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Dr. Howard L. Parris, Program Manager
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Dear Dr. Parris:

Recent commission policy and budget decisions related to NRC's Human Factors Program Plan have been incorporated into the enclosed draft of Revision 2. The principal effect of these decisions, with a few exceptions, is to shift staff efforts from development of regulatory requirements and guides to staff evaluation of industry self-initiatives and their effectiveness.

I request that you review the accuracy of the sections in the plan which describe industry activities for which you are responsible. Your proposed revisions to these sections, including new sections if appropriate, would be appreciated. Because our schedules and relative priorities for evaluation of industry self-initiatives will be influenced by the pace of industry's activities, I request that you broadly identify your schedules. Our plan is to finalize Revision 2 of the Human Factors Program Plan including staff and industry schedules by October 1, 1985. Your comments and estimated schedules are requested by August 15, 1985.

Sincerely,

Original Signed by
WILLIAM T. RUSSELL

William T. Russell, Acting Director
Division of Human Factors Safety
Office of Nuclear Reactor Regulation

Enclosure:
Revision 2

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U.S. NUCLEAR REGULATORY COMMISSION

HUMAN FACTORS PROGRAM PLAN

(NUREG-0985, REV. 2 DRAFT)

JUNE 30, 1985

FOREWORD

The U.S. Nuclear Regulatory Commission's Policy and Planning Guidance for 1982 (NUREG-0885, Issue 1) called for development of a long range human factors program plan. An initial version of the Human Factors Program Plan was issued in July 1983. Revision 1 of NUREG-0985 was issued in September 1984 to reflect allocations of the estimated FY-1985 budget and to respond to the requirements of Section 306 of the Nuclear Waste Policy Act of 1982 (PL 97-425). Revision 2 of the plan incorporates recent Commission decisions and policy related to elements of the plan. With a few exceptions, the principal effect of Revision 2 is to shift the plan from staff development efforts to staff evaluation of industry self-initiatives and the effectiveness of industry self-policing.

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APPENDIX A PROGRAM ELEMENT SCHEDULES

NOMENCLATURE

AEOD	Office of Analysis and Evaluation of Operational Data
AI	artificial intelligence
ANS	American Nuclear Society
ANSI	American National Standards Institute
AOA/ES	Advanced Operator Aids/Expert System (EPRI Program)
AOP	abnormal operating procedure
BWR	boiling water reactor
CFR	Code of Federal Regulations
CRGR	Committee to Review Generic Requirements
CRT	cathode-ray tube
DHFS	Division of Human Factors Safety
DOE	Department of Energy
DST	Division of Safety Technology
EDO	Executive Director for Operations
EEl	Edison Electric Institute
EOP	emergency operating procedure
EPRI	Electric Power Research Institute
FY	fiscal year
GL	generic letter
HFPP	Human Factors Program Plan
HRA	human risk analysis
IE	Office of Inspection and Enforcement
INPO	Institute for Nuclear Power Operations
LER	license event report
M&O	management and organization
MMI	man-machine interface
MOU	Memoranda of Understanding
NAS	National Academy of Sciences
NPP	nuclear power plant
NRC	U.S. Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
NSSS	nuclear steam supply system
NTOL	near-term operating license
NUMARC	Nuclear Utility Management and Human Resources Committed
OP	operating procedure
PAT	performance appraisal team
PRA	probabilistic risk assessment
PWR	pressurized water reactor
QA	quality assurance
RES	Office of Nuclear Regulatory Research
RG	regulatory guide
RO	reactor operator
SALP	systematic appraisal of licensee performance
SPDS	Safety Parameters Display System
SRO	senior reactor operator
SRP	Standard Review Plan
TMI-2	Three Mile Island Unit 2

1 INTRODUCTION

1.1 Purpose

The purpose of the U.S. Nuclear Regulatory Commission (NRC) Human Factors Program Plan (NUREG-0985, Revision 2) is to ensure that proper consideration is given to human factors in the design and operation of nuclear power plants (NPPs). The plan identifies the staff's approach to addressing human factors concerns important to NPP safety in FY 1986 through 1987.

1.2 Background

The functions, capabilities, and limitations of the personnel involved in the operation of NPPs must be thoroughly understood and included in the effort to evaluate the safety of NPPs. The accident at Three Mile Island Unit 2 (TMI-2) initiated the need to examine the involvement of human factors in NPP regulation and operation. NUREG-0660 was issued to describe a number of tasks that needed to be performed by the nuclear industry and the NRC. A significant number of these tasks were aimed at improving NPP safety through increased attention to the human element. To substantiate this need further, an analysis was performed of licensee event reports (LERs). That analysis indicated that about one third of all reportable events directly involve human performance.

In June and December 1980, the Commission issued policy statements that expanded the Commission's regulations of the requirements in NUREG-0737. The licensing review process now stresses consideration of human factors areas such as:

- (1) NPP staffing to ensure that the numbers, functions, and qualifications of personnel are adequate for safe operation
- (2) training programs for both licensed and nonlicensed NPP staff to ensure that personnel are able to meet existing job performance requirements
- (3) licensing examinations to ensure validity, reliability, and fairness of examinations and the examination process
- (4) procedures to ensure their adequacy and effectiveness
- (5) NPP control rooms and remote shutdown panels to ensure that they are designed to facilitate the man-machine interface (MMI)
- (6) utility management and organization to ensure its adequacy to support safe NPP operation
- (7) the impact of human error and human performance on NPP operation to ensure the development of adequate human factors information to support NPP safety

In 1982 the Commission approved SECY 82-111, "Requirements for Emergency Response Capability." These requirements were published as Supplement 1 to NUREG-0737 and transmitted to the industry as Generic Letter 82-33. This action applied important human factors requirements to operating plants, primarily in the areas of MMI and upgraded procedures, including training related to these two areas. The schedule for accomplishing these activities has been established through negotiation between Office of Nuclear Reactor Regulation (NRR) project managers and the utilities.

Section 306 of the Nuclear Waste Policy Act of 1982 (PL 97-425) directed the NRC to promulgate regulations or other appropriate guidance for the training and qualifications of civilian nuclear power plant operators, supervisors, technicians, and other appropriate operating personnel. In addition, PL 97-425 required NRC to establish simulator training requirements for applicants for operator licenses and for operator requalification programs, requirements governing NRC administration of requalification examinations, requirements for operating tests at civilian nuclear power plant simulators, and instructional requirements for licensee personnel training programs. The impact of Section 306 required significant revisions in the activities and schedules of many Human Factors Program Plan efforts. Revision 1 to this plan reflected these changes.

1.3 Structure of the Program Plan

The Human Factors Program Plan is structured as follows:

Section 1 describes the background that led to this plan, current activities, and program management.

Section 2 describes the special issues that either affect all aspects of the program or require involvement of more than one program element for their resolution.

Section 3 addresses the seven major program elements and the major tasks to be performed in FY 1985 through 1987. Any industry activities that are related to a particular program element also are addressed, as appropriate. The seven major program elements are

- (1) Staffing and Qualifications
- (2) Training
- (3) Licensing Examinations
- (4) Procedures
- (5) Man-Machine Interfaces
- (6) Management and Organization
- (7) Human Performance

1.4 Current Activities

This revision updates the NRC's Human Factors Program Plan to reflect recent Commission decisions and policy. The Commission's 1985 Policy and Planning Guidance (PPG), NUREG-0885, Issue 4, provided the basic philosophy of regulation and the specific objectives of the Commission, some of which directly relate to human factors issues. Specifically, the Commission directed the staff to "continue efforts approved in the NRC's Human Factors Program Plan

and "make effective use of available human factors data and take industry efforts (such as INPO) into account in developing NRC Programs" (Item III.7); to "maintain the capability to respond to innovative and advanced designs that might be presented for Commission review" (Item IV.J.1); and to determine an appropriate way to incorporate industry safety initiatives in nuclear regulation" (Item II). The Commission has made other specific decisions related to human factors issues (e.g., its decision not to proceed with general operating criteria and its policy statement to defer rulemaking on training). These decisions are reflected in the approach to some plan elements (e.g., Management and Organization, Staffing and Qualifications, and Training). This revision also reflects FY-1986 and -1987 budget decisions that resulted in consolidating NRC's human factors activities into the Office of Nuclear Reactor Regulation, Division of Human Factors Safety. As a result of these decisions, the NRC staff's role has shifted for some plan elements from development of new regulatory requirements to evaluation of industry self-initiatives and independent staff determination of the effectiveness of industry programs.

The activities planned within these program elements (1) will provide the technical bases for developing regulatory guidance, if necessary, or for concluding that nuclear industry self-policing activities are effective and (2) will improve the staff's capability to effectively perform licensing activities. Activities implemented under earlier revisions of the program plan supported decisions regarding the approach to regulatory action to resolve human factors issues. If the results of the programs indicate that new requirements should be promulgated, such proposals will undergo the normal review process, including development of a regulatory analysis and review by the Committee to Review Generic Requirements (CRGR).

1.5 Program Management, Coordination, and Integration

The success of this plan relies on effective interactions within the NRC and between the NRC and industry. The systems approach taken in this plan is intended to provide assurance that NRC human factors activities are appropriately integrated and that adequate and accurate human factors information is developed. The plan recognizes that activities initiated within INPO, EPRI, Edison Electric Institute (EEI), utility Owners Groups, and individual utilities often provide essential information to complement the activities described herein. To ensure that available information is effectively and efficiently used, these activities, and those at other Federal agencies and in foreign countries, will be coordinated and integrated with those described in this plan. Memoranda of Understanding (MOU) with INPO have been signed for those INPO activities related to staff efforts.

The Director, NRR has overall responsibility for implementation of the NRC Human Factors Program Plan (HFPP). The following program management controls will be implemented to ensure effective management, coordination, and integration:

- ° The Director, Division of Human Factors Safety (DHFS) is delegated responsibility for overall management, coordination, and integration.

- ° A cognizant Branch Chief will be assigned responsibility for management, and implementation of each program element.
- ° Quarterly program element reviews will be held by the Director, DHFS for each program element.
- ° Semiannually the overall program progress will be reported to senior NRC management (e.g., Directors, NRR, EDO, and other involved Office Directors).
- ° Annually the staff will report to the Commission program status and progress toward resolution.

2 SPECIAL ISSUES

Some special issues that impact the Human Factors Program Plan are relevant to more than one program element. These issues of concern are discussed below.

2.1 Prioritization

The staff recognizes that there must be orders of priority among the plan elements and among activities of individual elements. The plan was prioritized by the Division of Safety Technology (DST) in accordance with procedures established in NRR Office Letter 40. However, as a result of the FY-1986 and -1987 budget constraints some activities which were previously prioritized as low or medium priority have been deleted or deferred. In general, activities and end products associated with evaluation of industry self-initiatives and the effectiveness of industry self-policing and near-term regulatory actions will be given priority over activities related to review of advanced technologies. These latter activities are, however, considered high priority because they provide the necessary staff expertise to review, when proposed, the use of advanced technologies (e.g., new control room designs, artificial intelligence and computerized operator aids).

2.2 Hardware vs. Training/Procedures Solutions to Problems

Frequently, solutions to design-related human factors problems in operating NPPs are based on people-oriented changes (e.g., modifications to operator training or procedures). While this may be an appropriate resolution of some issues, overuse of this approach may overload both operators and operator training programs. Recent incidents have confirmed the need to take a systems approach to human factors problems and not necessarily rely on one-time solutions. Any decisions to adopt training as a solution to a safety issue instead of a design modification must recognize and incorporate the continuing cost of expanded training, possible increase of crew size, and increase in number of shifts in the cost/benefit evaluation.

2.3 Maintenance

The Commission's 1984 Policy and Planning Guidance (NUREG-0885, Issue 3) recommended the staff develop alternative regulatory approaches with respect to nuclear power plant maintenance. In response, the staff has developed the Maintenance and Surveillance Program Plan (SECY-85-129). During FY 1984, the staff considered including the Maintenance and Surveillance Program as an element in the HFPP. However, the definition and scope of activities involved in the Maintenance and Surveillance Program Plan are broader than those of the HFPP; therefore, implementation of the Maintenance and Surveillance Program Plan will be independent of the HFPP. The staff is coordinating their efforts on these plans to avoid duplication and to ensure that maximum results are obtained from both.

2.4 Probabilistic Risk Assessment

The ongoing and planned research has identified deficiencies and the lack of credible NPP human error data for use in performance of PRAs. Methods and techniques to substantially improve collection of NPP human error data for use in PRAs are being developed and evaluated. The Human Reliability element activities related to human error probability from Revision 1 of the HFPP have been incorporated into the RES Reliability and Risk Analysis Methods Program Plan (NUREG-1093). Results from this program are expected in early FY 1987 and will be evaluated for relevant information on human performance, which will be fed back to the applicable HFPP element.

2.5 Advanced Technologies

The ongoing development and installation of a safety parameter display system (SPDS) is envisioned as an important step in upgrading existing NPP designs in plant control rooms. This was required by Supplement 1 of NUREG-0737. Most of the SPDS designs are based on computer technology and cathode-ray tube (CRT) display techniques. It is anticipated that these expanded data and information management capabilities will be applied to other plant processes and procedures to make use of advanced technologies. As these new control and display technologies are being developed, guidance pertinent to the interface between them and the operator will be developed. The development of computer applications and artificial intelligence (AI) capabilities will effect process control and operating procedures.

2.6 Nuclear Industry Management Initiatives

The Nuclear Utility Management and Human Resources Committee (NUMARC) was established by the utility industry in April 1984 with an objective of improving performance of nuclear power plant personnel and management. The staff will monitor the effectiveness of the NUMARC initiatives and report its evaluation to the Commission. NUMARC activities are identified in this plan for staff monitoring and evaluation; especially NUMARC's activities for the program elements of Staffing and Qualifications, Training, and Management and Organization.

2.7 National Academy of Science

The NRC has contracted with the National Academy of Sciences (NAS) to conduct an independent study of human factors research needs in the safe operation of nuclear power plants. This study, which will be completed in FY 1986, will include an assessment of relevant completed human factors research by NRC and industry and recommendations for future human factors research based on identified deficiencies and need.

3 PROGRAM ELEMENTS

3.1 Staffing and Qualifications

The goal of this element is to provide a means to ensure that qualifications and staffing parameters at nuclear power plants (NPPs) are adequate for safe operation and support.

Section 306 of the Nuclear Waste Policy Act of 1982 directed the NRC to promulgate regulations or other regulatory guidance for the training and qualifications of appropriate plant operating personnel. Although the staff proposed rulemaking (SECY 84-76, 84-76A, and 84-76B), the Commission directed the staff to develop a policy statement on training and qualifications in response to the Act. The Commission decided not to promulgate any new qualification requirements for certain operating reactor personnel, except for licensed operators, for at least 2 years while permitting the INPO-managed accreditation program to provide the necessary basis for ensuring that NPP personnel have qualifications commensurate with the performance requirements of their jobs. Industry will be responsible for developing programs that will ensure that the personnel categories covered by the INPO-managed accreditation program have appropriate qualifications.

The issues of concern in this element include the development of a technical basis for minimum experience and educational qualifications of NPP personnel and the difficulties inherent in monitoring and objectively evaluating industry-based qualification programs. Another concern is the development of a technical basis for regulatory guidance in the areas of staffing and work scheduling for NPP personnel.

3.1.1 Major Tasks of Program Element

The DHFS staff is in the process of developing guidance on the appropriate minimum qualification requirements of NPP personnel.

On April 26, 1985, SECY-85-150 was sent to the Commissioners with two versions of the final policy statement on engineering expertise on shift. The first version was developed with NUMARC and the second version was a result of a memorandum from the Chairman to the Executive Director for Operations, dated February 22, 1985. After the final Commission decision, DHFS will make any necessary revisions and implement the final policy statement as directed.

A revision to Regulatory Guide 1.8 will be issued. The regulatory guide was issued for public comment in conjunction with the proposed rule change to 10 CFR 55. The staff will resolve public comments and then prepare a revised version on the basis of recommended changes.

A project designed to identify job-related qualifications for the operations shift crew will be completed. NUREG/CR-4051, "Assessment of Job-related Educational Qualifications for Nuclear Power Plant Operators," was published

in April 1985. The next task of the project is to conduct a systematic comparison of educational programs developed for operators and job-related academic knowledges identified in the INPO Job/Task Analysis.

The NRC will selectively review industry qualification programs as described in the Commission's policy statement on training and qualifications of nuclear power plant personnel. Methods and procedures will be developed to evaluate, on a sampling basis, industry's implementation of accredited training programs to ensure that personnel qualifications are commensurate with the performance requirements of their jobs. The staff also will review data from such reports as the systematic assessment of licensee performance (SALP), licensee event reports (LERs), and other inspection reports and performance data in order to correlate utility performance to personnel qualifications. This evaluation effort will help the NRC determine whether it should endorse industry-developed personnel qualification activities described in Section 3.1.2 below.

The staff plans to (1) evaluate the current policy statement on overtime and (2) to prepare a generic letter modifying GL 82-12, if necessary, to establish the appropriate limits and conditions of shift work, including overtime, shift duration, and shift rotation.

To determine the appropriate minimum staffing requirements and functions of NPP personnel to safely perform all required operations, the staff will (1) revise Regulatory Guide 1.114 to include guidance on the senior reactor operator in the control room and (2) investigate the feasibility of using manpower projection modeling techniques to determine minimum safe NPP staffing levels.

3.1.2 Industry Activities

INPO's Job/Task Analysis program for operating and support personnel provides a data source for developing criteria for NPP personnel qualifications. An industry standards committee [American National Standards Institute/American Nuclear Society (ANS 3.1) working group] also is developing recommendations on qualifications including experience and education for an American National Standard on selection, qualifications, and training of personnel for NPPs. NUMARC has developed shift-experience requirements for near-term operating licenses (NTOLs) in accordance with the requirements of Generic Letter 84-16.

Industry will develop programs to ensure the adequacy of personnel qualification programs through the accreditation of training programs. INPO's survey of industry staffing levels for operating and support personnel could provide a data source for developing criteria for NPP personnel staffing levels.

3.2 Training

The goal of this element is to provide the means to ensure that NPP personnel are able to meet job performance requirements and that a mechanism exists to assess and improve the quality and effectiveness of training programs.

The Nuclear Waste Policy Act of 1982 (PL 97-425), Section 306, directed the NRC to promulgate regulations or guidance for the training of NPP personnel. Initially, a rule (10 CFR 50.200-50.250) and regulatory guide were proposed

(SECY-84-76, 76A, 76B) to respond to that mandate. However, in recognition of the industry's initiatives in the area of training and in an effort to encourage further self-improvement, the Commission decided to refrain from new rulemaking in the training area for a period of at least 2 years. Instead, the Commission directed the staff to develop a policy statement which endorses the INPO-managed Accreditation Program as the means of assuring that industry programs encompass the five essential elements of training presented in the policy statement. It is the continuing responsibility of the NRC to evaluate applicants' and licensees' implementation of improvement programs to ensure that results are achieved and to evaluate the possible need for further NRC action based on the effectiveness of industry programs after the 2-year period.

Accomplishing this goal should ensure that NPP personnel are better trained.

3.2.1 Major Tasks of Program Element

In response to PL 97-425 Section 306, NRC has developed policy guidance, a Memorandum of Understanding with INPO regarding training and qualifications, and criteria and guidelines for use in conducting reviews for monitoring the effectiveness of industry developed performance-based training programs. NUREG/CR-4258, "An Approach to Team Skills Training of Nuclear Power Plant Control Room Crews," will be published by the end of FY 1985.

The staff also is evaluating the qualifications and training needed for instructors as well as the guidance in this area provided by INPO to utilities.

To provide adequate criteria and procedures for evaluating the effectiveness of the industry's development and implementation of performance-based training programs, the staff plans to develop procedures and methods to monitor the effectiveness of the industry performance-based training, including analysis of existing data bases. In connection with this effort, the Office of Inspection and Enforcement (IE) has implemented new performance-based training inspection procedures.

The staff will evaluate the effectiveness of the INPO-managed Accreditation Program to ensure that industry training programs produce the desired results.

The staff will revise Section 13.2 of the Standard Review Plan (SRP) to use in evaluating training programs of applicants for operating licenses.

3.2.2 Industry Activities

The INPO-managed Accreditation Program is a major undertaking to ensure the adequacy of utility training programs. This effort has resulted in the establishment of a training accreditation process designed to upgrade the quality of utility training programs. INPO also has developed technical reports to provide guidelines and criteria for training and qualifications of both licensed and nonlicensed NPP personnel. INPO's job-task analysis identified knowledges and skills to be used as the foundation for the development of curricula for training programs for licensed and selected nonlicensed personnel. INPO also has prepared a handbook for industry trainers to use in developing performance-based training programs.

3.3 Licensing Examinations

The primary goal of this element is to ensure that NRC-administered examinations consistently and validly measure the ability of reactor operator (RO) and senior reactor operator (SRO) candidates to safely perform their respective licensed duties and responsibilities.

The benefits that will result from the successful accomplishment of this goal include: The validation of test content will ensure that the knowledges and abilities measured in licensing examinations are job-related and important. The standardization of examination procedures will increase the reliability and consistency in examination practices among individual examiners and across regions. Delineation of the licensed operator knowledges and abilities based on job-task analyses will result in more effective use of utility training materials to prepare licensing examinations, as well as providing those responsible for the training of licensed candidates with a better understanding of the bases, objectives, and criteria used in the NRC examinations.

There are certain issues of concern associated with this effort. First, the implementation of changes resulting from these developmental efforts must avoid causing any unnecessary burden to either examiners, license candidates, or utility training programs. Second, because the knowledge and ability catalogs will delineate the generic test content domain, inconsistencies may arise between knowledges and abilities derived for licensing examination purposes and those derived from plant-specific job-task analyses.

3.3.1 Major Tasks of Program Element

Validated catalogs of RO/SRO knowledges and abilities are being developed for licensed operators at pressurized-water reactor (PWR) and boiling-water reactor (BWR) facilities, based on the INPO job-task analyses. Each draft catalog resulting from this process will be reviewed and tested by NRC licensing personnel. The need to further tailor the generic catalogs for the purpose of creating individual, plant-specific catalogs of knowledges and abilities for licensed operators also will be evaluated.

Work in the delineation of test content domains also will be focused on other job positions, including licensed operators at research and test reactors, instructors, and fuel handlers. In addition, an evaluation will be performed to identify any differences that should exist between the test content domains for initial and requalification examinations. If significant differences are identified, the existing RO/SRO catalogs will be reviewed to identify those knowledges and abilities most appropriate for measuring operator competence in this type of examination.

A system will be developed to ensure that all catalog knowledges and abilities stay current. The catalogs will be compared against other lists of generic knowledges, skills and abilities, when available, to ensure that catalogs contain complete and accurate information.

The procedural handbook for developing operator licensing examinations, using the knowledges and abilities catalogs, will be pilot-tested and revised. Further, a review of the existing catalog statements will be performed to

determine if the knowledges and abilities should be supplemented with additional information related to the level of knowledge, extent of knowledge, and the most appropriate mode of testing of each statement.

Special attention will be given to the operating test portion of the licensing examination. Procedures will be developed for use in constructing simulator scenarios, administering simulator examinations, scoring candidate performance, and reporting examination test scores. In addition, methods and criteria for evaluating the adequacy of NPP simulators for use in conducting operating examinations will be developed and validated. The qualifications required of personnel to be tasked with performing these evaluations will be identified.

More long-term efforts will focus on the identification and establishment of new systems of operator licensing, such as qualifying examinations administered at central locations, computer-assisted testing, and other new examination formats. The goals of long-term efforts include validity, resource efficiency, and the effective integration of test modes (i.e., oral, written, simulator) and test purposes.

The changes cited above will be implemented by conducting examiner training programs. Training program topics will involve the use of the handbook for developing operator licensing examinations, focusing on test outline development, test item construction, and candidate evaluation. Training will be conducted in the use of simulators for conducting operating examinations, focusing on simulator characteristics, observation skills, and systematic scoring and reporting procedures.

The development and implementation of computerized information systems will ensure consistency across the operator licensing function and will provide a system of easy and efficient access to procedural and archival examination material. Information bases slated for computerization include: a simulator scenario data bank, catalogs of operator knowledges and abilities, and a tracking system for simulation facility compliance and status of simulator upgrades. Computer programs to generate test and item statistics are currently under development. These statistics will be included in the existing Examination Question Bank to allow examiners to evaluate the effectiveness of written examination questions.

Existing regulations and regulatory guides (RGs) are being amended to reflect changes made in the examination process and to respond to PL 97-425. Revisions to 10 CFR 55 will ensure that these regulations reflect the systematic approach to the development of test material, as described above, including assurance that operating tests focus on the evaluation of candidates' ability to perform the actions necessary for the safe and competent operation of the facility. Revisions to RG 1.149, "Nuclear Power Plant Simulator for Use in Operator License Examinations," provide standards to judge the capabilities of simulation facilities for use in operator licensing. RG 1.8, "Qualification and Training of Personnel for Nuclear Power Plants," is being revised to endorse, with certain exceptions, ANSI/ANS Std. 3.1-1981, as well as to provide better consistency with recent utility efforts towards performance-based training. Revisions to RG 1.134, "Medical Evaluation of Nuclear Facility Personnel Requiring Operator Licenses," provide guidance in meeting the medical requirements proposed in 10 CFR 55 and endorse ANSI/ANS Std. 3.4-1983.

3.3.2 Industry Activities

INPO's control room operator job/task analysis is a major input in the development of content-valid examinations and will provide a basis for attempting to establish candidate evaluation criteria. Utility-derived test questions will be entered into the computerized Examination Question Bank and will serve as a source of examination material. Improved systems of updating examination reference material will be developed on the basis of facility changes. Subject matter experts from utility operating staffs will continue to be used in the development of knowledge and ability catalogs and other examination reference material. In addition, the "check operator" concept for requalification examinations is being considered by NUMARC.

3.4 Procedures

The goals of this element are (1) to ensure the adequacy and effectiveness of procedures to operate nuclear power plants, (2) to assess the effectiveness of automatic versus manual control of actions that are necessary for establishing safety-related functions during emergency conditions, and (3) to evaluate the application of advanced technology (i.e., artificial intelligence) in the enhancement of NPP personnel performance.

The benefits from these goals will be (1) to reduce risk to the public health and safety through use of procedures that allow operators to effectively maintain critical safety functions under all plant conditions (including upset and degraded core conditions), (2) to create a framework for evaluating the appropriateness of "reliance on the operator for safety-related actions" as a proposed resolution to unresolved safety and licensing issues, and (3) to maximize the safe operation of NPPs through the appropriate use of advanced technology.

3.4.1 Major Tasks of Program Element

NRR and the IE are developing a revised inspection module for NRC regional offices to use in auditing emergency operating procedures (EOPs). This revised module is being developed to ensure that procedure inspections are consistent with the ongoing EOP upgrade program. Similar revisions to inspection modules may be developed for other procedures when guidelines for their upgrading are prepared.

Under the severe stress of an accident, there is an increased likelihood that operators will make mistakes. Thus, appropriate guidance is needed to ensure that EOPs are written to minimize degradation of operator performance under conditions of severe stress. Methods to measure operator performance under stress conditions, while using EOPs, will be developed. EOPs will be evaluated under various conditions of stress to identify presentation methods that minimize the degrading effects of stress on operator performance.

As indicated in Supplement 1 to NUREG-0737, "Requirements for Emergency Response Capability," upgraded EOPs will reduce risk during emergencies because "human-factored, function-oriented emergency operating procedures will improve human reliability" To test this assumption, studies are being conducted using survey and experimental techniques to evaluate the inplant effectiveness and impact of upgraded EOPs. A cost/benefit analysis

will be performed as a part of this study to compare earlier event-based procedures with upgraded, function-based procedures. This analysis will aid in quantifying the results of the study in terms of (1) the effectiveness of event-based procedures versus the upgraded, function-based EOPs, (2) plant and environmental safety, and (3) cost to the industry and government. The methodology used to conduct this study may be applied to other investigations that evaluate the impact of other upgraded procedures on personnel performance and safety.

The issue of credit for operator actions during emergency conditions has existed for some time. The staff is evaluating trade offs between automation and manual operator actions to perform safety-related functions during accident conditions. This effort includes Generic Issue B-17, "Criteria for Safety-Related Operator Actions." This evaluation is expected to result in a staff position on credit for operator action as well as guidance to the industry on when it is appropriate to automate necessary safety functions. Revisions to the SRP also may result from this work.

On the basis of current efforts to evaluate the quality of and the problems associated with existing plant procedures, NRR anticipates developing guidance similar to NUREG-0899, "Guidelines for the Preparation of Emergency Operating Procedures," for industry to use to upgrade normal operating procedures (OPs) and abnormal operating procedures (AOPs). Future work in this area includes developing guidance and regulatory action for other plant procedures.

Preliminary investigation suggests that operators often experience difficulty when they are required to go from one procedure to another procedure. Studies based on operating experience and expert judgment are being used to develop guidance for recommending the appropriate interfaces that should occur within and between procedures. In addition, these efforts will determine the appropriate scope of different classes of procedures (e.g., normal, abnormal, emergency).

The advantages and disadvantages of various procedure presentation techniques and formats that are being used throughout the nuclear power industry are being investigated. This work will indicate any necessary regulatory action as well as provide recommendations for applying presentation techniques and formats to various procedures and conditions under which they will be used. These results also will be helpful to industry and to NRC inspectors in their inspections of plant procedures.

During the staff's development efforts for upgrading EOPs and evaluating OPs and AOPs, significant variations in the level of detail contained in the procedures were identified. Procedures with too little detail may have the potential for improper actions because of omission while too much detail may lead to confusion and subsequent improper action. The effectiveness of various levels of procedural detail on personnel performance will be evaluated and, if appropriate, regulatory guidance will be developed.

The application of artificial intelligence (AI) to nuclear reactor operations, specifically in the area of personnel performance enhancement, is being monitored for possible future application. The objective of this

effort is to maintain the ability to review AI techniques that may in the future be proposed to support nuclear power plant operations. Regulatory issues associated with AI include identifying nuclear AI applications that should be regulated, determining how to evaluate the safety impact of the technology, and establishing the review criteria for acceptable applications. Applications being considered by the industry include AI products (known as "expert systems") that act as "consultants" to control room operators, automated (computerized) procedures for specific plant conditions, and machine handling of alarms based on operator-provided guidance.

3.4.2 Industry Activities

The industry has several ongoing and planned research activities related to procedures enhancement. EPRI's program, Advanced Operator Aids/Expert System (AOA/ES), combines the Safety Parameter Display System (SPDS) with computer-based monitoring, enabling the operator to determine which emergency procedures to use in mitigating the consequences of an accident. The Halden project (a joint NRC/industry effort with other countries) plans to conduct a study on the computerization of procedures, and INPO has an ongoing program for developing procedure-writing guidance.

3.5 Man-Machine Interface

The goal of the activities in the area of man-machine interface (MMI) is to ensure the adequacy of the MMI in all aspects of nuclear power plant (NPP) operations to enhance the safe performance of the man-machine system.

The successful accomplishment of these activities will significantly reduce human errors and enhance job performance by plant personnel through improvements in control station and plant design and will improve the capability of the staff through better processes for evaluating reactor operating events involving human error.

There is concern about (1) the nature of regulatory guidance appropriate for addressing the use of advanced technologies in upgraded systems and (2) the necessity or desirability of imposing new human factors requirements on existing plant designs.

3.5.1 Major Tasks of Program Element

To date, regulatory attention has been primarily limited to those MMIs that exist in the control room and at the remote shutdown panel. Further evaluation is needed regarding interfaces at local control stations other than the remote shutdown panel. Operators use local control stations when control is not or cannot be effected from the control room. These local control stations are used routinely and on an emergency basis. The potential for human errors of both commission and omission in the manipulation of controls at local control stations can be reduced through the application of human factors review techniques similar to those applied in control room design reviews. The staff will evaluate the extent and safety significance of MMI problems at local control stations and propose alternative solutions for these problems. The staff will perform a regulatory analysis of alternatives and develop a regulatory position, if warranted.

NUREG-0700, "Guidelines for Control Room Design Reviews," provides a "standard of quality" for annunciator systems that, if incorporated, should minimize the potential for human error associated with these systems. Guidelines for annunciator system evaluation and near-term improvements have been developed by EPRI and the NRC. One of the major findings of these efforts was that during plant upsets the operators become "overloaded" with too many annunciators, reducing the system effectiveness and sometimes creating a negative factor. Advanced computer-based technologies are now available to provide the necessary logic to improve NPP annunciator systems. Recommendations for advanced annunciator systems have been developed based on an evaluation of results of studies by EPRI, NRC, and the Halden project, and other advanced alarm system development activities at Seabrook NPP and the Department of Energy (DOE) Savannah River reactor. Some utilities have initiated advanced alarm system studies. Utilities also have expressed interest in upgrading their annunciator systems because the existing systems are performing poorly and procurement of spare parts is becoming difficult. The overall effectiveness of operational aid systems in improving operator performance and the relative effectiveness of each alarm reduction technique should be evaluated and, if appropriate, demonstrated through simulator or field testing. Based on the results of this evaluation, a regulatory analysis will be performed for alternative solutions and a regulatory position developed. Applicable regulatory guidance and review and evaluation criteria will then be developed. The regulatory position is expected to address those advanced annunciator system design issues relevant both to upgrades of existing systems and to next-generation control rooms.

It is anticipated that new control room designs will make extensive use of computers and computer-driven displays. The DHFS staff will monitor advanced control room design activities in the development of new plants and will monitor the incorporation of advanced control room concepts in modifications to existing operational plants. The staff will identify what additional workload the automation places on control room operators and identify performance requirements for functions allocated to computer-driven devices. The DHFS staff will review function/task allocation between humans and computers during abnormal and emergency condition of plant operations.

The staff will evaluate industry guidelines on human-computer driven display interface hardware, which minimizes human error in the location, retrieval, access, and use of computer stored data, and identify the human factors features and faults of interactive computer graphic display devices. The staff also will evaluate the methods proposed by industry to validate and display plant data, considering both computer-processed data and analog hard-wired instruments.

3.5.2 Industry Activities

EPRI has several efforts underway directly relevant to the MMI program element. These efforts include the development of (1) a human factors primer tailored to the needs of the nuclear industry, (2) a procedure for reviewing and improving power plant communications, (3) guidelines for reviewing and improving power plant alarms, and (4) a computer-generated display system guide. The nuclear steam supply system (NSSS) vendors and the Halden project are engaged in the development and evaluation of advanced control room designs and alarm handling methods.

3.6 Management and Organization

The goal of this program element is (1) to evaluate industry (NUMARC/INPO) efforts to improve management and organization (M&O) at operating NPPs and (2) to develop improved evaluation techniques and materials for assessing M&O at NPPs.

3.6.1 Major Tasks of Program Element

For a period of 2 years, NRR staff will evaluate the effectiveness of the industry initiatives and assess the need for further regulatory activity in M&O. The staff's evaluation will include an independent evaluation of industry M&O at operating reactors through participation on performance appraisal team (PAT) reviews, evaluation of inspection reports, near-term operating license (NTOL) performance, and audits of M&O in selected functional areas such as training and maintenance. These functional area audits will be coordinated with staff evaluation of training accreditation and the staff's Maintenance and Surveillance Program.

The monitoring of industry efforts will include observing some of INPO's corporate plant visits. The staff's independent evaluations will be a coordinated effort among NRR, IE, and the regions.

Activities will be initiated to propose improvements to the NRR review guidelines covering management and organization at operating reactors.

The evaluation criteria applied by NRR and regional reviewers during the SALP review will be improved. The criteria used for evaluation of management involvement in the licensing activities functional area will be modified to be more specific, relevant, and objective. This change will aid NRR and regional reviewers in reaching decisions concerning assignment of SALP ratings to management involvement in the licensing activities.

SRP Section 13.1 will be revised to incorporate the management and organization guidelines and their accompanying workbook. These documents were developed to satisfy TMI Action Item 1.B.1.1 and to replace Draft NUREG-0731.

3.7 Human Performance

The goal of this element is to ensure that the role of human behavior in operational events at nuclear power plants is appropriately considered.

The accomplishment of this goal will ensure that the NRC and industry are fully informed of the effects of human performance on NPP operations and thus can continue to improve human performance.

The regulatory or technical issue of concern is the effectiveness of industry programs to report and disseminate information of events involving human performance.

3.7.1 Major Tasks of Program Element

Data and information on significant operating events will be evaluated to identify those situations where human performance was judged to be related to

the initiation, evaluation, or outcome of the event. In other words, the staff will evaluate events in sufficient detail to identify the contributions of human performance and the relationship between human performance and plant safety.

The staff will assess industry's procedures for evaluation of human performance, including INPO's SEE-IN Program and Human Performance Evaluation Program, to determine the effectiveness of those programs in disseminating human performance information to the nuclear industry.

The staff will coordinate its efforts with the Office of Analysis and Evaluation of Operational Data (AEOD) on human performance aspects of the licensee event report (LER) system to determine the accuracy and effectiveness of reporting categories.

The staff disseminates information to other program elements of the Human Factors Program Plan to provide information for improvements in human performance.

APPENDIX A
PROGRAM ELEMENT SCHEDULES
(To be included later)