

ADAMS Package Accession No. ML010750246

March 15, 2001

MEMORANDUM TO: Samuel J. Collins, Director
Office of Nuclear Reactor Regulation

FROM: Ashok C. Thadani, Director **/RA/**
Office of Nuclear Regulatory Research

SUBJECT: "THE EFFECTS OF ALARM DISPLAY, PROCESSING, AND
AVAILABILITY" – NUREG/CR-6691 AND "ADVANCED ALARM
SYSTEMS: REVISION OF GUIDANCE AND ITS TECHNICAL BASIS"
– NUREG/CR-6684

Attached for your information are two related contractor reports, NUREG/CR-6691, "The Effects of Alarm Display, Processing, and Availability," and NUREG/CR-6684, "Advanced Alarm Systems: Revision of Guidance and Its Technical Basis". NUREG/CR-6691 has the results of a simulator study of alarm prioritization and reduction aspects of advanced alarm systems that was conducted at the Halden Reactor Project (HRP), while NUREG/CR-6684 states interim guidance for the review of advanced alarm systems. The simulator study supports the technical basis for the interim review guidelines in NUREG/CR-6684. This work was done in response to the alarm prioritization and reduction techniques element of NRR User Need 98-025 and is intended to complete that element of the user need.

The alarm system is one of the primary means by which process abnormalities and failures are brought to plant personnel's attention. Advanced, computer-based alarm systems are designed to assist the operator by processing alarm data and improving the presentation of alarm information. This technology promises to provide a means of correcting many known deficiencies in alarm systems. Advanced, computer-based alarm systems are available and are being considered by utilities as they upgrade existing control rooms. Such systems are included in control room designs for advanced reactors. The Nuclear Regulatory Commission's (NRC) current review guidance does not include guidelines for all aspects of these advanced systems.

NUREG/CR-6684 updates and revises the NRC's guidance for reviewing alarm system designs. The revisions were based on NUREG/CR-6691 and on a review of new computer-based control room systems being introduced into conventional nuclear power plants in Europe. In addition, this effort examined recent research on alarm systems. In NUREG/CR-6684, new guidelines were developed and the criteria for some existing guidelines were modified or supplemented.

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These changes address the aspects of:

- Alarm Characterization and Definition
- Alarm Processing and Reduction
- Alarm Prioritization, Status and Message Availability
- Control-Display Characterization, Integration and Layout
- Backup, Test, Maintenance, and Failure Indication Features
- Alarm Response Procedures

The guidelines described in this document may be used as interim review guidance until they are incorporated into Revision 2 of NUREG-0700, "The Human-System Interface Design Review Guideline," as final guidance.

NUREG/CR-6691 documents the results of an empirical study of the impact of alarm system design characteristics on crew performance performed at the HRP using their HAMMLAB simulator. The characteristics of alarm system design that we investigated were display design, degree of alarm reduction, and availability/prioritization. Six two-person crews of nuclear power plant operators from the Loviisa Nuclear Power Plant completed sixteen test trials consisting of two trials in each of eight experimental conditions. Measures of plant performance, operator task performance, and cognitive performance were obtained. In addition, operator ratings and evaluations of the alarm characteristics were collected.

In essence, the results indicated that all the crews were able to detect the disturbances and handle them effectively. There were few significant effects on the plant, task performance, and cognitive measures. The most notable tendency was for the alarm effects to interact with scenario complexity. We believe that the performance effects were modest because the alarm systems were generally well designed, integrated into an information-rich environment, and the operators were able to shift their information-gathering strategies to compensate for the differences in designs. The operators' ratings and evaluations provided many insights on the strengths and weaknesses of the various alarm design features. The research played two important roles in developing regulatory guidance. The results confirmed that (1) the selected guidance is an acceptable extraction, synthesis, and interpretation of the information and (2) the guidance is appropriate to an NPP application. The results of this study were used in the development of NUREG/CR-6684 to extend and improve human factors guidance for the review of alarm systems.

Drafts of these reports were reviewed by NRR/DIPM and were independently peer reviewed by the human factors subcommittee (SC-5) of the Institute for Electrical and Electronic Engineers (IEEE).

Incorporation of the guidance included in NUREG/CR-6684 into Revision 2 of NUREG-0700 is consistent with the NRC strategic performance goals.

Making NRC activities more effective, efficient, and realistic -- by (1) standardizing the review process; (2) anticipating challenges posed by the introduction of new technologies, and (3) being supported by a strong technical basis.

S. Collins

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Maintaining safety -- by ensuring that alarm systems are designed to support operator needs and responses.

Increasing public confidence -- by adding consistency to the NRC review process.

If you have any questions or concerns, please contact me or J. Persensky at 415-6759.

Attachments:

NUREG/CR-6691 (**ADAMS Accession Number ML003770890**)

NUREG/CR-6684 (**ADAMS Accession Number ML003770903**)

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*See previous concurrence

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