CERTIFIED: George Apostolakis, August 7, 1996
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ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
JOINT SUBCOMMITTEE MEETING MINUTES:
PROBABILISTIC RISK ASSESSMENT AND WESTINGHOUSE
STANDARD PLANT DESIGNS
JUNE 5, 1996
ROCKVILLE, MARYLAND

The ACRS Joint Subcommittee on Probabilistic Risk Assessment (PRA) and Westinghouse Standard Plant Designs met on June 5, 1996, at 11545 Rockville Pike, Rockville, Maryland, in Room T-2 B3. The purpose of the meeting was to gather information concerning the Westinghouse AP600 Level 1 and shutdown PRAs. The entire meeting was open to public attendance. Mr. Noel Dudley was the cognizant ACRS staff engineer for this meeting. The meeting was convened at 8:30 a.m. and adjourned at 2:35 p.m.

ATTENDEES

ACRS

G. Apostolakis, Chairman
W. Lindblad, Member
I. Catton, Member
M. Fontana, Member
T. Kress, Member
D. Powers, Member
R. Seale, Member
W. Shack, Member
C. Wylie, Member
N. Dudley, ACRS staff

INDUSTRY

C. Monty, Westinghouse
T. Bueter, Westinghouse
C. Haag, Westinghouse
S. Sancaktar, Westinghouse
T. Schulz, Westinghouse

There were no written comments or requests for time to make oral statements received from members of the public. An attendance list of the NRC staff and public is available in the ACRS office files. Public participation during this meeting was limited to the presentations by the above named industry representatives.

INTRODUCTION:

Dr. George Apostolakis, the Subcommittee Chairman, convened the meeting at 8:30 a.m. He stated that the planned presentations would provide information to the Subcommittee concerning the AP600 Level 1 and shutdown PRAs. The Subcommittee will gather information, analyze relevant issues and facts, and formulate proposed positions and actions as appropriate for deliberation by the full Committee.

WESTINGHOUSE PRESENTATION:

Mr. Bruce Monty, Manager Risk Assessment Services Group, Westinghouse, introduced the Westinghouse technical staff and outlined the presentation, which included an overview of the AP600 design, the design process, and the Level 1 and shutdown PRA analyses.

All stages of the PRA were performed by the Westinghouse PRA group. The main objectives of the PRA were to:

- support NRC requirements for a design specific PRA,
- scope core damage frequency to less than the NRC safety goal
  - provide a tool for both design and operations, and
- bound seismic events by using the seismic margins approach.

Overview of AP600 Design

Mr. Terry Schulz, Westinghouse, provided the following overview of the key design features of the AP600 that affect the PRA. The overall system design, which was developed using PRA insights, reduces possible failure mechanisms and enhances overall safety. The design for the reactor coolant loop piping reduces the number of welds and the potential for pipe failure. The reactor vessel, which is larger than present designs, reduces the power density of the core. The reactor vessel has no bottom penetrations, below the loop penetrations. This design improves vessel integrity. The pressurizer is oversized to reduce challenges to the safety valves from pressure transients. All major piping is designed as leak before break to reduce the probability of a loss-of-coolant-accident (LOCA). Valves that require electric power to change position are DC powered, eliminating the need for AC power from either the diesels or off site power during accident scenarios. The major decay heat removal systems are passive in nature, further reducing the probability of system failure.

The AP600 piping layout reduces the problems encountered during mid-loop operations at operating plants. Further, Mr. Selim Sancaktar, Westinghouse, stated that conservative design and acceptance testing, combined with PRA insights, result in a robust design for the AP600.

Mr. Schulz, Westinghouse, and the Subcommittee discussed the defense-in-depth and diversity associated with the AP600 design.

Background and PRA Methodology

Dr. Sancaktar, Westinghouse, explained that since 1987 Westinghouse has used information from the AP600 PRA to improve the AP600 design. The Westinghouse PRA group has experience with the British

Sizewell B PRA and more than 20 domestic and foreign IPE/PRA studies. Dr. Sancaktar explained the development of the Level 1 PRA, which includes initiating events, event trees and success criteria, thermal hydraulic analyses, plant systems analyses, common cause failures, human reliability, data analysis, fault tree and event tree quantification, and importance and sensitivity studies. He discussed the development of the low power and shutdown PRA.

Dr. Sancaktar explained that the scope used for the AP600 PRA is defined according to revision 5/6 of the Advanced Light Water Reactor Utility Requirements Document. The methods used are standard quantitative methods such as described in NUREG-2300. Data used are mean values. Success criteria are derived from extensive thermal hydraulic analyses. Fault tree linking methods are used to quantify core damage sequence frequencies. Fault trees include system component failures, common cause faults, test and maintenance unavailability, and human errors.

Dr. Sancaktar stated that the AP600 design addressed PRA-related issues that dominate core damage frequency (CDF) at operating plants and provided the following examples.

PRA Issue	How AP600 addressed the Issue
Station Blackout (Loss of all AC)	Safety systems are not dependent on AC power.
Reactor Coolant Pump (RCP)seal LOCA	RCPs have canned motors that do not have seals.
Loss of support systems	Safety systems do not rely on AC power or cooling water support systems.
Interfacing systems LOCA	The reactor non-safety system pathways will be able to withstand reactor coolant system pressure.
Susceptibility to human errors	The design minimizes the importance of operator actions required to mitigate accidents.
ATWS	A diverse actuation system was added to the design to trip the reactor.

Reliability of reactor heat removal system (RHR)	Administrative controls require testing of systems prior to shutdown. System design prevents pump cavitation and provides improved instrumentation.
Loss of decay heat removal at shutdown	Passive injection requires no operator action or electric power sources.

Westinghouse and the Subcommittee discussed the schedule for completing the PRA, and the codes, models, system based procedures, and cognitive failures used in developing the PRA. They also discussed the quantitative reliability and uncertainty of the PRA results.

Level 1 PRA (At-Power Conditions)

Dr. Sancaktar presented the initiating event frequencies, dominant initiating events, and CDF results for at-power events. He provided comparison of the Level 1 PRA results to other plant designs and sensitivity studies.

Westinghouse and the Subcommittee discussed the origin of values used in the Level 1 PRA, the event sequences, the sensitivity of the analyses to operator actions, and the Idaho National Engineering Laboratory review of the PRA.

Shutdown PRA

Mr. Tim Bueter, Westinghouse, presented the dominant contributor to CDF during shutdown conditions. Shutdown risk is less than the at-power risk. Design features important to shutdown risk reduction are:

- Passive safety systems are available to back up normal decay heat removal functions.
- Loss of off site power coincident with shutdown is not significant due to passive injection, which requires no off site or diesel generator supplied AC power.

Mr. Bueter stated that no credit is taken for the in-containment refueling water storage tank injection flow paths, and all operator actions are calculated conservatively. Credit is taken only for safety-related systems used in mitigation of events, even though, nonsafety-related systems are available.

Westinghouse and the Subcommittee discussed normalizing the shutdown risk to an hourly basis, the seismic margins assumed, the need for a safety grade spent fuel pool cooling system, and the reliability of hot leg level instruments.

Conclusions

Mr. Monty concluded that based on eight years of performing a detailed PRA of the AP600 design:

- The AP600 design meets both the NRC and industry core damage frequency goals.
- The AP600 design demonstrates a significant core damage frequency improvement over current operating plants.
- Iterative PRA application has allowed design enhancements that address significant PRA issues.

SUBCOMMITTEE DISCUSSION:

Mr. Lindblad inquired how friction losses were accounted for in the passive design fluid flows. Mr. Schulz responded that the design incorporates conservative calculations for estimating friction losses and in calculating accident analysis. Further, when a plant is built start up tests will verify the friction loss factors and in-service testing will confirm the friction loss factors throughout the life of the plant.

Mr. Lindblad inquired if water chemistry is a factor in preventing corrosion and biological growth. Mr. Schulz responded that with the materials planned to be used, primarily stainless steel, corrosion was not expected to be a major concern. He noted that biological growth is a concern in the stagnant in-containment reactor water storage tank. This will be resolved by performing a system flow test to ensure flow is within design limits.

Mr. Lindblad inquired if tank temperature can impede passive flow. Mr. Schulz responded that there is a limit on standby tank temperatures, because subcooling plays a role in both flow and heat removal characteristics.

Mr. Lindblad questioned the design reliability of the startup feedwater pumps. Mr. Schulz described the startup feedwater as reliable but stated the system is not as reliable as the current safety grade auxiliary feedwater systems. There would be only two startup feedwater pumps in the AP600 design.

Dr. Seale asked if a fire PRA was available. Ms. Cindy Haag, Westinghouse, responded that a fire assessment is in progress.

The Subcommittee inquired if the same discipline used for designing safety-related systems carried over to the design of nonsafety-related systems. Mr. Schulz replied that the nonsafety-related areas are not designed to the same rigorous standards as safety-related systems. However, Westinghouse made some informed design decisions for nonsafety-related systems, such as, separation of components.

Mr. Lindblad asked if there is a time limit for startup of the diesel generators. Mr. Schulz responded that approximately two minutes was chosen to allow diesel generator warm up in order to avoid diesel engine failures.

Mr. Wylie asked if there is adequate protection for a chemical volume control system line breaks outside the containment. Mr. Monty stated that there are isolation valves between inside containment and outside containment, and that a detailed system drawing would contain details of the types of isolation valves.

SUBCOMMITTEE RECOMMENDATIONS:

The Joint Subcommittee proposed holding future Subcommittee meetings to hearing presentations on the AP600 Level 2 PRA and external events analyses.

BACKGROUND MATERIAL PROVIDED TO THE SUBCOMMITTEE:

1. SECY-96-128, "Policy and Key Technical Issues Pertaining to the Westinghouse AP600 Standardized Passive Reactor Design," dated June 12, 1996

2. Letter dated June 15, 1995, from T. S. Kress, Chairman, ACRS, to James M. Taylor, Executive Director for Operations, Subject: Proposed Commission Paper On Technical Issues Pertaining To The Westinghouse AP600 Standardized Passive Reactor Design

3. Letter dated August 8, 1995, from James M. Taylor, Executive Director for Operations, to T.S. Kress, Chairman, ACRS, Subject: Response To ACRS Comments On Commission Paper On Technical Issues Pertaining To The Westinghouse AP600 Design

4. Memorandum date July 2, 1996, from August Cronenberg, Senior ACRS Fellow, to ACRS Members and Staff, Subject: NRC Staff and Westinghouse Positions on AP600 Design Review Issues

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NOTE: Additional details of this meeting can be obtained from a transcript of this meeting available in the NRC Public Document Room, 2120 L Street, N.W., Washington, D.C. 20006, (202) 634-3274, or can be purchased from Nea R. Gross and Company Incorporated, Court Reporters and Transcribers, 1323 Rhode Island Avenue, N.W., Washington, D.C. 20005, (202) 234-4433.