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UNITED STATES  
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

July 27, 1999

MEMORANDUM TO: Sher Bahadur, Chief  
Engineering Research Applications Branch  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

FROM: John A. Calvert, Senior I&C Engineer  
Engineering Research Applications Branch  
Division of Engineering Technology  
Office of Nuclear Regulatory Research

*John A. Calvert*

SUBJECT: MEETING SUMMARIES OF RESEARCH STUDY ON THE CALVERT  
CLIFFS NUCLEAR PLANT DIGITAL FEEDWATER SYSTEM

References: (1) Letter, June 23, 1999: John W. Craig, Office of Nuclear Regulatory  
Research, Director of the Division of Engineering, to Kevin Cellars,  
Baltimore Gas and Electric Company, Manager of the Nuclear Engineering  
Department. Attachment 1

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The purpose of this letter is to report the results and highlights of technical discussions with the Instrumentation and Control (I&C) staff of Baltimore Gas and Electric (BGE) Company's Calvert Cliffs Nuclear Power Plant. The subject was our research study on the reliability modeling of their digital feedwater system.

Summary

We held two meetings at the Calvert Cliffs Nuclear Plant. In the first meeting on May 11, 1999, we gave a presentation to the BGE I&C staff about the research objectives. Our cooperative research partner, the University of Virginia Electrical Engineering Department, also presented the technical overview of the digital modeling they would use in the study. As a result of this meeting, BGE agreed to participate in the research study and we sent an acknowledgment letter to BGE (Reference 1). Attachment 2 lists the date, time, place and attendees at this first meeting.

We held the second meeting, called the Technical Interchange Meeting (TIM) No. 1, on July 14, 1999, to discuss the functional details of the digital feedwater system, to receive the technical documentation, and to establish technical contacts. We received most of the documentation. The proprietary documentation is awaiting arrangements from the vendor. The University of Virginia can use the received documentation to start the functional study of the system prior to modeling. Attachment 3 lists the date, time, place and attendees of the second meeting.

Objectives of Digital Reliability Modeling Research

John Calvert discussed NRC's objectives regarding the digital reliability modeling research. By using design data from Calvert Cliff's digital feedwater system, the NRC and its cooperative research member, the University of Virginia, are able to test prospective digital modeling techniques. The

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main benefit to BGE is first-hand exposure to the new analysis technology. Attachment 4 contains the slides from Mr. Calvert's presentation.

Digital Modeling Technique

Dr. Barry Johnson, of the University of Virginia, presented excerpts from the digital reliability and safety modeling presentation that he gave to the NRC Advisory Committee on Reactor Safety (ACRS) on May 3, 1999. He provided an overview of the digital modeling technique developed at the University of Virginia's Center for Safety-Critical Systems and described the process of modeling digital systems. He also presented some results of past digital system studies using the digital modeling technique. The technique is unique in that it can model the actual software executing on the digital hardware. Most techniques model either the hardware or the software, but not both together as they are in an actual application. This allows modeling the effect of the interaction of hardware and software. Attachment 5 contains the slides from Dr. Johnson's presentation.

BGE Perceived Benefits of Digital Modeling and Implementation

BGE mentioned that a possible benefit of such modeling technology is a balanced approach towards capturing digital system faults in the design and operational stages. BGE also mentioned that the installed digital feedwater system has a significant, positive impact on the plant's core damage frequency. The main reason is that the faster algorithmic response of the digital system helps prevent loss of feedwater after a plant trip so that feedwater is available for decay heat removal and alternate means do not have to be brought into play.

Plant Documentation

Bruce Geddes, of Baltimore Gas & Electric, presented overviews of the digital feedwater system and the digital feedwater controller. Design documentation, such as system/software requirements specifications, manuals, drawings, system design descriptions, and hazard analysis, were shown. Some of the items are proprietary to ABB-CE, and arrangements to use those documents are expected soon. The University of Virginia took the documents that were not proprietary for their use in the study project. Attachment 6 is the Digital Feedwater (DFW) Documentation Inventory.

Digital Feedwater Lab

Bruce Geddes provided a tour of the digital feedwater lab. The lab contains the replicas of the digital feedwater controller and a simulator to drive the controller. This lab is used by BGE to validate the correct operation of the digital feedwater controller modifications before they go into the plant. The possibility of the University of Virginia using the lab was also discussed.

Attachments: As stated

Distribution: See next page

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**ATTACHMENT 1**