Docket File

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

December 11, 1996

APPLICANT: Westinghouse Electric Corporation

PROJECT: AP600

SUBJECT: SUMMARY OF MEETING TO DISCUSS THE AP600 SCALING AND PIRT CLOSURE REPORT

The subject meeting was held on November 12, 1996, at the Rockville, Maryland, offices of Nuclear Regulatory Commission (NRC) between representatives of Westinghouse, the NRC staff, and NRC consultants. The purpose of the meeting was to provide the NRC staff and consultants an overview of how the AP600 scaling and PIRT closure report (WCAP-14727) provides closure to the AP600 testing program.

The NRC consultants provided Westinghouse with some general observations concerning the report, however, the NRC staff was not yet prepared to provide any formal comments. The NRC staff stated that it was close to being finished with its initial review of all but Chapter 3 of the report and should be able to provide comments by November 22, 1996. The staff stated that it had found some errata during its review of the report and would provide that information to Westinghouse by November 15, 1996. Westinghouse would also provide the staff a list of errata it had found since the report was issued. The staff hoped to have comments to Westinghouse on the general scaling approach (Chapter 3 of the report) by early December of 1996. Westinghouse expressed a desire to have a followup meeting or a teleconference after these comments are received and prior to the Advisory Committee on Reactor Safeguards subcommittee on T/H Phenomena meeting on this subject scheduled for December 18 and 19, 1996.

Based on discussions during the meeting on thermal stratification of the cold legs, Westinghouse agreed to a meeting action item (to be included in the open item tracking system). The action item is to provide the staff with any insights from testing that show the effect of multi-dimensional behavior (e.g. thermal stratification) on system response, and to identify any effects that would not be observed in the tests (e.g. effects on system response due to thermal stratification during a main steam line break or a steam generator tube rupture).

Following the meeting presentation, the open item tracking system was reviewed and updated.

DF03

Attachment 1 is the list of meeting attendees. Attachment 2 is the meeting agenda. Attachment 3 is the Westinghouse meeting presentation material. Attachment 4 is update to the open item tracking system.

original signed by:

William C. Huffman, Project Manager
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Docket No. 52-003

Attachments: As stated

cc w/attachments:
See next page

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WESTINGHOUSE - NRC MEETING

ON THE AP600 SCALING AND PIRT CLOSURE REPORT

NOVEMBER 12, 1996

MEETING ATTENDEES

NAME	ORGANIZATION
JOHN BUTLER	WESTINGHOUSE
LARRY HOCHREITER	WESTINGHOUSE
GENE PIPLICA	WESTINGHOUSE
BRIAN MCINTYRE	WESTINGHOUSE
ALAN LEVIN	NRC
JOHN BURTT	INEL
GUNOL KOJASOY	NRC CONSULTANT (U OF WISCONSIN)
FAROUK ELTAWILA	NRC (PART TIME)
PAUL BOEHNERT	NRC (PART TIME)
BILL HUFFMAN	NRC

Attachment 1

AGENDA

W/NRC Meeting on AP600 Test Program

November 12, 1996

1. Summary of PIRT/Scaling Closure Report Results and Conclusions — W
   - high level summary of what we did and what we learned

2. Overview of Unanticipated Phenomena (e.g., oscillations, stratification) — W
   - description of phenomena, is it test facility related or "real" for the plant
   - impact on the code validation
   - impact on the plant design and what we are doing about it

3. Results of staff review of PIRT/Scaling Closure Report (to date) — NRC

4. Review and discussion of remaining test program open items — W/NRC
   - confirm common understanding of remaining open items
   - identify necessary actions to close remaining open items
   - schedule for completion of remaining open items

Attachment 2

W/NRC Meeting on AP600
PIRT/Scaling Report

November 12, 1996

L. E. Hochreiter
E. J. Piplica
J. C. Butler

Westinghouse Electric Corporation

Attachment 3

W/NRC Meeting on AP600
PIRT/Scaling Report

Summary

- PIRT/Scaling Report Objectives were:
  - ☐ Provide a comprehensive assessment of the important phenomena for the AP600
  - ☐ Verify that the AP600 test provided data to assess the PIRT phenomena
  - ☐ Determine any distortions in the test facilities
  - ☐ Show that the test data is adequate for code validation

W/NRC Meeting on AP600
PIRT/Scaling Report

- To accomplish the objective, the PIRT/Scaling Report addresses:

  - ☐ Development of detailed PIRTs for each accident/phase (Chapter 2)
  - ☐ Top-down system scaling to determine relative importance for each system phenomena, scaled-up test comparisons to show scaling is proper, and to identify distortions (Chapter 3)
  - ☐ Top-down and Bottom-up scaling for each component test; and overlap between separate effect tests and integral tests (Chapter 4-8)

W/NRC Meeting on AP600
PIRT/Scaling Report

(Continued)

- ☐ Scaling distortion for the tests (Chapters 4-8), and discussion of the effects of distortion on the test data (Chapter 9) and to identify distortions (Chapter 3)
- ☐ Unanticipated phenomena observed in the tests (Chapters 4-8) including oscillations.
- ☐ Application of the test data for code validation

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PIRT/Scaling Report

- What did we learn:

  - From the systems scaling, in Chapter 3
    - inertia effects are very small and are least properly scaled
    - buoyant and resistance effects dominate for most AP600 accident scenarios
    - SPES/OSU were well scaled relative to AP600
    - Systems scaling in Chapter 3 supports the component scaling already performed
    - Systems scaling was also useful for examining distortions

W/NRC MEETING ON AP600
PIRT/Scaling Report

- From the distortion assessment in Chapters 4-8, and 9 we learned:
  - » There are test distortions, however, the program, taken as a whole, provides sufficiently undistorted data to assess the phenomena.
  - » The two integral tests complement each other.

W/NRC MEETING ON AP600
PIRT/Scaling Report

(continued)

- The phenomena observed in the separate effects tests are also seen in the integral tests, with less distortion.
- Lack of scaling similitude was known for each facility and was addressed during the testing.
- Sufficient data exists to validate the highly ranked PIRT phenomena in an accurate fashion.

W/NRC MEETING ON AP600
PIRT/Scaling Report

Overview of Unanticipated Phenomena

- There was no real unanticipated phenomena observed in the separate effects tests.
  - ☐ Rapid condensation in the CMT was anticipated and a diffuser was designed.
  - ☐ The lower PRHR heat transfer was a mild surprise but could be addressed with increased number of tubes.
  - ☐ The ADS test performed as expected.

W/NRC MEETING ON AP600
PIRT/Scaling Report

- Systems Tests Unanticipated Phenomena

  SPES Integral Systems tests

  - ☐ PRHR Heat Transfer was primarily in the top horizontal section - while initial surprise, 20/20 hindsight would indicate that we should not have been surprised.
  - ☐ Pressure/Flow Oscillations are caused by the higher power compensation used in SPES for heat loss compensation.

W/NRC MEETING ON AP600
PIRT/Scaling Report

- OSU Integral Systems Tests

  - ☐ CMT Refill in LTC is a OSU scaling distortion due to the reduced height in the test.
  - ☐ LTC oscillations are due to "over filling" the test facility such that the pressure is prevented from venting out the hot leg. As a result, the pressure increases in the vessel and reduces the DVI flow such that additional steam is generated. Some of the steam is initially condensed at the top of the downcomer but as more steam is generated, it depresses the mixture level in the upper plenum and vents out the ADS-4.

W/NRC MEETING ON AP600
PIRT/Scaling Report

(continued)

The oscillations, if they occur in AP600:

- are damped
- are limited by the pressure head in ADS-4
- may not occur in AP600

W/NRC Meeting on AP600
PIRT/Scaling Report

- Thermal stratification of cold legs was investigated as a design issue for the AP600.

W/NRC Meeting on AP600 PIRT/Scaling Report

- Ansaldo performed analysis of OSU tests and the AP600.
  - » RELAP code used to establish plant conditions during LOCA.
  - » Determine the T/H conditions for 0.5 inch to 2 inch breaks
  - » Establish the PRHR return flow rates and temperatures
  - » Establish the draindown conditions for the SGs

W/NRC Meeting on AP600 PIRT/Scaling Report

- Application of the EPRI Stratification Screening Criteria and determination of stratification profiles.
  - » Based on Richardson's number (stratified if $Ri_p > 4$)
  - » Conservative interpretation of T_{hot}, T_{SAT}, and T_{cold} and PRHR outlet temp assumed
  - » Conservative interpretation of fluid profile (insignificant mixing of hot/cold fluid interface) assumed
  - » Establish worst case thermal profile for the cold legs

W/NRC Meeting on AP600 PIRT/Scaling Report

- Structural evaluation performed using RELAP fluid conditions
  - » ANSYS model (3-D) used to determine pipe metal temperature distribution.
  - » ANSYS model (3-D) used to determine pipe stress levels.

W/NRC Meeting on AP600 PIRT/Scaling Report

- Conclusions
  - » LBB analysis shows stress levels below allowable
  - » Fatigue analysis show insignificant usage factors

W/NRC Meeting on AP600 PIRT/Scaling Report

- Steam condensation events in the AP600 annular downcomer were investigated.

W/NRC Meeting on AP600 PIRT/Scaling Report

- Steam condensation events were observed in OSU testing of LOCA events:
  - Westinghouse report concluded condensation events occurred in the annular downcomer.
  - Changing water levels in reactor vessel caused condensation incidents.
  - Normal instruments not detecting peak pressure from condensation events (only 1.5 ms).
  - Pressure differential due to condensation events detectable by DP measurements.
  - Water level changes detectable by level instruments (water slug motion)
  - Peak pressures indications by rapid response instruments of approximately 25 psi.
  - No detectable damage resulting from events in OSU.

W/NRC Meeting on AP600 PIRT/Scaling Report

- Condition for condensation event initiation was related to accumulator injection during LOCA.
  - Water level drops to or below cold leg elevation during LOCA.
  - A steam volume existing in upper end of downcomer.
  - Cold fluid from accumulator injection breaks up T_{SAT} boundary layer in downcomer.
  - Condensation event causes DP between upper plenum and annular downcomer.
  - Changing water level in reactor vessel causes water slug to hit top of annular downcomer.

W/NRC Meeting on AP600
PIRT/Scaling Report

- ANSALDO performed analysis using RELAP5 Code of OSU and AP600.
  - Full RELAP5 model could not produce condensation event due to excessive condensation rate model.
  - No steam volume possible in the annular downcomer.
  - Simplified RELAP models of OSU and AP600 with disconnected cold legs and one-dimensional model of annular downcomer.
  - Condensation events successfully simulated, however, with excessive system DP and resulting slug velocities.

W/NRC Meeting on AP600 PIRT/Scaling Report

- Observation based analysis of water hammer events.
  - System DP measured in OSU during condensation events used with simplified RELAP model.
  - Slug velocities calculated by RELAP compared with observations in OSU - conservative.
  - RELAP slug velocities used to calculate water hammer peak pressure (Yukowski).
  - Calculated peak pressure compared with measured values in OSU - conservative.
  - OSU measured DP scaled to AP600 based on OSU scaling ratio (4).
  - RELAP calculated slug velocity for AP600 used to calculate peak water hammer pressure.
  - Calculated peak pressure below design pressure for core barrel.
  - Calculated peak pressure likely conservative by factor of 3 for AP600

OITS UPDATE

OITS #	NRC STATUS	STATUS INFORMATION UPDATE
7	Action N	Related to OITS #3083
3083	Action N	Related to OITS #7
25	Action N	Staff to review PRHR Final Test Report
1617	Action N	Staff to review PRHR Final Test Report
1619	Action W	Westinghouse has not completed all RAI responses
1620	Resolved	Staff review of OSU test reports complete
2089	Action W	No information on Westinghouse actions indicated in status summary
2267	Action N	Staff to review ITP information for acceptability
3104	Action N	Staff to review PRHR Final Test Report
3130	Action N	Staff to review Scaling and PIRT Closure Report
3396	Action N	Staff to review response to RAI 440.568