ADAMS Package No. ML010190077

January 18, 2001

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

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

SUBJECT: "A STUDY OF CONTROL ROOM STAFFING LEVELS FOR ADVANCED REACTORS" – NUREG/IA-0137

Attached for your information and potential use is the contractor report, "A Study of Control Room Staffing Levels for Advanced Reactors" - NUREG/IA-0137, prepared by B. Hallbert and A. Sebok, of the Institutt for Energiteknikk, and D. Morisseau, formerly of the USNRC, now retired. This NUREG/IA reports on the results of a study conducted at the Halden Reactor Project and can be used as part of the technical basis for review guidance on control room staffing levels for advanced reactor applications. The work was done in response to NRR User Need 98-025.

The report documents the results of an empirical study of operator and plant performance in simulators at the Loviisa nuclear power station, which represented the conventional control room, and at the Halden Man Machine Laboratory (HAMMLAB), which represented the advanced plant control room. The advanced plant design employed passive systems. Two control room staffing configurations were employed in each plant setting: a staffing configuration reflecting the requirements of 10 CFR 50.54 (m); and a staffing configuration that involved a reduced number of control room operators. Five scenarios were chosen to evaluate the effects of plant type and crew size on performance. The scenarios were: 1) steam generator tube rupture with a stuck open steam generator safety relief valve in the affected steam generator, preceded by a fire in the turbine hall; 2) interfacing systems loss of coolant accident with compounded instrument failures due to the incident; 3) sustained total loss of feedwater; 4) loss of off-site power with a single steam generator safety relief valve stuck open, and; 5) steam generator overfill. Eight crews of operators from the Loviisa nuclear power station in Finland participated in the study: four crews in the conventional plant setting; and four crews in the advanced plant setting. Measures included ratings of crew performance and transient management, operator workload, situation awareness, and team interaction. The findings of the study revealed a number of effects of crew size and plant type, and their combination on operator performance. The report documents the study and discusses the implications and issues raised by this performance-based evaluation of control room staffing requirements for advanced passive reactors.

CONTACT: J. J. Persensky (jjp2), REAHFB:DSARE:RES
(301) 415-6759

Some of the findings from this research were:

> The minimum-sized crews in the advanced plant demonstrated the best rated crew performance. Crews in the advanced plant experienced significantly higher workload than crews in the conventional plant, yet their performance was superior.
>
> Normal-sized crews performed better than minimum-sized crews on cooldown and stabilization tasks. However, both crew sizes performed similarly on critical task completion.
>
> Minimum-sized crews performed better than normal-sized crews in the advanced plant; conversely, normal-sized crews performed better than minimum-sized crews in the conventional plant.
>
> Minimum-sized crews experienced more workload than normal-sized crews, with the control room supervisor (CRS) experiencing most of the additional workload. The dual role CRSs expressed concerns about working effectively in such a stressful capacity.
>
> Crews in the advanced plant setting exhibited better and more stable team interaction than crews in the conventional plant. The advanced plant configuration provided close operator workstations centered around a common overview display, which served as a focus of operator discussions.

Drafts of this report were reviewed by NRR/DIPM.

There are no recommendations for change to 10 CFR 50.54 (m) for current plants included in this NUREG/IA. However, the conclusion that,

> "... decisions about control room staffing should be based upon design features including function allocation, automation, integration, and plant-specific characteristics (e.g., passive system performance). Validation and verification using measures of operator and crew performance are necessary to determine the staffing complement needed to operate the plant."

could serve as a portion of the technical basis for and the impetus for consideration of the staffing issue as a candidate for performance-based rulemaking. Such a regulation would allow designers to establish minimum staffing levels through consideration of the role of the human in system function and design. That regulation could replace or be an alternative to the existing prescriptive rule, which sets minimum staffing levels regardless of design and function allocation. Such a rule would help:

> **Reduce unnecessary regulatory burden** -- by using performance information to establish staffing levels
>
> **Maintain safety** -- by ensuring human actions are analyzed with the appropriate criteria and thoroughness

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

Attachment: As stated (ML003774060)

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