Key structural dimensions will be included in Section 3.7. The AP1000 containment configuration will be shown in Section 3.8.2. To demonstrate feasibility, Westinghouse proposes to assess a few critical items in the Design Certification Application using seismic results from the AP1000 hard rock analyses. These assessments will be available for NRC review during the review of the Design Certification Application and could include:

Containment vessel preliminary design for internal pressure, external pressure and SSE (DCD 3.8.2)
- Containment vessel Service Level C and ultimate pressure (DCD 3.8.2)
- Shield building roof (DCD 3.8.4)
- Nuclear island basemat (DCD 3.8.5)
- Nuclear island stability (DCD 3.8.5)

Westinghouse and NRC should agree in phase two on the above list of items that would need to be considered during the Design Certification phase.

The COL applicant will be responsible for completing the structural design using the results of their seismic analyses.

Piping Design (DCD Section 3.6 and 3.9)

Extensive detail was provided and reviewed in the AP600 Design Certification. The methodology and acceptance criteria will be identical for the AP1000. AP1000 layout is similar to the AP600. The AP600 piping design and analyses are sufficient to demonstrate both feasibility and method of implementation for the AP1000. The COL applicant will be responsible for completing the piping design, including leak before break evaluation and pipe rupture hazard evaluation.

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 27, 2000

Mr. W. E. Cummins, Director
Advanced Plant Development Unit
Westinghouse Electric Company
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355

SUBJECT: AP1000 PRE-APPLICATION REVIEW - PHASE ONE

Dear Mr. Cummins:

This letter provides the results of the U.S. Nuclear Regulatory Commission (NRC) staff's phase one assessment of Westinghouse's AP1000 pre-application review. You requested the NRC to proceed with phase one in your letter of May 4, 2000, so that the scope of a design certification review could be determined (phase two). The results of the NRC's phase one assessment and estimates of the professional staff hours needed to perform the phase two review are given in Enclosure 1. A summary is provided in Enclosure 2. Our confidence in the accuracy of these estimates depends upon the schedule for the phase two review and the availability of the AP600 reviewers.

If Westinghouse chooses to proceed with the phase two assessment, it must submit a written request specifying the items that the NRC should evaluate. Westinghouse should also provide information that NRC can use to determine the priority for the phase two review, as part of the NRC's Fiscal Year 2001 workload. We will use the following performance goals to prioritize your request and any information that you choose to provide will assist us in developing a schedule for the phase two review.

1. Maintain safety, protection of the environment, and the common defense and security.
2. Increase public confidence.
3. Make NRC activities and decisions more effective, efficient, and realistic.
4. Reduce unnecessary regulatory burden on stakeholders.

An explanation of these goals is provided in the NRC's Strategic Plan (NUREG-1614, Vol. 2, Part 2). If you have any questions on this matter, please contact Jerry N. Wilson of my staff.

Sincerely,

Samuel J. Collins, Director
Office of Nuclear Reactor Regulation

Project No. 711

Enclosures: As stated

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cc w/encls: See next page

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PHASE ONE RESULTS

The following assessment addresses the five items proposed by Westinghouse in its letter of May 31, 2000, and an additional item (exemptions) proposed by the NRC staff for evaluation in phase two of the AP1000 pre-application review. The resource estimates assume that Westinghouse will provide complete, high-quality submittals to support the phase two review and that NRC will not need to make any written requests for additional information. Our confidence in the accuracy of these estimates depends upon the schedule for the phase two review and the availability of the AP600 reviewers.

Item 1 - Scope of NRC Review

The purpose of this item is to determine the scope of the NRC's design certification review of an AP1000 application, specifically, which sections of the AP600 design control document (DCD) will not require re-review for the AP1000 DCD. In order to perform this evaluation, the NRC staff expects Westinghouse to provide the following:

1. A description of its proposed design changes containing a level of detail comparable to that provided in Section 1.2 of the AP600 DCD.

2. An annotated Table of Contents for the DCD, Tier 2, identifying unchanged sections.

3. A rationale for why no change is needed in that section of the AP600 DCD.

The NRC's review of Item 1 will require about 30 staff members for about 1 month and will consume about 1000 professional staff hours, depending on the availability of former AP600 reviewers. This estimate does not include a review of Tier 1 information or NUREG-1512, "Final Safety Evaluation Report related to Certification of the AP600 Standard Design."

Items 2 and 3 - Test Program and Analysis Plan

The purpose of these items is to determine if the AP600 test program meets the requirements of 10 CFR 52.47(b)(2)(i) for the AP1000 design and if the analytical codes used for AP600, with changes proposed by Westinghouse, are acceptable for analyzing the AP1000. Specifically, the question is will the NRC require Westinghouse to perform additional tests or make further modifications to the analytical codes to support an AP1000 application for design certification. In order to determine whether the AP600 test program (including test matrices) and code validation are sufficient for the AP1000, Westinghouse must develop a Phenomena Identification and Ranking Table (PIRT) for the AP1000, identify key thermal-hydraulic (T/H) phenomena and parameter ranges, and identify any new phenomena or differences from the AP600 PIRTs for large- and small-break loss-of-coolant accidents (LOCAs) and non-LOCA transients. It is also expected that Westinghouse will provide the following:

1. AP1000 Analysis Plan and Scaling Assessment of the AP600 Test Program
2. AP1000 Passive Core Cooling System Design Margins Assessment

The following discussion identifies additional information that the NRC staff expects to be addressed by Westinghouse in its submittal for Items 2 and 3 and provides estimates of the staff effort needed to review these issues.

Separate Effects Tests

Westinghouse must demonstrate that the existing separate effects tests of the passive residual heat removal system (PRHR) heat exchanger (HX), automatic depressurization system (ADS), and core makeup tank (CMT) sufficiently cover the ranges of key T/H phenomena and parameters or acquire additional test data. For example:

1. Westinghouse must demonstrate that the ADS test conditions provide sufficient coverage of the operating conditions expected in the AP1000 design. Westinghouse must provide justification as to why the range of T/H conditions covered by the AP600 ADS test program and the data acquired therefrom, provide an adequate basis for validation of code models for ADS performance analysis for the AP1000.

2. The PRHR behavior has a significant effect on reactor coolant system behavior over a wide range of design basis accidents. The PRHR HX tests were performed with three straight tubes compared to the C-tube HX in the AP600 and AP1000 designs. Although the staff concluded that the straight tube based heat transfer model did an adequate job of predicting C-tube performance for the AP600, the AP1000 PRHR system has larger pipe connections to the HX, higher flow and heat transfer, and possibly new T/H phenomena such as vapor blanketing the HX tubes during both natural circulation and forced convection modes. Westinghouse must demonstrate that the straight tube test bundle adequately simulates the C-tube HX design, whether the ROSA PRHR design, which was used for confirmatory tests, is adequate to simulate the AP1000, and whether the test data cover the ranges of PRHR HX T/H phenomena and parameters. It is possible that additional PRHR tests in a substantially upgraded test facility may be required.

3. The CMT tests were performed with the test article that is half of the height and 1/7.8 of the diameter of the AP600 CMT design. Westinghouse must demonstrate that the AP600 CMT tests are adequate for the AP1000 design, including scaling, test matrix, and data.

Integral System Tests

Westinghouse must submit a scaling report for the integral system tests, such as OSU/APEX and SPES-2 (high pressure, full vertical scale), for the AP1000 and demonstrate that the test matrices of OSU/APEX and SPES-2 provided adequate coverage of the break sizes and locations to address important system-related phenomena identified in the AP1000 design. It is possible that additional integral system tests may be required, especially for validation of the NOTRUMP code for small-break LOCA analysis and the WCOBRA/TRAC code for long-term cooling analysis.

The NRC's review of the separate effect and integral system tests will be performed by one staff member for about 30 weeks and will consume about 1200 professional staff hours. This estimate assumes that the AP600 test program reviewer will not be available to evaluate these tests, and a new staff member will have to spend a significant amount of time reviewing the AP600 test program to prepare for the phase two assessment.

Critical Heat Flux Test

The AP1000 will use a fuel design of a 14-foot active fuel length compared to the 12-foot VANTAGE-5H used in the AP600, and it will have a higher power density than in the AP600 fuel design. Therefore, the NRC staff believes that Westinghouse should include a review of test data necessary to ensure that the WRB-2 critical heat flux (CHF) correlation used for the AP600 is applicable to the ranges of T/H and geometric parameters of the AP1000 fuel design. Westinghouse will have to either (1) provide justifications on the applicability of the WRB-2 CHF correlation to the new fuel design by demonstrating that sufficient test data exist to cover the geometrical and T/H conditions of the new fuel design or (2) acquire additional CHF data to cover the new fuel design and T/H conditions and demonstrate that the WRB-2 correlation adequately predicts the new data, or develop a new CHF correlation (including WRB-2 modification). The NRC's review of the CHF correlation will require one staff member and consume about 40 professional staff hours.

WCOBRA-TRAC

WCOBRA-TRAC was benchmarked for a long term cooling (LTC) application to four experiments in the OSU/APEX facility. In the AP600 review, the power density limit that could be supported by natural circulation in the primary system was not established. Since the AP1000 has higher power density than the AP600, some analysis (or even testing) is required to establish that the OSU/APEX results used in the AP600 WCOBRA-TRAC LTC validation are valid for the AP1000 design. The resource estimate assumes that the AP600 reviewer will evaluate WCOBRA-TRAC for LTC and large-break LOCA and will consume about 320 professional staff hours for 2 to 3 months.

LOFTRAN/LOFTTR2

The LOFTRAN code that was used for transient analyses is hardwired specifically for the AP600 design and has models for each AP600 component that are very hardware specific. The code will have to be modified for the different AP1000 components. Conditions for the main steamline break (MSLB) and steam generator tube rupture events will be significantly different. Westinghouse needs to explain how LOFTRAN has been or will be changed to model AP1000 and why these changes are appropriate.

NOTRUMP

The AP600 Final Safety Evaluation Report (NUREG-1512) concludes that the approval of NOTRUMP for use in the small-break LOCA analysis is given specifically for the AP600, which means it is restricted to that configuration and power level. There were numerous problems with the AP600 analysis that would require the whole code and analysis qualification to be

re-evaluated. For example, the code does not calculate non-condensable gas in the system, as required by NUREG-0737, "Clarification of TMI Action Plan Requirements," item II.K.3.30. It would have to be shown that non-condensable gas would not be injected into the system for the AP1000 design. The AP600 test program was unable to track the gas in the system.

The AP600 small-break LOCA analysis did not predict uncovery of the core, but the predicted level was very close to the top of the core. In fact, there was a two-phase mixture in the core for some of the breaks. The AP1000 core is 2 feet longer, with a higher linear heat generation rate and a higher power density. If the AP1000 analysis predicts core uncovery, there can be little doubt that transition boiling will occur. That is another problem because the transition boiling correlation was found to be unacceptable in the AP600 review. Therefore, the heat transfer package review will have to be reopened.

The NRC's review of LOFTRAN and NOTRUMP will require one staff member for 2 to 4 months and will consume 300 - 600 professional staff hours, depending on the availability of the former AP600 reviewer. The NRC's review effort will require going back over the testing program to determine the validity of the tests for this new configuration.

WGOTHIC

The large-scale test (LST) facility was a proof-of-principle test and not a scaled test facility and exhibited shortcomings in both scaling and prototypicality (mass and energy inputs, heat sinks - both short term and long term - compartments, etc.). Therefore, it could only address some portions of the evaluation model and could not be used as an integral test. At the scale of the AP1000 design, these issues are likely to be more significant. In addition, the physical modeling of the AP600 design was based on scaling the model used in the WGOTHIC calculations of the LST.

The mass and heat transfer correlations used in WGOTHIC came from separate effects tests or technical journal references. The applicable ranges of these correlations need to be examined at the scale of the AP1000. In addition, the passive containment cooling system (PCS) water flow characteristics were developed in the cold water distribution test (WDT) facility. The WDT modeled the range of the AP600 PCS water flow rates, although the actual flow rates in the AP600 are higher than tested. The WDT also modeled the expected surface conditions of the AP600 (material, coating, and surface defects). The AP1000 PCS water flow rates and surface conditions may not be adequately represented by the WDT.

Westinghouse is expected to provide the following information in its phase two submittal:

1. A PIRT evaluation that addresses the parameter ranges of the heat and mass transfer correlations and the PCS water (film) correlations used in WGOTHIC to justify their use at the scale of the AP1000 design or if new or additional experimental programs are needed to extend their ranges. Westinghouse also needs to address the multipliers approved for the AP600 as related to the AP1000.

2. A scaling evaluation of the LST facility to accomplish the following:

a. Demonstrate that the AP1000 model (lumped-parameter nodalization - node sizes, boundaries, etc.) is justified.

b. Demonstrate that the PCS water flow characteristics (flow rate, delay time, cover areas, film stability, surface defects, loss coefficient in the external annulus, etc.) are justified and within the correlation ranges developed for the AP600.

c. Demonstrate that the mass and energy (LOCA and MSLB) driving forces as they would influence jet characteristic, plume rise, wall boundary layers, and so on, are justified and within the mass and heat transfer correlation ranges.

3. The "Limitations and Restrictions" (see NUREG-1512, Section 21.6.5.8.3) on the AP600 evaluation model need to be justified or modified accordingly for the AP1000.

The NRC's review of WGOTHIC will use the former AP600 reviewer for 1 to 2 months and will consume about 120 professional staff hours.

Item 4 - AP1000 Probabilistic Risk Assessment

The purpose of this item is to determine if the AP1000 design certification application can utilize the AP600 probabilistic risk assessment (PRA), Level 1, supplemented with a sensitivity study to meet the requirements for a design-specific PRA. This proposal would be acceptable if changes associated with initiating event frequencies and system configurations, failure mechanisms, failure data, and success criteria do not have a significant impact on PRA results and insights. Westinghouse expects to be able to confirm, through additional analyses, that the initiating event frequencies and the success criteria for both systems and operator actions used in the AP600 PRA event trees are also valid for the AP1000. If this exercise is successful, the AP600 PRA quantification will be maintained. In case some success criteria, which affect the results and insights of the PRA and its use in the certification process, change, the PRA will need to be requantified with the new success criteria.

The NRC staff will determine whether the results of the AP1000 Level 1 PRA LOCA Success Sequences Analysis Report are sufficient to conclude that the AP1000 Level 1 success criteria for LOCA are the same as those for the AP600 design. Westinghouse used the MAAP4 code to screen PRA success criteria for the AP600. MAAP4 was benchmarked against the NOTRUMP code with risk-significant accident sequences for the AP600. The AP600 PRA also used a "margin-based" approach for the resolution of the T/H uncertainties. The review of the AP1000 PRA success criteria will involve benchmarking of MAAP4 for its validity for AP1000 event sequence analysis, and sufficient margins to address T/H uncertainties. As previously discussed, a determination must be made as to whether NOTRUMP is adequate for the analysis of the small-break LOCA for the AP1000. Consequently, a determination must also be made as to whether the MAAP4 benchmark with NOTRUMP for the AP600 is adequate for the AP1000. To benchmark MAAP4 for the AP1000 PRA, Westinghouse must rerun the risk- significant sequences used for the AP600 benchmark with both MAAP4 and an acceptable NOTRUMP and evaluate any significant differences in the results. Conservative bounding inputs and assumptions must be employed to demonstrate adequate margins to core damage. The NRC staff needs to evaluate Westinghouse's criteria and bases used in the comparisons between the AP1000 and the AP600 results to justify that these comparisons are sufficient for concluding that

the same AP600 success criteria are being maintained. Otherwise, Westinghouse must use the benchmarked MAAP4 code to rerun a spectrum of event sequences, following a similar approach as the one used for AP600, to demonstrate that the success criteria are the same. Therefore, Westinghouse must provide the following Level 1 PRA information:

1. A detailed description of the approach that will be followed to confirm the validity of the success criteria for both systems and operator actions. In the AP600 PRA, the success criteria were determined by a risk-based margins approach that used conservative assumptions for key T/H parameters, such as decay heat. This process resulted in success criteria that are sequence dependent and take into account T/H uncertainties. Westinghouse should discuss how the proposed design changes will affect the implementation of the margins approach for the AP1000. If it is proposed that some portion of the AP600 margins approach implementation be retained, Westinghouse should provide documentation showing that this action will not compromise the robustness of the success criteria (for both systems and human actions) used in the AP1000 PRA models.

2. A list of changes in the AP600 design with an explanation of why such changes would not introduce additional hardware failure mechanisms or increases in hardware failure rates. Both power operation and shutdown operation need to be addressed.

The NRC's review of Item 4 will require three former AP600 reviewers for 3 to 4 months and will consume about 800 professional staff hours.

Item 5 - Defer Selected Design Activities

The purpose of this item is to determine if selected design activities can be deferred to the combined license review stage. Specifically, it must be determined if Westinghouse can use design acceptance criteria (DAC) in lieu of detailed design information for the AP1000 seismic analysis, structural design, and piping design. In order to perform this evaluation, the NRC staff expects Westinghouse to provide the following:

1. Revised DCD Sections 2, 3.6, 3.7, 3.8, and 3.9 for the AP1000.
2. Draft DACs for seismic analysis, structural design, and piping design.
3. Results of an AP1000 seismic analysis for a hard rock site.
4. Westinghouse's rationale for using DAC in lieu of detailed design information.

The NRC's review of Item 5 will require three staff members for 2 to 3 months and will consume 400 to 500 professional staff hours, depending on the availability of former AP600 reviewers. In addition to the submittals previously mentioned, Westinghouse should consider the following structural issues regarding the feasibility of converting the AP600 design to the AP1000 design:

1. Dynamic stability of the nuclear island (sliding and overturning) - the ability of safety significant plant structures to resist sliding and overturning as a result of an earthquake is very important. Because of the increase of (1) the height of the shield building and the containment vessel, (2) the size of the cooling water storage tank and the size of nuclear steam supply system (NSSS) components, the overall horizontal seismic force and

overturning moment will increase in comparison to the AP600 design. Westinghouse should demonstrate that the factors of safety for both horizontal sliding and overturning motion as a result of seismic excitation meet the acceptance criteria.

2. Westinghouse should demonstrate the adequacy of its 6-foot-thick foundation mat (in the balance-of-plant area) under the increased design loads (dead loads and seismic loads) for the AP1000.

3. Because the design margin of some critical sections documented in the AP600 DCD (for example, modular walls for the reactor water storage tank) is minimal, Westinghouse should demonstrate the adequacy of these critical sections under the increased design loads (thermal load, pressure load, and seismic loads).

4. If Westinghouse plans to use a newer edition of the design codes (e.g., American Society of Mechanical Engineers [ASME] 1999 Addenda) for the design of safety-related structures, it will be required to (1) compare the new codes with those already endorsed by the NRC, (2) identify differences between the two sets of design codes, (3) evaluate the significance of these differences, and (4) demonstrate an acceptable level of quality and safety in the use of the new codes pursuant to 10 CFR 50.55a(a)(3)(i).

5. Because of the increased size of NSSS components (diameter and height), the thermal and pressure loads in the subcompartments are expected to increase. Assuming these loads are found acceptable, Westinghouse needs to demonstrate the design adequacy of the subcompartment walls with these higher subcompartment pressures.

6. Westinghouse will need to demonstrate that the AP1000 steel containment will continue to meet the containment performance requirement for severe accidents (withstand the internal pressure at 24 hours after the start of an accident at ASME Service Level C limits).

7. The staff's preliminary review of the "Tier 2 Master Table of Contents of AP1000 DCD" found that changes to additional sections, tables, and figures of the AP600 DCD will be necessary for the AP1000 design. For example, because of the design changes of structural elements (i.e., the height of the shield building, the size of the cooling water storage tank), the dead weight of the nuclear island will be increased significantly, especially in the containment area (i.e., the containment shell, internal structures, and the shield building). Therefore, Section 3.8.5.4.3, "Analysis for Loads During Construction," should either be deleted because it is plant specific or revised. Additional sections that need to be changed are as follows:

   a. Seismic Design: Section 3.7.2.4, Table 3.7.1-2, Figures 3.7.1-17 through -19, and Figure 3.7.2-1.

   b. Steel Containment Design: Sections 3.8.2.1.1, 3.8.2.1.3, 3.8.2.4.1.2, 3.8.2.4.2.2, and 3.8.2.4.2.3 and Tables 3.8.2-2 and 3.8.2-3.

   c. Foundation Mat: Sections 3.8.5.1, 3.8.5.4.1, 3.8.5.4.2, 3.8.5.4.3, and 3.8.5.5.3.

Exemptions

The purpose of this item is to determine if any of the exemptions that were granted for the AP600 design certification can be used in the AP1000 application. In order to perform this evaluation, the NRC staff expects Westinghouse to provide the following:

1. Identification of all exemptions that Westinghouse plans to request for the AP1000.
2. Justification for the exemptions in accordance with the requirements of 10 CFR 50.12.

The NRC's review of Item 6 will be performed by the AP1000 project manager, in consultation with selected staff members, and will be completed within 1 month and consume about 80 professional staff hours, depending on the availability of former AP600 reviewers.

Project Management for Phase Two

If Westinghouse decides to proceed with phase two of the AP1000 pre-application review, a senior project manager and a backup project manager will be assigned to manage the NRC staff's review. If phase two lasts 6 to 8 months, the project management effort will consume about 600 professional staff hours. This effort includes preparation of a paper on the phase two results for the Commission's review, a phase two letter report, and participation in internal briefings.

Advisory Committee on Reactor Safeguards

The NRC staff recommends that the Advisory Committee on Reactor Safeguards (ACRS) participate in the phase two portion of the AP1000 pre-application review. Therefore, an estimate was made of the hours the ACRS and the NRC staff would consume during two full Committee meetings and one Subcommittee meeting, namely, about 60 hours per meeting session for a full Committee meeting and 100 to 180 hours per meeting day for a Subcommittee meeting, based on billable hours in the past.

If the ACRS holds a full Committee meeting on the AP1000 phase one results, it is estimated that 10 NRC staff members would attend the meeting for 2 hours and consume 20 professional staff hours. These hours are in addition to the 60 hours needed by the ACRS. A memorandum from John T Larkins (ACRS) to William D. Travers (EDO), dated June 21, 2000, on the AP1000 pre-application review is provided in the attachment.

If the ACRS holds a full Committee meeting on the AP1000 phase two results, it is estimated that 15 NRC staff members would attend the meeting for 2 hours and consume 30 professional staff hours. These hours are in addition to the 60 hours needed by the ACRS. It may also be necessary to hold a 2-day subcommittee meeting on the test program and analytical codes, before the full Committee meeting on the phase two results. The Subcommittee meeting will consume about 170 professional staff hours to prepare and participate in the 2-day Subcommittee meeting and about 280 hours of ACRS time.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
WASHINGTON, D.C. 20555-0001

June 21, 2000

MEMORANDUM TO: William D. Travers
Executive Director for Operations

FROM: John T. Larkins, Executive Director
Advisory Committee on Reactor Safeguards

SUBJECT: AP1000 PRE-APPLICATION REVIEW

During the 473rd meeting of the Advisory Committee on Reactor Safeguards, June 7–9, 2000, the Committee considered the proposed AP1000 advanced reactor design pre-application and the issues that would need to be addressed as part of the staff's review of a license application. Attached is a list of issues that the Committee decided should be addressed by the Westinghouse Electric Company.

Attachment: ACRS Issues Related to the Review of the AP1000 Design

Reference:
Westinghouse Electric Company Slides, "AP1000 Overview," presented to the NRC staff on April 27, 2000.

cc: A. Vietti-Cook, SECY
J. Craig, OEDO
G. Millman, OEDO
S. Collins, NRR
D. Matthews, NRR
J. Wilson, NRR

Attachment

ACRS ISSUES RELATED TO THE REVIEW OF THE AP1000 DESIGN

1. The staff should ensure that the Westinghouse Electric Company's application for the AP1000 design includes the following:

   a. Scope of additional analyses needed for the Standard Safety Analysis Report (SSAR) Chapter 15 accidents. (Revised codes used in the analyses may need to be revalidated.)

   b. Clear identification of the inadequacies in the NOTRUMP code and the steps taken to compensate for them. (A convincing demonstration of the applicability of the revised NOTRUMP code to the AP1000 design is needed.)

   c. Demonstration of the scalability and adequacy of the existing thermal-hydraulic integral and separate effects data.

   d. Identification of additional experiments or analyes needed to justify crediting in-vessel core debris retention as part of the licensing basis.

   e. An evaluation of core performance.

   f. An evaluation of the impact of any changes in performance ratings resulting from design changes.

   g. An evaluation of the effects of the pool of water above the containment on containment structures during seismic events.

2. The staff should ensure that the Westinghouse Electric Company's probabilistic risk analysis for the AP1000 includes the following:

   a. In-containment aerosol behavior, especially the effects of particle charging

   b. Catastrophic failure of the steel shell containment

   c. Containment bypass accident sequences, especially sequences involving steam generator tube ruptures

   d. Reactor coolant system depressurization reliability

   e. Efficacy and reliability of external cooling of the containment shell

   f. Stratification and mixing in the containment