

18.5 Staffing and Qualifications

10 CFR 50.54 (i) through (m) require a minimum number of main control room (MCR) operators to monitor and control the plant at any given time. The roles and responsibilities of the shift supervisor (SS) are delineated separately from the minimum number of MCR operators. Analysis of the human system interface (HSI) design is necessary to determine the task loading and the margin to and propensity for human error with regard to how the plant normally operates for various abnormal or emergency conditions. Analysis of actual staffing numbers is an iterative process. Initial assumptions are reviewed, validated, and modified as necessary following the analyses associated with other elements of the human factors engineering (HFE) program.

The analysis described in this section serves as input to aid in the development of an adequate staffing plan for the operating crew. A COL applicant that references the U.S. EPR design will confirm that actual staffing levels and qualifications of plant personnel specified in Section 13.1 of the COL application remain bounded by regulatory requirements and results of the staffing and qualifications analysis. This site-specific information shall be based on corporate staffing philosophy, existing site operations, fleet operations, and plant design. Overall plant staffing plans incorporate organizations including operations, maintenance, engineering, licensing, operations support such as radiological protection, instrumentation and controls, chemistry technicians, security personnel, management, and administration.

18.5.1 Objectives and Scope of Analysis

For developing the conceptual design for HSIs, and considering the minimum staffing requirements established in 10 CFR 50.54 (i) through (m), a U.S. EPR design goal is to design the plant and the HSI so that three licensed operators can safely monitor and control the plant from the MCR under all operating conditions, including normal operation, startup, shutdown, abnormal operation, and accidents. Because of the levels of automation inherent in the instrumentation and controls (I&C) architecture, only one licensed operator is needed at the controls during normal power operations. A second licensed operator is required by law to be on shift to provide defense in depth; the second licensed operator is not required to be continuously at the controls. In addition, a senior reactor operator (SRO) licensed control room supervisor shall remain present or readily available at all times in accordance with 10 CFR 50.54 (m). U.S. EPR design input assumptions also require that each operating crew include an SRO licensed SS, a shift technical advisor (STA) (may be combined with the SS position if the requisite qualifications for each position are fulfilled), a number of non-licensed operators (NLO), and a maintenance crew consisting of a supervisor and technicians from chemistry, radiation protection, I&C, electrical, and mechanical technicians as noted in the U.S. EPR Human Factors Engineering Program Topical Report (Reference 1). Qualification requirements for operations shift personnel are described in Section 13.1.3.

The objective of the U.S. EPR staffing and qualifications analyses is to demonstrate that the HSI design and the number, roles, and responsibilities of the plant operating

staff is able to adequately meet the demands of the processes of the plant. The initial assumption for the roles and responsibilities of operators during a full range of operating conditions is documented in Section 4.1 of Reference 1. The initial staffing assumption is based on operational experience from the U.S. EPR predecessor designs (i.e., European N4 and Konvoi pressurized water reactor (PWR) designs which are in turn based upon Westinghouse-designed PWRs currently operating in the U.S.). A higher level of automation exists for the U.S. EPR than for the predecessor plants. This higher level of automation supports fewer operators at the controls even considering additional monitoring requirements for added automation features.

To obtain an optimum staffing level for the U.S. EPR, factors associated with other elements of the HFE program are considered. For example:

- The operating experience review (OER), Section 18.2, identifies staffing level related aspects of operating plants of similar design under various conditions and operating modes.
- Functional allocation (FA) decisions, Section 18.3, are evaluated to achieve maximized performance without placing excessive demands upon the operators, and to determine the monitoring tasks required of operators when functions are automated.
- Task analysis (TA), Section 18.4, provides input to the MCR staffing levels by including workload analysis as part of the overall TA process. The objective is to verify that the control room HSI adequately supports operator performance. Workload analysis must carefully consider assumed roles and responsibilities and qualification requirements of operators.
- Human reliability analyses (HRA), Section 18.6, provides input to the consideration of staffing levels on plant safety and reliability. In particular, risk-significant or time critical human actions (HAs) are examined during the TA to determine the need for reassignment, changes to operator roles, or the need to change the number of operators required.
- The role of the operator is an important consideration in the HSI design process. Section 18.7 addresses the engineering process of optimizing coordinated operator actions such as the demand on operators during the use of control elements and display elements concurrently and the design of effective support.
- Because the U.S. EPR uses a computer-based procedure system, concurrent use of multiple procedures has an effect on the role of operators and on staffing demand.

18.5.2 Staffing and Qualifications Analysis Methodology

To obtain an optimum staffing level, the initial staffing assumption (Reference 1) may be iterated as a result of the other HFE analyses as previously described. The objectives of the staffing analysis are specifically tied to the development of procedures and the associated TA. Initially, tasks are assigned to crew members based on U.S. EPR predecessor operating experience and on established roles and responsibilities as noted in Reference 1. The process then builds on these assumptions. Procedures are

developed and integrated with the HSI operational concept. Then, the impact of any new tasks associated with the use of integrated procedures is considered in regard to existing tasks and roles of the crew members. This consideration helps to determine if task allocation adjustments are necessary. Changes in team roles and responsibilities may result from the adjustments to individual crew member responsibilities. Finally, individual team member qualification requirements may evolve with changes in team and individual roles.

A full-scale mockup of the MCR working area, including main control consoles (i.e., workstations) and the plant overview panel is used to verify physical layout aspects such as availability of workspace, physical access, visibility, and related anthropometric and HFE issues. The MCR mockup is also used for walk-through exercises to examine issues such as staffing levels, task allocation, and procedure usage.

A computer-based procedure system is available to the operators via the HSI. This computer-based system helps achieve the staffing goal for the MCR by reducing the mental burden and workload of the operators. The use of computer monitoring of tasks and automation reduces parallel activities being performed by operators and the probability of human error.

The integrated system validation conducted as part of the verification and validation (V&V) process includes the following evaluations:

- Establishment of HSI adequacy for achieving HFE program goals.
- Confirmation of function allocation and task structure assigned to personnel.
- Establishment of the adequacy of MCR staffing levels and the adequacy of the various HSIs to support the staff in accomplishing their tasks.
- Integration of operating procedures.
- Confirmation of the dynamic aspects of the HSI for task accomplishment.
- Evaluation and demonstration of error tolerance to human and system failures.

18.5.3 Results

If it is determined from the integrated system validation that plant staffing and HSI design goals are not achieved, a decision is made to redesign the appropriate system, modify the roles and responsibilities of effected staff (taking into account the effect on plant safety and reliability), or adjust staffing numbers. A final check is then performed to verify that the staffing numbers and configuration are still in compliance with the requirements of 10 CFR 50.54 (i) through (m). The staffing and qualification analysis is summarized in conjunction with the V&V results (see Section 18.10) and includes an evaluation of the number and qualifications of personnel needed to operate, maintain, and test the U.S. EPR based on the HSI design features for normal, abnormal, and emergency conditions.

18.5.4**References**

1. ANP-10279P, "U.S. EPR Human Factors Engineering Program Topical Report," January 23, 2007.