Docket File

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

March 7, 1994

Docket No. 52-003

APPLICANT: Westinghouse Electric Corporation

FACILITY: AP600

SUBJECT: SUMMARY OF MEETING TO DISCUSS THE PROBABILISTIC RISK ASSESSMENT (PRA) FOR THE AP600

On February 15, 1994, representatives from the Westinghouse Electric Corporation (Westinghouse) and the Nuclear Regulatory Commission (NRC) met to discuss the discuss the PRA for the AP600. Enclosure 1 is a list of attendees. Enclosure 2 is a copy of the staff's presentation. Enclosure 3 is a copy of the Westinghouse slide presentation.

The staff opened the meeting stating that it intended to provide a status of its review of the PRA for the AP600, and to identify the major issues resulting from its review to date. Some of the issues identified during the meeting represented the views of the staff's contractor, and may not have undergone the final evaluation of the staff.

Westinghouse then stated that it has been using the PRA as a design tool, which has resulted in some design changes. The designer indicated that it was concerned with the status of the review because of the effect of the focussed PRA on resolving the issue of regulatory treatment of non-safety-related systems for the AP600.

The staff indicated that there is not a lot of experience with passive systems in PRAs, and that it has identified several areas of concern based on its review of the PRA to date. Areas of concern include

- passive system reliability
- use of MAAP to determine the success criteria
- areas where the success criteria was undefined or unclear
- treatment of containment bypass sequences in the PRA
- human reliability assessment
- data used in the PRA, particularly failures of the instrumentation and controls
- external events
- inadequate treatment of maintenance during shutdown
- modelling of shutdown events
- uncertainty analysis

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The staff indicated that responses to certain requests for additional information were insufficient, and that there was little discussion as to the strengths and weaknesses of the design. The staff was concerned that the values used for initiating event frequencies and human error probability appeared to be low with little supporting justification. In addition, the staff requested Westinghouse to provide further discussion of the role of the operator in response to failure of the instrumentation and controls of the facility.

The staff requested better documentation on how MAAP was used to determine the success criteria. The staff indicated that it had concerns with the way the PRA addressed risk from fire and flooding, and how the seismic analysis was performed.

Westinghouse then presented a discussion of how it was updating the Level 2 PRA. The designer indicated that it was including a containment failure probability distribution, it was going to update containment event trees, it was modifying the decomposition event trees, and it was using an updated MAAP 4 analysis in the Level 2 PRA.

In summary, it was agreed that Westinghouse and the staff would complete the following action items in the near future to support the review of the PRA:

- The staff will provide comments on the seismic margins analysis.
- Westinghouse will provide a response to Q720.11, which requests a direct comparison of MAAP to a best estimate thermohydraulics code. In addition, Westinghouse indicated that it was working on providing the staff with the MAAP 4.0 Users Manual.
- Westinghouse will provide better documentation of the success criteria used in the Level 1 PRA.
- Westinghouse will submit the results of the requantified Level 2 PRA by the end of March 1994.

In addition, the staff requested that Westinghouse provide a comparison of risk profiles between the AP600 design and operating Westinghouse plants. This comparison should include a comparison of AP600 design strengths and weaknesses compared with operating Westinghouse designs. The staff also requested Westinghouse to address key insights that resulted from the PRA, and describe the changes that were made to the design as a result of these insights.

At the end of the meeting, the participants agreed to continue discussions and develop followup requests for additional information, with a goal to minimize the number of issues in the draft safety evaluation report.

Thomas J. Kenyon, Project Manager
Standardization Project Directorate
Associate Directorate for Advanced Reactors
and License Renewal
Office of Nuclear Reactor Regulation

Enclosures:
As stated

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AP500 PROBABILISTIC RISK ASSESSMENT

FEBRUARY 15, 1994

Meeting Attendees

NAME	AFFILIATION
Thomas Kenyon	NRC/NRR/PDST
James W. Johnson	NRC/NRR
Rick Hasselberg	NRC/PDST
Marie Pohida	NRC/NRR/DSSA
Adel El-Bassioni	NRC/NRR
Mario Gareri	NRC/NRR/DRCH/HICB
Mark Rubin	NRC/OCM
Gene Y. Hsii	NRC/NRR/SRXB
Brad Hardin	NRC/RES/DSIR
John Gallagher	NRC/NRR/HICB
Hulbert Li	NRC/NRR/HICB
Narinder Trehan	NRC/NRR/EELB
Arthur Buslik	NRC/RES/PRAB
Frank Talbot	NRC/NRR/RPEB
Bob Palla	NRC/NRR/DSSA/SPSB
Shou-nien Hou	NRC/NRR/DE/ECGB
Chris L. Hoxie	NRC/NRR/DSSA/SCSB
Jim Lazevnick	NRC/NRR/DE/EELB
Suzie M. Wittenberg	NRC/NRR/DRCH/HICB
Greg Galletti	NRC/NRR/DRCH/HHFB
Jim Bongarra	NRC/NRR/DRCH/HHFB
Farouk Eltawila	NRC/RES/AEB
Brian A. McIntyre	Westinghouse
Chanh Tran	Westinghouse
Isaac Wallace	Westinghouse
Jim Scobel	Westinghouse
Cindy Haag	Westinghouse
Selim Sancaktar	Westinghouse
David I. Gertman	INEL
Dana Kelly	INEL
John H. Bickel	INEL
Phillip G. Ellison	INEL
Nathan Sill	INEL
Bob Youngblood	BNL

Enclosure 1

STAFF OVERVIEW OF THE AP600 PRA

PROBABILISTIC SAFETY ASSESSMENT BRANCH (SPSB)
FEBRUARY 15, 1994

Enclosure 2

SCHEDULE

WESTINGHOUSE SUBMITTED AP600 PRA JUNE 1992.

56 ROUND ZERO RAIS SUBMITTED TO PROJECTS AUGUST, 1992.

APPROXIMATELY 261 ROUND ONE RAIS SUBMITTED JULY, 1993.

SPSB RECEIVED WESTINGHOUSE RESPONSES TO ALL ROUND ONE RAIS EARLY NOVEMBER 1993. (STILL WAITING FOR THE ROUND ZERO RAI RESPONSE ASKING W TO COMPARE THE RESULTS OF MAAP VS. BEST ESTIMATE THERMOHYDRAULICS CODE)

STAFF MET WITH WESTINGHOUSE IN NOVEMBER, 1993 TO DISCUSS RTNSS.

REVISED SEISMIC ANALYSIS RECEIVED MID DECEMBER, 1993. SEISMIC ANALYSIS ONLY CONTAINED METHODOLOGY. STAFF STILL WAITING FOR RESULTS.

INEL REVIEW OF RAI RESPONSES DUE LATE FEBRUARY TO SPSB.

SPSB REVIEWING RAI RESPONSES CONCURRENTLY.

SIMILAR TO PAST REVIEWS, SPSB WILL CONTINUE TO INTERACT WITH THE WESTINGHOUSE PRA GROUP AS THE REVIEW EVOLVES.

SPSB PREPARING FOR DSER (DUE SEPTEMBER 1994)

OVERALL

STAFF CONCERNED WITH DEPTH OF RISK INSIGHTS DEVELOPED BY WESTINGHOUSE

WESTINGHOUSE HAS INCORPORATED FEW RAI RESPONSES INTO THE PRA AS ASKED BY RAI 720.59.

STAFF CONCERNED WITH QUALITY OF RAI RESPONSES.

REVIEW STRATEGY

ADVANCED REACTOR PRA REVIEWS ARE INTERACTIVE IN NATURE.

MAJOR EMPHASIS ON DERIVATION OF INSIGHTS ABOUT:

- DESIGN STRENGTHS AND WEAKNESSES
- DESIGN TOLERANCE OF SEVER ACCIDENT CHALLENGES AND HUMAN ERRORS
- DESIGN ROBUSTNESS IN CASE OF EXTERNAL EVENTS
- QUALITY OF THE PRA STUDY AND ITS ADEQUACY FOR POTENTIAL POST CERTIFICATION USES

LIST OF PRA MAJOR ASSUMPTIONS AND RISK SIGNIFICANT INSIGHTS CONSTITUTE A MAJOR INPUT TO DCD (TIERS 1 AND 2)

FOLLOWING COMPLETION OF WESTINGHOUSE RAI RESPONSES, STAFF PLANS TO:

CONDUCT DETAILED REVIEWS OF AREAS OF CONCERN

DEFINE OUTSTANDING ISSUES

DEVELOP A LIST OF KEY ASSUMPTIONS AND MAJOR INSIGHTS

COMPLETE THE DSER

INTERACTION WITH WESTINGHOUSE IS EXPECTED FOR EACH OF THE ABOVE ACTIONS.

GENERAL AREAS OF CONCERN

- PASSIVE SYSTEM RELIABILITY
- USE OF MAAP TO DETERMINE SUCCESS CRITERIA
- CONTAINMENT BYPASS SEQUENCES
- HUMAN RELIABILITY ANALYSIS
- DATA
- EXTERNAL EVENTS
- MODELING OF SHUTDOWN
- PRA INSIGHTS

CONTAINMENT BYPASS SEQUENCES

IN RAI 720.74, STAFF ASKED FOR A DISCUSSION OF CONTAINMENT BYPASS SEQUENCES WHICH STAFF IDENTIFIED DURING LOADING OF THE PRA ONTO IRRAS. NO DISCUSSION OF THESE SEQUENCES APPEARED IN THE PRA.

RAI 720.74 RESPONSE CONTAINED NO DISCUSSION OF THESE SEQUENCES AND NO PRA REVISION. RESPONSE STATED THAT THESE SEQUENCES ARE AT THE VERY BOTTOM OF TABLE F-2:

SYS-IEC2E	SYS-CIR	SYS-IWTM
SYS-IEC2L	SYS-IWTIM	

STAFF WILL REQUEST A DISCUSSION OF THESE SEQUENCES IN THE PRA (INCLUDING IMPORTANT OPERATOR ACTIONS). IN DSER, STAFF WILL HIGHLIGHT CONTAINMENT INTEGRITY DURING SEVERE ACCIDENTS.

REQUANTIFICATION BY STAFF CONSULTANTS INDICATE THAT THESE SEQUENCES DOMINATE THE AP600 RISK PROFILE IF RECOVERY ACTIONS ARE NOT CREDITED.

UNCERTAINTY ANALYSIS

STAFF BRIEFLY REVIEW UNCERTAINTY ANALYSIS

WESTINGHOUSE PRESENTED UNCERTAINTY DISTRIBUTIONS FOR THE PLANT DAMAGE STATES

STAFF WILL REVIEW IN DETAIL ERROR FACTORS

STAFF FOUND LITTLE DISCUSSION OF THE RESULTS AS THEY RELATED TO STRENGTHS AND WEAKNESSES OF THE DESIGN.

STAFF WILL REQUEST INSIGHTS ABOUT DESIGN FROM THESE RESULTS

SENSITIVITY ANALYSES

STAFF BRIEFLY REVIEWED SENSITIVITY ANALYSES

ANALYSIS CONSIDERED IMPACT OF INCREASING THE FOLLOWING GROUPS OF COMPONENTS BY A FACTOR OF TEN:

CHECK VALVES, MOVS, OPERATOR ACTIONS, AND I&C COMPONENTS

STAFF WILL REQUESTS THAT RESULTS BE INCLUDED IN PRA

SELECTION CRITERIA OF COMPONENT GROUPS NOT INCLUDED. STAFF WILL ASK MORE QUESTIONS REGARDING GROUP SELECTION CRITERIA.

IMPORTANCE ANALYSES

WESTINGHOUSE COMPLETED IMPORTANCE ANALYSES FOR BASIC EVENTS AND SYSTEMS

STAFF ASKS THAT IMPORTANCE ANALYSES FOR SYSTEMS BE INCLUDED IN PRA.

DATA

LOCA INITIATING EVENT FREQUENCIES

COMMON CAUSE FAILURE OF I&C SOFTWARE

COMMON CAUSE FAILURE OF SOFTWARE HAD VERY HIGH RISK ACHIEVEMENT VALUES. FAILS AUTOMATIC ACTUATION OF ADS.

THE NUCLEAR INSTALLATION INSPECTORATE (NII) OF THE UK HAS CONSIDERED THE VALUE (10E-3 PER DEMAND) FOR SIZEWELL B.

COMMON CAUSE FAILURE OF I&C HARDWARE

RAI 720.105 ASKED FOR BASIS FOR DETERMINING CCF OF MICROPROCESSOR COMPONENTS (IE. CCF OF THE EPO BOARDS)

COMMON CAUSE FAILURES OF I&C HARDWARE ALSO DOMINATE RISK ACHIEVEMENT VALUES.

RAI RESPONSE TO 720.105 CONTAINED NO DISCUSSION OF HOW THE VALUES WERE OBTAINED.

SHUTDOWN

VERY LOW CORE DAMAGE FREQUENCIES WERE ESTIMATED. STAFF ACKNOWLEDGES AUTOMATIC ACTUATION GRAVITY INJECTION VIA DAS.

PAST SHUTDOWN PRAS HAVE IDENTIFIED MAINTENANCE AS A KEY CONTRIBUTOR TO SHUTDOWN RISK.

HOWEVER, MAINTENANCE UNAVAILABILITIES NOT INCORPORATED INTO THE SHUTDOWN PRA.

LOSS OF SUPPORT SYSTEMS SUCH AS AC POWER NOT INCLUDED AS A POTENTIAL LOSS OF NRHR (ASKED IN RAI 720.175).

RAI 720.175 ASKED WESTINGHOUSE TO SHOW HOW SHUTDOWN MAINTENANCE WAS INCORPORATED INTO SHUTDOWN PRA. RESPONSE TO 720.175 STATES MAINTENANCE UNAVAILABILITIES IN APPENDIX C. STAFF REVIEW OF APPENDIX C FOR NRHR AND DC POWER FOUND LITTLE.

NO EXTERNAL EVENTS (FIRE AND FLOODS) WERE CONSIDERED FOR SHUTDOWN WHEN BARRIERS ARE MORE LIKELY TO BE COMPROMISED.

Idaho
National
Engineering
Laboratory

AP600 HRA Issues

Presented by:

David I. Gertman

EG&G Idaho, Inc.

INTRODUCTION

- There are several HRA issues that the INEL has identified for further review since the last RAI submittal. These items are currently being evaluated by the NRC staff as potential issues:

  - HEPs are unacceptable (unrealistically low as submitted).
  - Roles of the operator in response to I&C systems failures needs to be developed.
  - HRA for external events has not been adequately performed.
  - Need to discuss how results from the HRA have been used to benefit the existing design.

Idaho
National
Engineering
Laboratory

Developing Level I Issues

Presented by:

Phillip G. Ellison
EG&G Idaho, Inc.

INTRODUCTION

- There are several items that have been identified in the Level I quantification that are receiving increased review. These items are currently being evaluated by the NRC staff as potential issues. Three of these items are:

  - Hybrid system success criteria
  - Passive System Operability
  - The use of MAAP in assessing hybrid system behavior

MODULAR ACCIDENT ANALYSIS PROGRAM

- The INEL has identified an item with the use of MAAP in the analysis of AP600's hybrid system performance.
- The INEL may recommend that a mechanistic thermohydraulics model be utilized in place of MAAP to determine the AP600's plant response for:
  - Hybrid/Passive System Success Paths Passive System Operability/Reliability
  - If RAI response 720.11 is not provided or found to be inadequate. This is based on Westinghouse's response to RAI 720.109, 720.110, 720.111, and 720.108.

PASSIVE SYSTEM OPERABILITY

- Two items have been presented to the NRC staff for review that concern passive system operability. These items are:

  - the reflood ability of passive systems for different indicators of core damage,
  - the determination of the thermal system reliability for the minimal system equipment configurations.

SUCCESS CRITERIA

- The INEL has presented to the NRC staff several items associated with the accident sequence success criteria. These issues are:
  - Hybrid System Minimal Equipment Configurations
  - The Selected Mission Time
  - The transition from a stable passive cooling condition to cold shutdown

INTRODUCTION

- The INEL has identified items may need to be addressed in the following external events:
  - Internal Fires
  - Internal Floods
  - Seismic Events

INTERNAL FIRE RISK

- Improved analysis and/or additional commitments may be required to address the following items:
  - Control Room Fires
  - Human Errors during Fires
  - Turbine Building Fires
  - Separation of Divisions
  - Fire-Induced Failures

INTERNAL FLOODING RISK

- Improved analysis and/or additional commitments may be required to address the following items:
  - Human Errors during Floods
  - Spray Scenarios
  - Separation of Divisions
  - In addition, improved documentation is required to permit a detailed review of the analysis.

SEISMIC ANALYSIS

- Improved analysis and/or additional information may be necessary to address the following items:
  - The seismic analysis is incomplete
  - HCLPFs for shutdown systems
  - Relay chatter analysis
  - Seismic induced ATWS events
  - HCLPFs for components used in the analysis
  - Identification of seismic system boundaries
  - The interaction of non-seismically qualified equipment on seismic category 1 equipment or structures
  - Analysis needed to bound the various sites

SEISMIC ANALYSIS

Issues Continued

- The separation requirements between the qualified and non-qualified equipment may be an ITAAC issue.
- Post seismic evaluation of the plant.

AP600 PRA ISSUES

MEETING WITH

NUCLEAR REGULATORY COMMISSION

INTRODUCTION

BRIAN A. McINTYRE, MANAGER

ADVANCED PLANT SAFETY AND LICENSING

Enclosure 3

AGENDA

• Introduction	W / NRC
• Overview of PRA	NRC
• Examples of Level 1 PRA Issues	NRC
• Human Reliability Analysis	INEL
• Passive System Operability	INEL
• External Events	INEL
• Level 2 PRA Update	Westinghouse
• Where do we go from here?	All

AP600 PRA

- Submitted to NRC on June 26, 1992
- SAMDA report submitted December 1992
- Majority of RAIs received July 22, 1993
  - 261 PRA RAIs
    - 50% Design-related questions
    - 25% Level 1 PRA & external events
    - 25% Level 2 PRA
- RAI responses submitted October 20, 1993
- Feedback needed on responses

REGULATORY TREATMENT OF NONSAFETY SYSTEMS

- THE Key Issue in AP600 review
- Industry / NRC agreement on approach — May 1993
- Westinghouse submittal — September 24, 1993
  - NRC senior management briefing — October 26, 1993
  - NRC staff briefing — November 8, 1993
- Focused PRA will be included in PRA Revision
- Staff concern over resolving RTNSS without PRA review
- Progress on PRA review is essential

COMMISSION BRIEFING
JANUARY 22, 1994

What are the Critical Path Items? (Commissioner Rogers)

- Westinghouse
  - Maintaining testing schedule
- NRC
  - PRA RAIs to Westinghouse

CONCLUSION

- It is time to put the ball in Westinghouse's court
  - Send PRA RAIs
  - Establish "working meetings" to resolve specific PRA-related issues
  - Review RTNSS Focused PRA

AP600 LEVEL 2 PRA UPDATE

JIM SCOBEL

RISK MANAGEMENT AND OPERATIONS IMPROVEMENT

AP600 LEVEL 2 PRA UPDATE

Overview

- In response to NRC concerns expressed in December '92 meeting and Requests for Additional Information
  - Conditional Containment Failure Probability Distribution
  - Updated Containment Event Tree
  - Decomposition Event Trees
  - MAAP4 Analyses
- Apply to current Level 1 PRA results
- Applicable to future Level 1 PRA revisions

AP600 LEVEL 2 PRA UPDATE

Conditional Containment Failure Probability Distribution

- Response to RAIs 720.202, 720.203 and 720.204
- Developed based on containment failure modes from AP600 SSAR Section 3.8.2.4
  - Cylindrical shell
  - Top head
  - Equipment hatches
  - Personnel air locks
  - Mechanical and electrical penetrations

Conditional Containment Failure Probability Distribution (continued)

- Uncertainty and variability considerations
  - Material properties
  - Analytical models
  - Construction practices
- Function of pressure
- Temperature assumed to be 400°F (477°K)

AP600 LEVEL 2 PRA UPDATE

Updated Containment Event Tree

- Response to RAI 720.209

- Containment event tree includes nodes for phenomena
  - Hot leg creep failure
  - Thermally-induced steam generator tube failure
  - Early hydrogen combustion
  - In-vessel steam explosion
  - In-vessel debris retention
  - Debris quench and coolability
  - Early containment failure
  - Late hydrogen combustion
  - Intermediate containment failure
  - Late containment failure
  - Excessive containment leakage

- Phenomena nodes quantified with decomposition event trees and conditional containment failure probability distribution

- Number of release categories increased to sixteen

AP600 LEVEL 2 PRA UPDATE

Decomposition Event Trees

- Response to RAIs 720.209, 720.214, 480.027 and 480.036
- Consideration of uncertainties in severe accident phenomena and quantification of frequency
- Seven DETs under construction
  - Thermally-induced RCS pressure boundary failures
  - Early hydrogen combustion
  - In-vessel steam explosion
  - In-vessel debris retention
  - Ex-vessel steam explosion
  - Debris coolability
  - Late hydrogen combustion

AP600 LEVEL 2 PRA UPDATE

MAAP4 Analyses

- Updated MAAP4 code
  - Improved core makeup tank model including cold leg recirculation
  - Updated core melt and relocation including debris pool formation and relocation to lower head
- Increased number of base cases and sensitivity cases modeled