CERTIFIED BY:
Carlyle Michelson - 10/2/93

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SUMMARY/MINUTES OF THE ACRS SUBCOMMITTEE ON ADVANCED BOILING WATER REACTORS JULY 28, 1993 BETHESDA, MARYLAND

PURPOSE

The ACRS Subcommittee on Advanced Boiling Water Reactors held a meeting on July 28, 1993. The purpose of the meeting was to review the fire-related aspects of the advanced boiling water reactor (ABWR) design. A copy of the meeting agenda and selected slides from the presentations are attached.

The meeting was convened at 11:00 a.m. and adjourned at 3:55 p.m. The entire meeting was open to public attendance. No written comments or requests for time to make oral statements were received from members of the public. The Designated Federal Official for this meeting was Mr. Herman Alderman.

ATTENDEES: Principal meeting attendees included:

ACRS

C. Michelson, Chairman
I. Catton, Member
P. Davis, Member
C. Wylie, Member
D. Karydas, Consultant
J. Quintiere, Consultant
N. Siu, Consultant
H. Alderman, Cognizant Staff Engineer

General Electric

R. Raftery
G. Ehlert
M. Nik-Ahd
C. Oza
A. Beard

NRC Staff

C. McCracken

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DESIGNATED ORIGINAL

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Opening Remarks by Mr. C. Michelson, Subcommittee Chairman

Mr. Michelson said that the purpose of this meeting was to review the fire-related aspects of the ABWR design. He noted that, at a later date, the Subcommittee will be looking at the staff's safety evaluation report related to this matter. At that time, the staff will be asked about their views of the fire-related aspects of the design. He pointed out that today's meeting was primarily supported by the General Electric Nuclear Energy (GE) Company. He said the NRC staff personnel would respond to questions, as needed, during this meeting.

Fire Risk Analysis - Mr. R. Raftery, GE

Mr. Raftery said that when GE started the fire risk analysis, the Fire Induced Vulnerability Evaluation (FIVE) methodology was well under development. The General Electric Nuclear Energy Company reached an agreement with the NRC that the use of the FIVE methodology in conjunction with screening analysis would be an appropriate technique to investigate ABWR fire risk. He said that FIVE provides an approach to identifying significant fire areas and then carrying these on to further determine their relative degrees of importance. He said that the FIVE methodology is used to define fire areas, and then to consolidate the fire areas into larger groups.

There was a discussion between the Subcommittee and GE regarding the "completeness" of the FIVE methodology. This issue was raised by an evaluation of the NRC's fire protection program.

Mr. McCracken, NRC staff, commented that the evaluation was conducted by a group of four people who questioned one specific area of the FIVE program. This group didn't get a consensus opinion from the NRC fire protection community. He noted that the FIVE methodology is being reassessed

Mr. Raftery said that although there were fire barriers within divisions, credit is not taken for these. The only fire barriers for which credit is taken are those between divisions. He said that it is assumed that smoke from any division will not adversely affect shutdown conditions. When he was questioned about this conclusion, he replied that the implication was that the smoke removal system will be successful.

Mr. Raftery summarized the Fire Risk Analysis Methodology. He noted that Phase I was the application of the FIVE methodology to identify areas as fire areas or significant fire areas based on the shutdown systems and equipment in the areas. Phase II was a quantitative approach to determine fire ignition frequencies for all the areas containing safe shutdown equipment. The next step was to apply the ABWR internal event PRA to assess core damage.

Mr. Raftery summarized this work. He noted that all the fire areas were successfully screened. The overall methodology is very conservative. The fire risk analysis led to design modifications to the plant.

Fire Protection Design and Criteria - M. Nik-Ahd, GE

Mr. Nik-Ahd discussed the criteria and system design for the fire protection systems. He noted that the design criteria included: 10 CFR 50.48, Branch Technical Position CMEB 9.5-1, IEEE standard 384, and Regulatory Guide 1.75.

He pointed out some of the features of the design. There are three independent ECCS divisions, each of which is capable of bringing the plant to a safe shutdown. There are four divisions of instrumentation and control. In general, the HVAC ducts or cable raceways do not penetrate fire barriers. In the rare cases where they do, fire-rated penetrations are provided. The design approach is to minimize divisional sharing of HVAC systems. The control room complex HVAC system is independent from all others. If the control room HVAC system should fail, and it is necessary to evacuate the control room, then a remote shutdown system is provided.

The primary containment is inerted during operations and a fire in the containment cannot prevent safe shutdown of the plant. Three-hour fire-rated barriers are provided between safety divisions, safety-related divisions, and within the divisions for special hazards such as the diesel generator rooms and the day tank rooms. The smoke removal mode will exhaust the smoke outside of the building. The areas outside of the fire area will be maintained at a higher air pressure to minimize smoke migration. A sabotage analysis was performed to determine the consequences of a fire.

Mr. Nik-Ahd said that the equipment in every room was considered for the fire hazard analysis. One of the primary considerations was to identify which equipment provides core cooling. Another concern was to determine the type of fire detection and suppression systems available at each location. Inadvertent operation of the fire suppression system was considered for each location.

The conclusion from the fire hazards analysis is that the effects of fire or inadvertent actuation of fire suppression systems would be confined to one division, and the plant can be operated safely.

<u>Diesel Generators</u> - Mr. C. Oza, GE

Mr. Oza described the diesel generators. He said there were three diesel generators, each housed in a separate division, and all are enclosed in three-hour barriers.

In response to a question from Mr. Michelson whether there were any penetrations in the floor, Mr. Oza said there were none.

Dr. Karydas asked how long the day tank fuel would burn if it spilled in the diesel area. Mr. Oza replied that he didn't have an exact answer, but it would be a long time.

Mr. Oza said that there are two fire detectors for each diesel generator. They are located on the ceiling of the room. The fire suppression system is a pre-action foam water sprinkler system that is automatic. This is backed up by a manual foam hose reel.

Mr. Beard, GE, noted that the automatic foam extinguishing system will be designed to meet the fire standards requirement NFPA-11.

Mr. Michelson asked if there was an Inspection, Tests, Analyses, and Acceptance Criteria (ITAAC) for fire protection. Mr. Oza said there was and it was 2.15.6. Mr. Ehlert said there was a problem if a fire standard was referenced in an ITAAC. The ITAAC has the status of a legal document. Once the fire standard is referenced, it is impossible to revise or change the standard.

<u>Miscellaneous Topics</u> - Mr. C. Oza, GE

Mr. Oza stated that most fires smolder and generate smoke before they heat up and ignite. This usually allows time for detection and suppression before the fire ignites.

Mr. Oza pointed out that even if a fire progressed to the ignition stage, there were three divisions of instrumentation and controls. Even with the unlikely loss of one division, there were two divisions to bring the plant to a safe shutdown.

Mr. Michelson postulated a hypothetical scenario involving the 250 volt batteries. Noting that these batteries are not seismically qualified, he postulated a seismic event with a battery falling and fracturing the battery case. The battery acid leaks out and possibly chemically reacts to form hydrogen or is carried by the HVAC system to other areas of the plant where corrosion of electronic components is possible. An alternate scenario would assume the HVAC system is inoperative.

Mr. Beard said that the amount of hydrogen that would be generated from the above postulated event would be very small. He said that the battery acid would probably drain to the Division I basement. In the remote chance that the battery acid didn't drain to the basement, it could chemically react to form hydrogen. The amount formed would be so small that it would take many hours to create a flammable concentration. He said that transport of the battery acid out of the battery room did not seem to be credible, and if it were, under a worst case scenario, any damage would be limited to Division I.

ACTIONS, AGREEMENTS, COMMITMENTS

1. Subcommittee Chairman Michelson proposed to report to the full Committee during the August meeting.

2. The General Electric Nuclear Energy Company (Mr. Beard) agreed to provide written information on the following:

   a. The location of all the division 1E Motor Control Centers.

b. A description of the control power for fire protection systems.

c. A description of the control room subfloor fire detection and fire suppression.

ATTACHMENTS:

1. Agenda
2. Handouts

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NOTE: Additional meeting details can be obtained from a transcript of this meeting available in the NRC Public Document Room, 2120 L Street, NW, Washington, DC 20006, (202) 634-3273, or can be purchased from Ann Riley and Associates, Ltd., 1612 K Street, NW, Suite 300, Washington, DC 20006, (202) 293-3950.

MEETING OF THE ACRS SUBCOMMITTEE ON
ADVANCED BOILING WATER REACTORS
JULY 28, 1993
BETHESDA, MARYLAND
ROOM P-110

- AGENDA -

		APPROXIMATE TIME
I.	Introductory Remarks by Subcommittee Chairman - C. Michelson	11:00 - 11:10 a.m.
	Presentation by the General Electric Corporation	
II.	ABWR Fire PRA	11:10 - 12:00 noon
	* * * * * * **LUNCH** * * * * * * *	12:00 - 1:00 p.m.
III.	Fire Hazards Analysis Including 9.5-1 Fire Protection System (Diesel Generator Compartment)	1:00 - 2:30 p.m.
IV.	Fire Barrier Design (Including Diesel Generator Compartment)	2:30 - 3:30 p.m.
V.	G.E. Summary	3:30 - 3:45 p.m.
VI.	Subcommittee Discussion	3:45 - 4:00 p.m.
VII.	Adjournment	4:00 p.m.

Fire Risk Analysis

Fire Analysis

- Overview
- ABWR fire prevention and mitigation features
- Methodology
- Plant fire areas
- Safety-related building fires
- Control room fire
- Turbine building fire
- Modifications identified by fire analysis
- Results/conclusions

Overview

- Mutual NRC/GE agreement that fire risk screening analysis approach appropriate to assess ABWR fire
- Mutual NRC/GE agreement that EPRI fire and vulnerability evaluation (FIVE) methodology appropriate vehicle for performing analysis
- FIVE provides prescriptive procedures for identifying fire compartments, defining ignition frequencies, and performing quantitative screening analyses of fire risk
- Plant fire areas and frequencies defined with FIVE methodology
- Fire risk bounded using ABWR internal event PRA fault trees and event trees
- ABWR fire risk found to be very low

ABWR Fire Prevention and Mitigation Features

- Separation among divisions
- Fire barriers
- Fire protection system
- Smoke removal system

Methodology (Based on EPRI FIVE)

- Phase I – Qualitative Analysis
  - Identify plant fire areas
  - List safe shutdown systems
  - Identify safe shutdown systems/equipment by fire area
  - Identify significant fire areas
- Phase II – Quantitative Analysis
  - Define fire compartments for evaluation
  - Evaluate fire vulnerability frequency for fire compartments
  - Determine fire ignition frequencies
  - Conservatively apply ABWR level 1 PRA to assess core damage frequency by fire area
- Criterion for screening acceptability is that core damage in any fire area be less than 1E-06 per reactor-year

Plant Fire Areas (Examined by Major Grouping)

- Safety-related building grouping
  - Reactor building (except primary containment)
  - Control building (except control room complex)
  - Intake structure
  - Grouping contains all equipment required for safe shutdown except that within primary containment and the control room complex
  - Subdivided by fire barriers into three safety divisions
  - Conservatively assumed fire in any location in divisional fire area results in total loss of function of division
- Control room complex
- Turbine building

Safety Related Building Fires

- Fire ignition frequencies
  - Division 1 — 8.2E-02/yr
  - Division 2 — 8.4E-02/yr
  - Division 3 — 8.9E-02/yr
- Assumed consequences
  - Total loss of safety function of division (conservative assumption)
- Bounding level 1 PRA event tree used to quantify
  - Isolation/loss of feedwater
- Bounding CDF screening values
  - Division 1 fire — 4.3E-08 per reactor-year
  - Division 2 fire — 1.1E-07 per reactor-year
  - Division 3 fire — 5.6E-08 per reactor-year

Control Room Fire

- Fire ignition frequency
  - 4.4E-02
- Loss of all control from control room (following scram)
- Redundant system
  - Remote shutdown panel
- Bounding level 1 PRA event tree used to quantify
  - Isolation/loss of feedwater
  - Functions limited to those at remote shutdown panel plus reactor core isolation cooling (RCIC)
- Bounding CDF screening value
  - 8.9E-07 per reactor-year

Turbine Building Fire

- Fire ignition frequency
  - 1.8E-01/yr
- Possible consequence
  - Plant shutdown concurrent with loss of offsite power
- Bounding level 1 PRA event tree used to quantify
  - Loss of offsite power
- Bounding CDF screening value
  - 2.2E-07 per reactor year

Modifications Identified & Implemented as a Result of Fire Risk Analysis

- Provision for control of additional SRV at remote shutdown panel
- Requirement that RCIC be capable of being controlled from outside the control room complex

Results/Conclusions

- All fire areas successfully passed screen
- Methods applied are very conservative
- Fire risk analysis led to design modifications

ABWR Fire Protection

Presentations to:

Advisory Committee on Reactor Safeguards

Subcommittee on Advanced Boiling Water Reactors

Alan Beard
Gary Ehlert
Mo Nik-Ahd
Chandra Oza
Bob Raftery

Fire Protection Issues to be Discussed

- ABWR Fire Risk Assessment
  - Bob Raftery
- Fire Hazards Analysis
  - Mo Nik-Ahd
- Fire Barrier Design
  - Chandra Oza
- Other Issues of Interest
- Summary
  - Alan Beard

Summary of ABWR Fire Protection Features

- ABWR fully meets the requirements of BTP CMEB 9.5-1
- Only 1 of the 3 Engineered Safety Feature Divisions is required to bring the plant to safe shutdown in the event of a fire
- Fire Protection Features are designed into the plant prior to initial concrete
- 3-hour fire barriers are used to provide physical separation cf redundant trains except where not practically achievable

ABWR Design Enhancements that Improve Fire Survivability

- Smoke Removal Modes of Operation for the HVAC Systems
- 3-hour fire barriers (masonry in most places)
- Combustion Turbine Generator
- Redundant Storage Tanks for Fire Water Storage
- Limited Occurrences of Redundant Safety Components Located in a Different Divisional Fire Area