Task HF5: Man-Machine Interface (Rev. 4)

The objective of this task was to ensure that the man-machine interface (MMI) is adequate for the safe operation and maintenance of nuclear power plants. This objective was to be attained by developing: (1) human factors engineering guidelines for correcting MMI problems; and (2) regulatory guidance for integrating human factors engineering into new designs and into advanced technological improvements incorporated into existing designs.

This task was also to provide for the preparation of evaluation tools for: (1) the next generation of nuclear power plants; and (2) expected changes or upgrading to designed plants in the area of data and information management and improved annunciator systems. These efforts were expected to improve the staff's capability

to evaluate reactor incidents involving MMI errors. This task was identified as four distinct items in Table 7 of the NRC 1985 Annual Report (Items 5.1, 5.2, 5.3, and 5.4). The following is a discussion of these four items.

ITEM HF5.1: LOCAL CONTROL STATIONS DESCRIPTION

Previous regulatory efforts dealing with the MMI were limited to the control room and remote shutdown panel. It was believed that further guidance regarding local control stations and auxiliary operator interfaces was necessary as well as additional guidance regarding improvements to existing annunciator systems.

Information was to be developed to determine if guidance on local control station design and auxiliary operator interfaces with these stations was required. To accomplish this task, job/task analyses of control room crew activities were to be conducted to identify and describe communication and control links between the control room and the auxiliary control stations. In addition, the functions of the auxiliary personnel were to be analyzed from the task analyses to estimate the potential impact of auxiliary personnel job errors on plant safety.

CONCLUSION

The issue was given a high priority ranking and a survey of safety-significant local control stations was conducted at 4 plants. This survey included remote shutdown panels, local diesel generator panels, and local ECCS panels. Deficiencies found were poor lighting, poor labeling, obstructed view of instrumentation, and

unavailable communication equipment. The survey was documented in NUREG/CR-3696.[1]

A preliminary value/impact analysis that considered various combinations of upgrades involving panel re-design as well as functional centralization was completed and documented in NUREG/CR-5572.[2] However, with the publication of NUREG-1150,[3] the potential risk reduction was found to be considerably lower than previously anticipated and work was curtailed. The staff's studies were published in NUREG/CR-6146.[4] Thus, this issue

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[1] NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, (1st Ed.) November 1975, (2nd Ed.) March 1980, (3rd Ed.) July 1981.

[2] NUREG/CR-5572, "An Evaluation of the Effects of Local Control Station Design Configurations on Human Performance and Nuclear Power Plant Risk," U.S. Nuclear Regulatory Commission, September 1990.

[3] NUREG-1150, "Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants," U.S. Nuclear Regulatory Commission, (Vol. 1) December 1990, (Vol. 2) December 1990, (Vol. 3) January 1991.

[4] NUREG/CR-6146, "Local Control Stations: Human Engineering Issues and Insights," U.S. Nuclear

was RESOLVED and no new requirements were established.[5] In an RES evaluation,[6] it was concluded that consideration of a 20-year license renewal period did not affect the resolution.

ITEM HF5.2: REVIEW CRITERIA FOR HUMAN FACTORS ASPECTS OF ADVANCED CONTROLS AND INSTRUMENTATION

DESCRIPTION

The existing human engineering guidelines for nuclear power plant control rooms primarily addressed the control, display, and information concepts and technologies that were being used in process control systems. While these guidelines were adequate for the existing generation of nuclear power plants, the staff did not believe that they were sufficient for advanced and developing technologies that could be introduced into existing and future designs. Improved annunciator systems utilizing advanced technologies were expected to become available and guidelines for the utilization and evaluation of these longer-term annunciator improvements were to be developed, based on evaluations of results from advanced concept activities performed by governmental and commercially-sponsored research activities.

Thus, this issue focused on the potential risk that could result from the human error in the use of control room annunciators and included consideration of Items HF4.5 (automation and artificial intelligence), HF5.3 (operational aids), and HF5.4 (computers and computer displays). Proposed solutions to this combined issue

were to be changes to the SRP,[7] industry guidance such as a Regulatory Guide, and development of the necessary staff expertise to evaluate proposed designs for the MMI based on advanced technology.

CONCLUSION

This issue was given a high priority ranking and work was undertaken to determine the potential public risk from human error in the use of information from control room annunciators and to assess the safety significance of

upgrades identified in studies documented in NUREG/CR-3217[8] and NUREG/CR-3987.[9] However, work

on this issue was terminated[10] when the development of review guidance for advanced annunciators was integrated into an existing RES program to develop an "Advanced Human-Interface Design Review Guideline."

Regulatory Commission, September 1994.

[5] Memorandum for J. Taylor from E. Beckjord, "Termination of Work on Generic Safety Issue HF5.1 'Local Control Stations,'" June 29, 1993. [9312220224]

[6] NUREG/CR-3217, "Near-Term Improvements for Nuclear Power Plant Control Room Annunciator Systems," U.S. Nuclear Regulatory Commission, April 1983.

[7] NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, (1st Ed.) November 1975, (2nd Ed.) March 1980, (3rd Ed.) July 1981.

[8] NUREG/CR-3217, "Near-Term Improvements for Nuclear Power Plant Control Room Annunciator Systems," U.S. Nuclear Regulatory Commission, April 1983.

[9] NUREG/CR-3987, "Computerized Annunciator Systems," U.S. Nuclear Regulatory Commission, June 1985.

[10] Memorandum for J. Taylor from E. Beckjord, "Resolution of Human Factors Generic Issue 5.2, 'Review Criteria for Human Factors Aspects of Advanced Controls and Instrumentation,'" June 29, 1993. [9312220225]

The review guidance was later published in NUREG/CR-6105.[11] In an RES evaluation,[12] it was concluded that consideration of a 20-year license renewal period did not affect the resolution.

ITEM HF5.3: EVALUATION OF OPERATIONAL AID SYSTEMS DESCRIPTION

Staff guidance pertinent to MMI involving new control and display techniques were to be prepared to include: (1) identification of new and developing display and control technologies having a potential application in nuclear power plant control rooms; (2) development of evaluating methods and design criteria related to visual displays; and (3) establishment of the criteria needed for regulatory assessment of advanced control room concepts. In addition, the control and display requirements for crew response needs following a seismic event were to be identified.

Based on the results of an investigation of means for monitoring and verifying operations, test, and maintenance activities, the staff was to make determinations concerning: (1) the comparative adequacy of status monitoring in plants that did not have automatic monitoring systems; (2) the adequacy of operational systems designed to

be in conformance with Regulatory Guide 1.47[13]; and (3) the development of long-term improvement guidance addressing the feasibility and value/impact of instrumentation backfits.

CONCLUSION

This issue was covered in Item HF5.2.

ITEM HF5.4: COMPUTERS AND COMPUTER DISPLAYS DESCRIPTION

A program plan will be developed to evaluate the safety significance and problems relating to the management of data and information in the nuclear power plant control room during abnormal events. Products may include the development of guidelines on control room information management during severe transients and accidents. These guidelines may be in the form of NUREG reports and Regulatory Guides.

CONCLUSION

This issue was covered in Item HF5.2.

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[11] NUREG/CR-6105, "Human Factors Engineering Guidance for the Review of Advanced Alarm Systems," U.S. Nuclear Regulatory Commission, September 1994.
[12] Memorandum for W. Russell from E. Beckjord, "License Renewal Implications of Generic Safety Issues (GSIs) Prioritized and/or Resolved Between October 1990 and March 1994," May 5, 1994. [9406170365]
[13] Regulatory Guide 1.47, "Bypassed and Inoperable Status Indication for Nuclear Power Plant Safety Systems," U.S. Atomic Energy Commission, May 1973. [7907100191]