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AN OVERVIEW OF THE PROBABILISTIC ANALYSIS STAFF PROGRAMS ON HUMAN FACTORS

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Background

The Probabilistic Analysis Staff (PAS) is sponsoring several projects to study human error in nuclear reactor plants. Two of these projects focus on characterizing and quantifying human error. The resulting characterization and quantification of human error should be useful in an assessment of the impact of human error on risk and in the formulation of new regulatory requirements. This paper outlines the following: (1) problem statement, (2) program objectives of two on-going projects, and (3) plans for additional research.

Problem Statement

In October 1975, the Reactor Safety Study (WASH-1400) was released. Among its many conclusions, the study identified human error as a major contributor to some serious hypothetical accident sequences.

Failure to restore valves or switches to their proper standby alignment following tests or maintenance was found to dominate system unavailability for a few systems in WASH-1400. Other potentially important human errors before an initiating event include flawed design, personnel training, procedures, and maintenance.

Human error may also play an important role in that class of accidents in which the initiating event itself degrades the operability of the safety systems thus challenged. For example, failure to follow procedures in safety system surveillance testing might disable the system and precipitate a trip.

Third, human reliability is extremely important during the course of an accident. Particularly in those accidents which take a long time to develop, operator intervention can be expected. The analyst has a difficult task to identify and quantify the likelikhood of the many possible courses of action the operators may take.

Approach - The Quantification of Human Error

In an attempt to better understand human error, the Probabilistic Analysis Staff (PAS) is sponsoring two projects to model and quantify human error. One project involves the evaluation of nuclear reactor operator error from an analysis of past Light Water Reactor experience. This project is being conducted

by Iowa State University (ISU) Nuclear Safety Research Group. The other project is the development of a human factors handbook through the Statistics and Reliability Group of Sandia Laboratories.

The objectives of the ISU project are to (1) model quantitatively human performance under a range of reactor operating conditions, and (2) evaluate operator error based on commercial nuclear plant experience reflected in Licensee Event Report (LER) data. This project involves the analysis of all LER records from 1972 to present, extracting and evaluating those records which contain indications of possible human error, and coding the information based on an ISU-developed classification scheme for statistical and modeling analysis. In addition to other results, the project has provided frequency counts and cross-tabulations of human errors with respect to many variables including, but not limited to, component type (e.g., valves), reactor type (PWR, BWR), system affected, and type of human error such as "left valve closed." Using the above results, we may be able to derive the probability of human error under varying operating procedures and instrument design and configuration conditions.

Since psychological factors as well as physical factors contribute to human error, the PAS contract with Sandia Laboratories is aimed at providing a qualitative methodology to identify psychological and procedural conditions which may be used to condition the estimate of human error probability. The objective of this project is to prepare a handbook for use in evaluating human errors in operating reactors. This handbook includes the identification of environmental conditions and operating procedures which have a high likelihood of contributing to or reducing the probability of human error. The handbook also attempts to provide a qualitative method to estimate error rates relating to given environmental conditions, operating procedures, and psychological conditions (e.g., fatigue).

Future Intentions

PAS human factors research may be expanded to complement current research projects in order to meet the needs of the NRC mission. Additional research may be aimed at developing a nuclear industry human error data base and to eventually predict the occurrence of human errors in operating reactors, particularly where human error dominates and significantly contributes to the risk. Future research may include the analysis of operator behavior in experimental (simulation) settings, evaluation of other available nuclear industry data which may include a record of the occurrence and description of human error. Additional research is being planned to support future regulatory initiatives aimed at improving instrumentation. The specific objectives include better system status indications and improved in-plant accident response.

Conclusion

The importance of human error in the man-machine interface of operating reactors is widely recognized. PAS is attempting to broaden our knowledge of human reliability, to develop a data base, and to develop prediction models.