NUREG/CR-1750

Analysis, Conclusions, and Recommendations Concerning Operator Licensing

Manuscript Completed: November 1980
Date Published: January 1981

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NRC FIN B6871

ABSTRACT

This report provides an independent perspective to the U. S. Nuclear Regulatory Commission regarding the requirements and practices for control room operator licensing. Analysis, conclusions and recommendations are provided in the following areas:

- Selection, training and certification of control room operators,
- Effectiveness of the NRC operator licensing program,
- Methods to assure continued competence of operators,
- Methods for maintaining a highly motivated and dedicated operator work force,
- Upgrading of presently licensed operators to meet proposed requirements,
- Training and qualification of non-licensed operating, maintenance and technical support personnel,
- Qualifications of Operator Licensing Branch (OLB) examiners and
- Organization of the OLB.

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IMAGE EVALUATION
TEST TARGET (MT-3)

REQUIREMENTS FOR OPERATOR LICENSING

EXECUTIVE SUMMARY

Background

A vital component of the operational safety of nuclear power plants is the employment of qualified personnel. In May 1980, as a part of a major program to reassess its requirements regarding nuclear power plant personnel, the U.S. Nuclear Regulatory Commission (NRC) contracted Analysis & Technology, Inc., to conduct an independent study of requirements and practices regarding the selection, screening, training, licensing, requalification and performance of nuclear power plant licensed operators and the training and qualification of non-licensed operations and maintenance personnel.

The objectives of this study were to evaluate the adequacy of current requirements and practices and provide recommendations in the following areas:

- o Selection and training of nuclear power plant personnel, with focus on licensed operators,
- o Regulations, procedures and practices used to evaluate qualifications of personnel by utility management and the NRC,
- o Regulations, procedures and practices employed by the NRC and utility management to assure continued competency of licensed individuals,
- o Adequacy of current regulatory requirements and NRC implementing guidance regarding selection, training, licensing and requalification,

- o Motivation and job satisfaction of nuclear power plant operators and relative compensation and status of these individuals compared to those in other high-technology fields where similar responsibilities are exercised,
- o Upgrading of all present operators to meet proposed program improvements and
- o Selection, training and retraining of NRC examiners and staffing of the operator licensing organization.

To provide a basis of information which was both representative of industry-wide practices and sufficient for in-depth analysis, Analysis & Technology personnel conducted field survey trips consisting of document research and personal interviews at the following locations:

- o Nine nuclear power stations,
- o Six vendor- and utility-operated training centers,
- o Institute of Nuclear Power Operations (INPO),
- o NRC, Operator Licensing Branch (OLB),
- o NRC, Region I Office of Inspection and Enforcement,
- o NRC, Headquarters Offices of Nuclear Reactor Regulation (NRR) and Inspection and Enforcement (IE) and
- o Offices of two NRC Resident IE Inspectors.

Analysis

The approach used to evaluate industry and NRC requirements and practices discerned from information collected during field survey trips included:

- o Development and use of analytical tools,
- o Statistical analyses of historical data,
- o Administration and analysis of a licensed operator job satisfaction questionnaire and
- o Comparisons of NRC and industry practices with those of organizations with related functions and responsibilities.

Two key analytical tools were developed as bases for several of the evaluations conducted during this study. The first was a generic reactor operator (RO) and senior operator (SRO) job task analysis which defined the duties and responsibilities of these individuals. This analysis provided a basis for:

- Development of licensed operator training program criteria,
- Development of operator selection, screening and certification criteria and
- Evaluation of the NRC licensing examination process.

The second key analytical tool was the training program criteria, developed from the RO and SRO job task analysis, which defined the content areas and instructional settings (classroom, in-plant, generic or plant-specific simulator) appropriate for licensed operator training and requalification programs. Utility and training center programs were evaluated against these criteria. In addition, the training program criteria were used in:

- Developing selection, screening and certification criteria,
- Evaluating NRC implementation and enforcement practices and
- Evaluating qualifications for license training instructors.

To factor historical data into the development of selection and advancement criteria, an analysis of predictive indices of operator performance based on available training, performance and background information was conducted. This analysis also aided in determining the validity of the NRC written licensing examination as a predictor of operator performance.

To assist in assessing licensed operators' motivation and their perception of status, a job-satisfaction questionnaire administered to reactor operators and senior operators at visited reactor sites was analyzed.

To compare the NRC and the nuclear power industry with other organizations with similar functions, the related practices of foreign civilian and U.S. Navy nuclear programs and the Federal Aviation Administration (FAA) were investigated.

Findings

In the review of utility and training center programs and the interviewing of numerous operations and training staff personnel, a broad spectrum of practices was identified. Some organizations have created impressive, comprehensive programs in many of the areas investigated that exceed existing requirements and reflect an obvious corporate management commitment. At the other end of the spectrum exist organizations that are apparently interested only in satisfying minimum requirements. The OLB has provided a needed element of objectivity to the process of evaluating the qualifications of operating personnel; however, there exist areas in which improvements in industry and NRC practices could provide increased assurance of the operational safety of nuclear power plants. It is with consideration of all of these utility, training center and NRC practices that the following conclusions and recommendations relating to the major subject areas of this study are presented.

License Training

License training programs used by facilities to train RO and SRO candidates are undergoing a period of revision and change. Many programs are being lengthened and made more comprehensive in nature. As a result of a general industry shortage of personnel with operations experience, most utility training departments are understaffed in light of their training obligations.

Historically, license training programs have not been designed using systematic approaches to define the required functions, responsibilities and performance standards of licensed operators. Instead, many of these programs have been designed around the NRC license examination categories. As a result, these training programs are somewhat limited in their ability to provide complete training of required RO and SRO skills and knowledges. Facilities should be required to conduct a formal assessment of these programs to ensure that they provide training in the terminal and enabling skills and knowledges required for adequate RO and SRO job performance. These assessments should be based on plant-specific job task analyses.

Current on-the-job training practices generally lack the formality and completeness to assure adequate training in RO and SRO job performance areas that do not lend themselves to instruction on control room simulators. Facilities should be required to formalize this phase of training in a manner that will ensure that the terminal skills and knowledges that license candidates must learn in plant are individually accounted for and evaluated.

Inadequate emphasis is provided in most cases to training programs that prepare RO licensed individuals for SRO licensed functions. Facilities should upgrade these programs to provide more emphasis on SRO functional requirements and development of leadership, management and supervisory skills.

For some required skills and knowledges, a plant-specific simulator is a necessity for achieving complete training. Some other skills and knowledges, which could be completely taught on plant-specific simulators, also have alternative instructional settings suitable for complete training (for example, generic simulators in combination in some cases with in-plant drills). The NRC should establish requirements for the use of simulators in training. A long-range goal should be adopted to require that all facilities conduct training on a simulator specific to the plant. For existing plants, there may be some special cases in which a waiver of a plant-specific simulator requirement might be appropriate. Such waivers must be based on adequate assurances that all required RO and SRO skills and knowledges can be taught completely by an alternative technique.

Simulator training programs are generally too short to permit training in all the required skills and knowledges which, by necessity, must be taught during simulator training. These programs rely on a specified number of hours on the simulator rather than training to a predetermined level of proficiency. The NRC should establish minimum time requirements for simulator programs based on the training objectives required to be accomplished during simulator training and the operational experience of candidates. Operator certification on simulators should be expanded to include performance of emergency and abnormal operations as well as normal operations (in addition to reactor startup).

A significant discrepancy exists in the level of proficiency of instructors with respect to instructional skills. Few instructors receive formal training in this area. Before being assigned any instructional duties, all training personnel should be required to attend a certified course or program specifically aimed at the application of instructional methods and techniques. Facilities should implement periodic workshops or retraining programs to assess and improve these skills.

The NRC's practice of not using a strong management approach in regulating the industry has fostered a broad spectrum of industry practices with varying degrees of comprehensiveness and effectiveness. The NRC should develop detailed license training program approval criteria based on training content requirements derived from a generic RO and SRO job task analysis. NRC audits should be upgraded to include all license training programs and the emphasis of these audits should be expanded to include the adequacy of facility internal requirements for training and the actual conduct of training.

No single organization within the NRC is responsible for the adequacy of license training. The current existence of highly subjective requirements with little detail, in combination with the split responsibility between the OLB and IE organizations, casts doubt as to the effectiveness of this arrangement. The OLB should be assigned these responsibilities since its personnel are the recognized authorities on operator training practices.

Selection, Screening and Certification

Present utility practices for selection ensure that current requirements are met or exceeded.

Current requirements are adequate for determining the medical qualifications of operators except that more comprehensive programs for identifying unsuitable personality dysfunction should be required for all nuclear power plants. These programs should include psychological interviews, psychological tests and background investigations.

Based on analyses conducted during this study, certain minimum operational experience requirements should be required before issuing RO and SRO licenses. An RO candidate should have performed the functions of auxiliary operator for a period of one year and an SRO candidate should have at least one year of experience as a licensed operator.

The practice followed at some facilities of using seniority as the sole criterion for selection for advancement has a negative influence on operator motivation and places an unnecessary burden on operator training, certification and licensing programs to screen marginal candidates. Facilities should use a combination of criteria that are directed toward selecting candidates who are most suitable for advancement.

A high school diploma (or equivalent) provides adequate background education for acquiring RO-level skills and knowledges. SROs, however, require some college-level instruction in related technical subjects due to their increased responsibilities and involvement in decision-making, problem-solving and analysis processes. A college degree in engineering or other related field is not a necessary requirement for the Shift Supervisor position.

Utilities use appropriate techniques for tracking student progress. However, not all utilities give appropriate emphasis to the importance of verifying that trainees have acquired all the skills and knowledges of one phase of training before advancing to the next. Facilities should be required to establish formal methods for certifying satisfactory knowledge and performance for each applicable phase of their training programs and make records of trainee performance available to OLB examiners. This practice would identify potential areas of weakness and permit OLB examiners to probe these areas to ensure adequate knowledge before licensing.

Utility corporate management personnel currently required to sign certifications of license candidates' competence should actively participate in the certification process. This certification should consider personal character issues beyond those of technical competence and training received. Interviews should be conducted to assess the candidates' appreciation of reactor safety responsibilities and their obligations to the utility and the general public.

Licensing

In order to conduct the best comprehensive evaluation of RO and SRO applicants with the limited personnel resources of the OLB, a combination written, oral and operating examination (using an appropriate control room simulator) is required. Applicants should be required to pass all three parts of the examination in order to be licensed.

RO and SRO written examinations do not probe the applicant's knowledge to a sufficient depth and do not include all the skills and knowledges determined to be suitable for written examinations. As a result, these written examinations do not have sufficient content validity (that is, a passing score on the written examination does not ensure that an applicant has sufficient knowledge to function as an RO or SRO). Based on an analysis conducted to determine if a statistically significant relationship existed between RO or SRO examination scores and operator performance, these examinations appear to have no criterion-referenced validity (no relationship to job performance). In addition, the current written examination format makes it difficult to ensure the reliability (that is, consistency) of the examination. RO and SRO written examinations should be revised to improve their content validity and reliability by organizing examinations around required RO and SRO skills and knowledges, developing more operation-oriented questions that evaluate knowledge to greater depth, implementing examiner training programs in test development and scoring and integrating objective (multiple-choice) questions into appropriate sections of the examinations.

A number of subject areas currently a part of licensing oral examinations cannot be properly examined through this method. Current OLB oral examination practices provide no means to ensure consistent scoring and result in tests which are not auditable. The scope of these oral tests should be limited to those subject areas suitable for examination by a walk-through of the applicant's facility. A number of improvements should be made to procedures for administration of these tests to provide for more reliable and auditable results.

Present operating tests (which require only a reactor startup demonstration) do not adequately ensure that an applicant is able to recognize or respond to emergency or abnormal conditions. Operating tests should be conducted on control room simulators. The scope of these tests should be expanded to include evaluation of applicant performance in a variety of emergency, abnormal and normal operations.

OLB licensing practices and requirements have placed too much emphasis on the written examination and not enough emphasis on operating tests. Since some utility training programs are more structured toward ensuring that applicants pass OLB licensing examinations than upon performance-related criteria, these programs do not provide comprehensive training in the same areas in which the examinations are deficient.

Assuring Continued Operator Competency

Although the components of current requalification programs (for example, preplanned lectures, on-the-job training, evaluations, etc.) are collectively suitable for accomplishing requalification goals, deficiencies in the employment of these techniques reduce the effectiveness of these programs. Utilities should be required to conduct a formal assessment (based on a plant-specific job task analysis) of their requalification training programs to ensure that adequate retraining is provided for all RO and SRO required skills and knowledges not reinforced during normal plant operations. As part of the requalification program approval process, the facility should be required to identify the methods that will be used to provide the required retraining for each skill and knowledge. Such analyses would identify specific needs for in-plant training (possibly including drills), simulator training, lectures and self-study.

A control room simulator is needed to provide complete retraining in a number of RO and SRO skills and knowledges that are not reinforced during normal plant operations. Most control room simulator retraining programs used by utilities are too short and are not provided often enough to ensure adequate retraining of the skills and knowledges required in these task areas. The NRC should require control room simulator training as part of each facility's requalification program. In addition, the NRC should establish minimum time requirements for these simulator programs and maximum allowable intervals between them.

Utilities use appropriate techniques (required reading and lectures) to make operations personnel aware of lessons learned from operating experience. They do not, however, routinely reinforce this information with practical training (simulator and in-plant). Some of the current methods used to provide this information to facilities (for example, LERs) lack sufficient detail to permit effective training on these problems. The NRC should require that, as a part of their requalification program, utilities commit to conducting training on lessons learned from operating experience. This training should include practical training, where appropriate, conducted on a simulator or in plant. The NRC should improve its present systems for providing this information with the objective of ensuring that sufficient detail is provided for effective training use.

Utilities and the NRC inappropriately rely on the results of the annual written examination as the basis for judging operator competence. Most of the utilities visited do not have an effective system for periodic comprehensive evaluation of operator competence and neither does the NRC. Use of an annual written examination of comparable scope and depth as the NRC licensing examination fosters development of requalification programs designed around passing these examinations, has a negative effect on operator motivation and is, by itself, an ineffective tool for evaluating many aspects of operator competence. Evaluation of licensed operator competence should consist of a comprehensive program, such as one suggested in this report, that uses the most effective combination of evaluative tools integrated into a requalification program that is more performance-related, less repetitious and more challenging to operators than current programs.

Operator Compensation, Status and Motivation

For the most part, operators are dedicated and motivated individuals who have positive feelings about their jobs. In contrast to these positive feelings, however, there exists a general dissatisfaction with salaries, advancement paths, overtime requirements and company communication and decision-making processes.

Utility management should actively pursue a policy of increased interpersonal relations and effective communications. Survey results indicate that a majority of operators perceive that communications within the company are inhibited and that management disregards their feelings and needs.

Clear avenues of advancement should be delineated and communicated to operations personnel. Utilities that have formulated advancement channels should clearly communicate them to operations personnel. Utilities that have not yet delineated advancement channels should do so.

Utilities should commit to creating a sizeable increase in their operator work force. The benefits derived from having more operators are numerous and include a profound improvement in operator satisfaction.

Operator salaries should be carefully reviewed in the context of the responsibilities and the requirements imposed upon them and in relation to other utility occupations.

Non-Licensed Personnel

Non-licensed personnel in several functional job descriptions perform tasks that have a potential effect on the safe operation of the plant and the health and safety of the public. A wider range of practices exists for training, qualification and certification of non-licensed personnel than for licensed operators. Comprehensive training, qualification or certification programs are not the norm in the industry. For the majority of non-licensed personnel, informal on-the-job training is the primary method for establishing qualification.

A comprehensive evaluation needs to be conducted for each of these functional positions to develop criteria for satisfactory qualification. The NRC should require that utilities formally certify the qualifications of these non-licensed personnel and work with the industry to develop industry-wide criteria for this certification.

Operator Licensing Organization

Assuming a stronger management role in regulating the industry will require that the OLB expand its staff. The OLB should adopt criteria for selection of examiners which permit selection of degreed individuals (engineering or related sciences) with reactor operations experience and non-degreed individuals with extensive operating experience as a licensed senior operator.

The OLB should establish formal training and retraining programs for examiners. These programs should include instruction and practice in job-related areas as well as technical training.

The OLB should establish a formal certification program for examiners that certifies their ability to administer operator examinations and audit training programs at specific classes of facilities. Certification requirements should be applied consistently to all examiners (permanent or part-time).

As an interim measure until the OLB can reach full complement to perform all licensing and requalification examination functions, the NRC should use SRO licensed senior instructors at vendor training centers to administer operating tests on control room simulators which might otherwise be excluded due to OLB staffing limitations.

Expansion of its role will include OLB assumption of additional examination and audit responsibilities and necessitate decentralization of the OLB for it to perform its functions more effectively. This decentralization should include assignment of groups of OLB examiners at IE regional offices.

Implementation

In parallel with this study, the OLB has independently reviewed its requirements and practices. This review has resulted in the implementation of some near-term improvements and the identification of areas for long-term improvements. These efforts point out the genuine interest in improving operational safety that exists within the OLB and at other levels of the NRC. Similar interest also exists within the industry with the individuals who are responsible for the selection, training and performance of operators. Although a number of specific improvements have been identified in this study, the awareness of responsible individuals at all levels in the industry and the NRC of the importance of the operator (and personnel in general) in the safe and competent operation of nuclear power plants provides an optimistic prospect for achieving these improvements. What remains to be accomplished is the implementation of an integrated plan of near-term and long-term goals and a commitment by the NRC and the industry to a coordinated effort to achieve these goals.

1. INTRODUCTION

This report describes an independent study conducted by Analysis & Technology, Inc., for the U.S. Nuclear Regulatory Commission (NRC) of requirements and practices regarding selection, screening, training, licensing, requalification and performance of nuclear power plant control room operators and the training and qualification of other non-licensed personnel.

The objectives of this study were to evaluate the adequancy of current requirements and practices and provide recommendations in the following areas:

- Selection, screening and training of licensed operators,
- Evaluation of operator qualifications (certification) by utility management,
- Licensing of operators by the NRC,
- Regulations, procedures and practices employed by the NRC and utility management to assure continued competency of licensed individuals,
- Adequacy of current regulatory requirements and NRC implementing guidance regarding selection, training, licensing and requalification of operators,
- Motivation and job satisfaction of nuclear power plant operators and relative compensation and status of these individuals compared to those in other high-technology fields where similar responsibilities are exercised,
- Upgrading of all present operators to meet proposed program improvements,
- Training and qualification of non-licensed operating, maintenance and technical support personnel and

- Selection, training and retraining of NRC examiners and staffing of the operator licensing organization.

Field survey trips to the following locations were conducted to collect information essential for addressing the first eight objectives above:

- Nine nuclear power stations,
- Six vendor - and utility-operated training centers,
- Institute of Nuclear Power Operations (INPO) and
- NRC, Operator Licensing Branch (OLB).

In addition, to collect information relating to the staffing and training requirements of the NRC operator licensing organization, field survey trips were conducted to the following locations:

- NRC Region I Office of Inspection and Enforcement,
- Headquarters Offices of Nuclear Reactor Regulation (NRR) and Inspection and Enforcement (IE) and
- Offices of two NRC resident IE inspectors.

Selection of the nuclear power plant sites and training facilities visited was based on a desire that they be representative of all existing facilities and provide an adequate sampling of different training programs. Power plant selection was based on a desire for:

- A significant sample of the total number of operating reactor plants (18 operating units are represented),
- A distribution of pressurized water reactor (PWR) and boiling water reactor (BWR) plants comparable to the nationwide distribution,

- A distribution of reactor-plant vendors [General Electric (GE), Westinghouse (W), Babcock & Wilcox (B&W) and Combustion Engineering (CE)] comparable to the nationwide distribution,

- A distribution of reactor-plant ages comparable to the nationwide distribution and

- A sampling of training program differences based on:

  - Utility size,
  - Degree of investment in operating nuclear power plants,
  - Participation and involvement by training service contractors and vendors and
  - Availability and proximity of simulators.

Training facilities were selected on the basis that they provide:

- A significant number of different simulator designs and capabilities,

- Training programs designed by utilities, reactor vendors and training service contractors and

- A sampling of plant-specific and generic simulators.

The principal objective of these field surveys was to collect sufficient information through extensive document research, questionnaires and structured interviews with operations, maintenance, technical support and training personnel to provide a clear and representative view of industry and NRC requirements and practices in the areas to be investigated.

Document research was conducted using detailed checklists. A listing of specific questions was prepared and used during each personal interview. Personnel interviewed during field survey trips to reactor sites and training centers included:

- Control Room Operators (RO licensed),
- Supervising Control Room Operators (SRO licensed),
- Shift Supervisors,
- Auxiliary Operators undergoing RO license training,
- Training Department Supervisors (reactor sites and training centers),
- Training Department Assistant Supervisors and Senior Instructors (reactor sites and training centers),
- Training Department Instructors (reactor sites and training centers),
- Superintendents of Operations and
- Superintendents and Supervisors of non-licensed maintenance and professional-technical support personnel.

In addition to factual information, the opinions and viewpoints of these personnel on the problems facing the nuclear power industry and their potential solutions were solicited. Appendix G provides a listing of document information collected and typical interview questions for field surveys to reactor sites. Appendix H provides this same information for field surveys to training centers.

The adequacy of present requirements and practices with respect to licensed operators was evaluated primarily through a job task analysis, which provided the basis for identification of necessary content areas and instructional settings of RO and SRO training programs and appropriate evaluation methodologies for NRC licensing examinations. Analysis results, conclusions and recommendations in areas pertaining to licensed operators are provided in each section of Chapter 2, "Licensed Operating Personnel."

In order to provide recommendations concerning which non-licensed operating, maintenance or technical support personnel, if any, should be licensed or certified, task inventories for these functional positions were developed. When evaluated against current training and qualification requirements and practices, these task inventories provided the basis for conclusions and recommendations. Non-licensed personnel training and qualification sues are the subject of Chapter 3.

Chapter 4 provides analysis results, conclusions and recommendations regarding OLB examiner selection, training and qualification practices and organization of the OLB.

The impact of the recommendations of this study on present federal regulations, regulatory guides and NRC implementing guidelines is the subject of Chapter 5.

Chapter 6 summarizes the conclusions and recommendations of this study.

2. LICENSED OPERATING PERSONNEL

2.1 INTRODUCTION

This chapter addresses the current requirements and practices regarding the selection, training, licensing, retraining and performance of reactor operators (ROs) and senior reactor operators (SROs). To avoid confusion, since functional titles of operator positions in utility organizations vary widely across the industry, the following conventions will be used when referring to specific operator positions:

> Auxiliary Operator (AO). Non-licensed operator responsible for operations of systems and components as directed by licensed operators.
>
> Control Room Operator (CRO). Person responsible for control room operations of systems and components. Holds an NRC Reactor Operator license as a minimum requirement.
>
> Supervising Control Room Operator (SCO). Person in charge of CROs on shift - first-line supervisor. Holds an NRC Senior Reactor Operator license as a minimum requirement.
>
> Shift Supervisor (SS). Person in charge of operations on shift at the station. Holds an NRC Senior Reactor Operator license as a minimum requirement.

Figure 2.1 presents a typical career pattern for an operator from initial selection as a utility employee through advancement to the position of Shift Supervisor. This chapter focuses on the portion of this career path starting with an auxiliary operator's selection for RO license training. In this selection milestone, the auxiliary operator is verified to satisfy all NRC and utility minimum qualifications for licensed operators and is selected for participation in the RO license training program.

During the training program, the RO candidate must satisfy certain screening criteria and be certified by the utility as ready for the NRC licensing examination. Upon

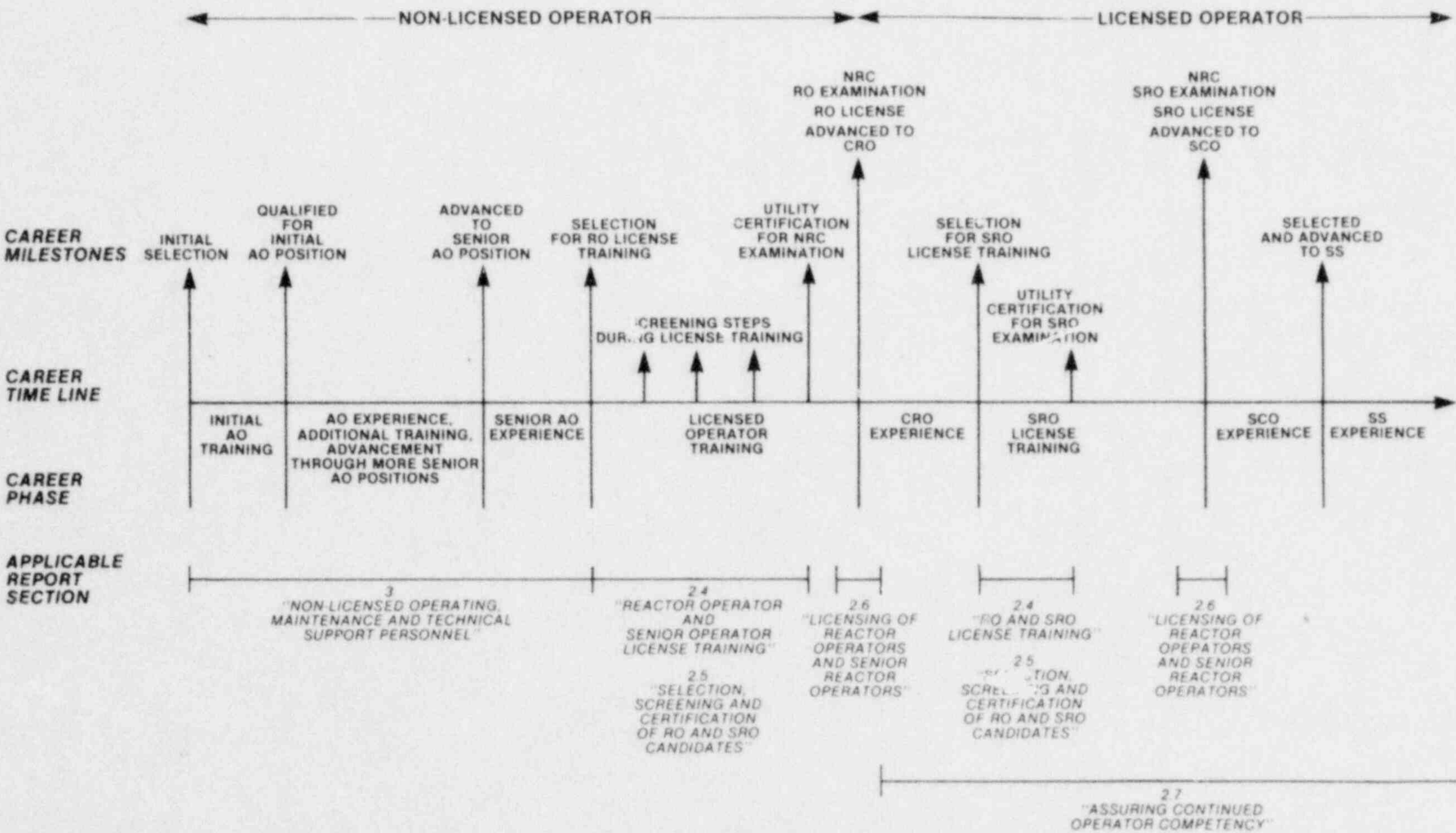


Figure 2.1 Typical Operator Career Pattern

satisfactory completion of examination and licensing as an RO, the operator is advanced, as openings occur, to CRO and begins participating in a licensed operator requalification program. After a satisfactory period of performance as CRO, the operator again goes through the selection, training, certification and licensing process for the Senior Reactor Operator license. Subsequent advancement to SCO is followed by a period of experience as a senior operator and continued participation in a requalification program. SCOs judged to be appropriately qualified and capable are selected and advanced to Shift Supervisor positions as openings become available.

As shown in Figure 2.1, each of these career phases is addressed in an appropriate section of this chapter. In each section, industry standards and NRC regulatory requirements are indicated and current utility practices and NRC practices are reported. To permit comparison, the related practices of foreign civilian and U.S. Navy nuclear programs are also discussed. The selection, training and requalification practices of Great Britain, West Germany and Canada were selected for discussion on the basis of the magnitude and sophistication of the nuclear reactor programs in these countries and the availability of suitable information. Licensed reactor operators are compared with U.S. Navy enlisted operators and senior reactor operators are compared with Navy Engineering Officers of the Watch. To permit comparison with another regulatory agency with analogous training responsibilities, the related practices of the Federal Aviation Administration (FAA) are also discussed. In each key subject area, an evaluation of current utility and NRC practices is presented and final conclusions and recommendations are offered.

Figure 2.2 presents a pictorial representation of the analysis network that was followed for this chapter. Two key analysis steps are evident upon review of this network: (1) performance of a job task analysis of RO and SRO licensed operators, and (2) development of predictive indices of licensed operator performance.

The RO and SRO job task analysis defines the responsibilities of these individuals and provides a basis for: the development of criteria against which operator training programs can be evaluated (Section 2.4), the development of operator selection, screening and certification criteria (Section 2.5), and an evaluation of the NRC licensing process (Section 2.6). The job task analysis technique is discussed in more detail in Section 2.2.

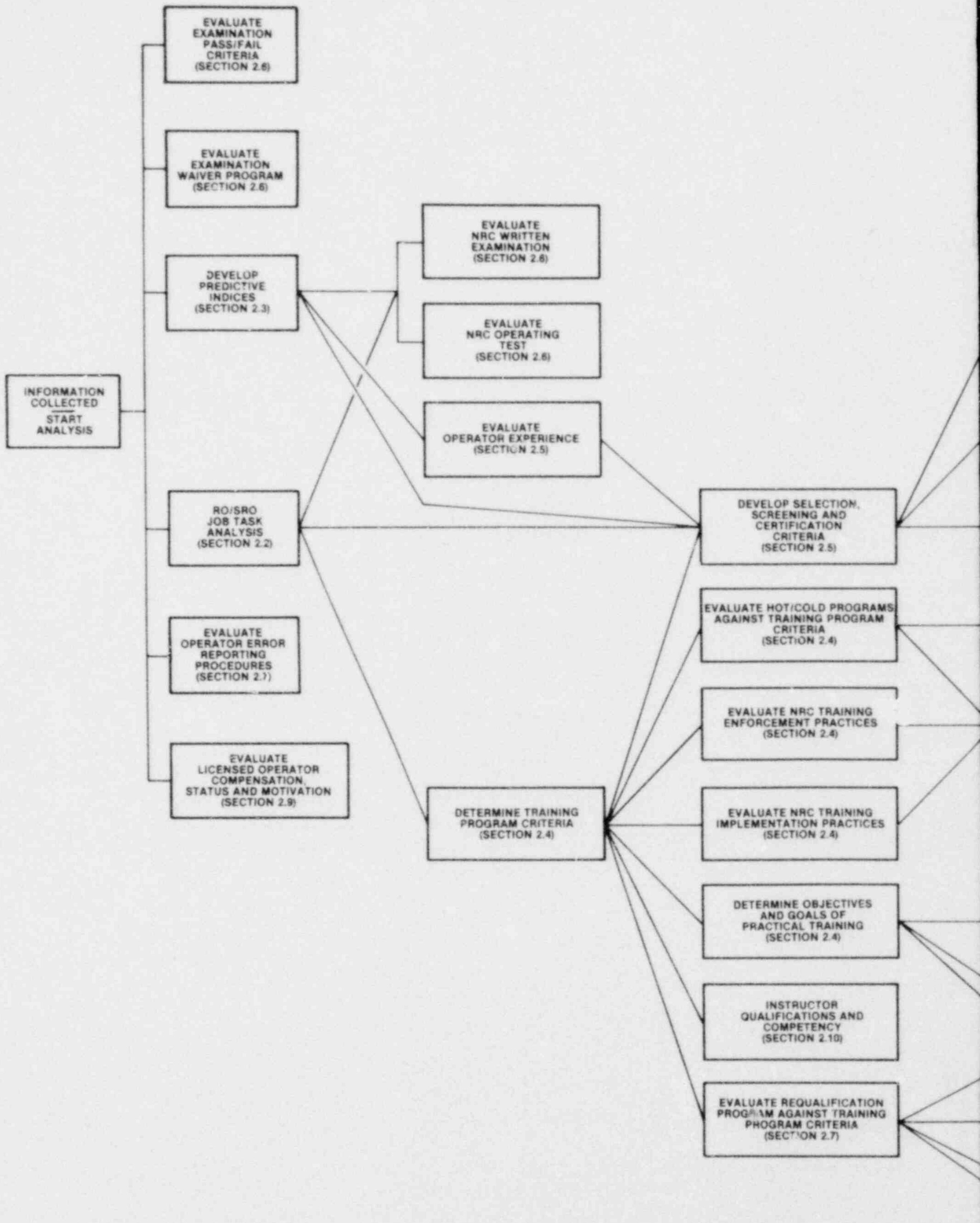
In an effort to factor historical data into the determination of selection and screening (including advancement) criteria, an analysis of predictive indices of operator performance based on available personnel training, performance and background information was conducted. This analysis was also used to determine of the validity of the NRC examination as a predictor of operator performance (Section 2.6). A more detailed discussion of the development of operator performance predictive indices is provided in Section 2.3.

As indicated above, Section 2.4 discusses the development of the training program criteria for RO and SRO training and evaluates current programs against these criteria. Selection, screening and certification practices are discussed in Section 2.5. The RO and SRO training program criteria were considered in evaluating these practices.

Section 2.6 reviews the current process for licensing of operators including evaluation of the NRC written examination and operating test, review of the examination waiver program and evaluation of examination pass/fail criteria.

Methods for maintaining operator competency, including utility requalification programs, operator error reporting procedures and NRC implementation and enforcement of requalification requirements, are evaluated in Section 2.7. Specific requalification objectives for present operators identified through the analyses presented in this chapter are addressed in Section 2.8. Section 2.9 provides the results of an analysis of the compensation of reactor operators as compared to the compensation of personnel in other high-technology fields and an evaluation of the results of a job-satisfaction and motivation questionnaire provided to licensed control room operating personnel during the field survey trips. Alternatives and recommendations for improving operator job satisfaction are also presented.

Since one of the controlling factors in the adequacy of any training program is the caliber of its instructors, this aspect of operator training and requalification is discussed in the final section of this chapter. The training program criteria developed in Section 2.4 were used to determine the necessary qualifications of instructors and to evaluate the methods available for determining instructor competency.


INFORMATION COLLECTED — START ANALYSIS
EVALUATE EXAMINATION PASS/FAIL CRITERIA (SECTION 2.6)
EVALUATE EXAMINATION WAIVER PROGRAM (SECTION 2.6)
DEVELOP PREDICTIVE INDICES (SECTION 2.3)
RO/SRO JOB TASK ANALYSIS (SECTION 2.2)
EVALUATE OPERATOR ERROR REPORTING PROCEDURES (SECTION 2.1)
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EVALUATE REQUALIFICATION PROGRAM AGAINST TRAINING PROGRAM CRITERIA (SECTION 2.7)

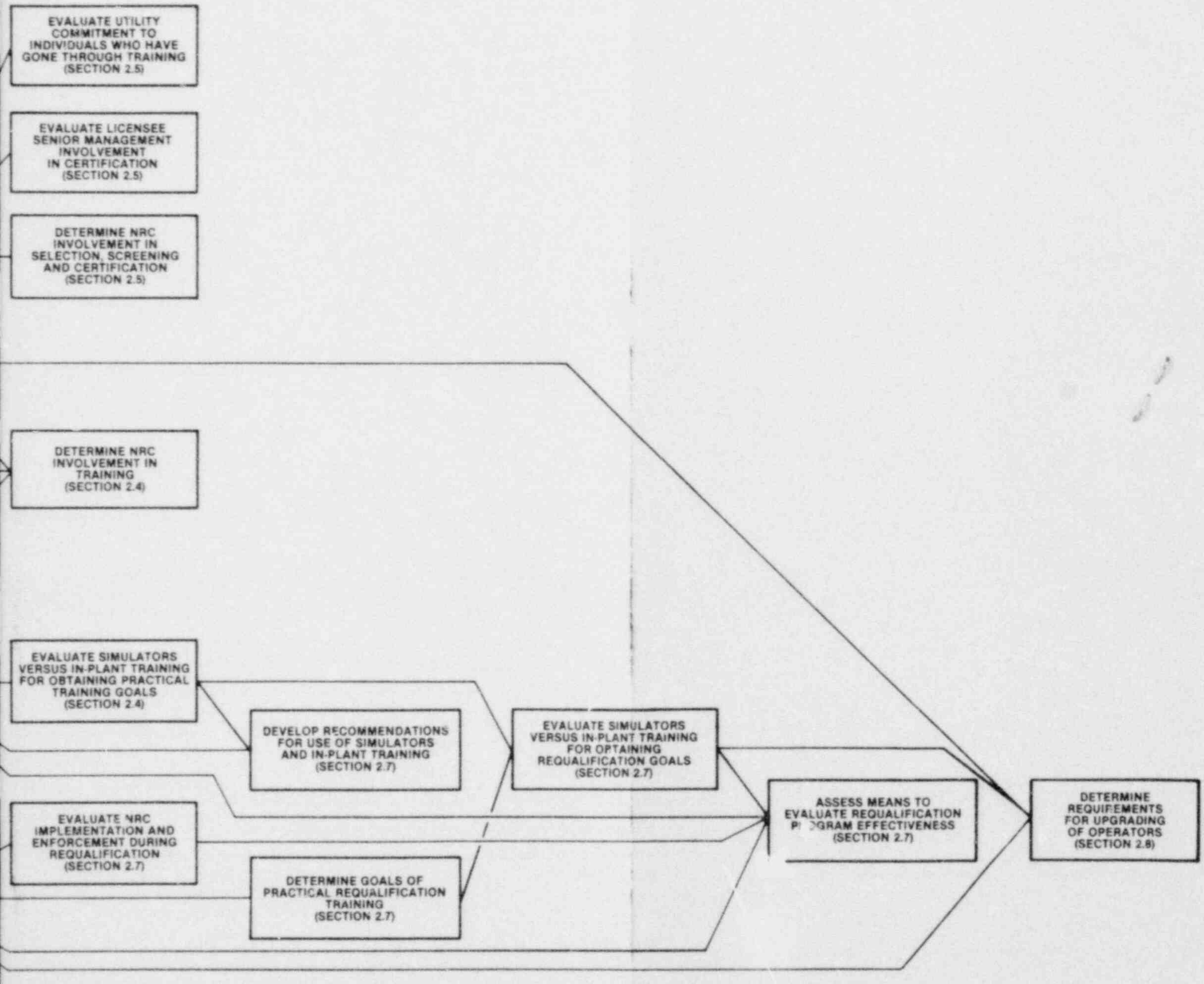

Figure 2.2 Chapter 2 Analysis Network

2.2 JOB TASK ANALYSIS

A fundamental requirement in evaluating RO and SRO training programs, personnel selection practices, licensing requirements and advancement prerequisites is the performance of an RO and SRO job task analysis that defines adequate on-the-job performance. Section 2.2.1 describes the methodology used in developing the RO and SRO job task analysis. Section 2.2.2 presents a representative result of the analysis, while complete job task analysis results are presented in Appendix A.

2.2.1 Description of Job Task Analysis Methodology

Job task analysis is a systematic method of collecting and analyzing work data to produce objective and complete work requirements. In general, it is performed by collecting work information, subdividing the information into work units, and identifying the conditions and standards associated with each work unit.

The methods and terms used in this analysis are those described and defined in "Interservice Procedures for Instructional Systems Development" (1). The first terms to be understood are job, duty, task and element. Figure 2.3 illustrates the relationship between these layers of a job breakdown. For the purposes of the job task analysis, the following terms are defined:

A job is a group of positions which are identical with respect to their major or significant tasks and sufficiently alike to justify their being covered by a single analysis (that is, RO positions and SRO positions).

A duty is one of the major subdivisions of work performed by one individual (for example, responding to emergencies would be a duty for ROs and SROs). Duty titles are often used in job analysis to categorize groups of tasks in organizing task lists.

Job analysis is actually conducted at the task level, with a task being the lowest level of behavior in a job that describes the performance of a meaningful function (for example, carry out emergency operating procedure for loss-of-coolant accident).

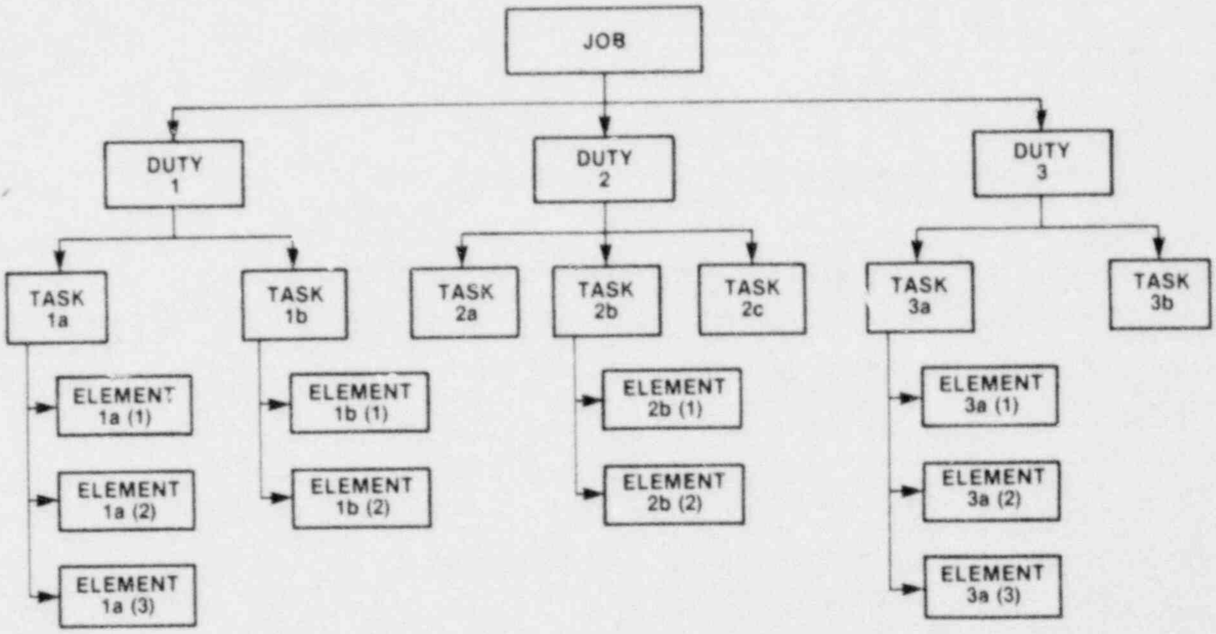

Figure 2.3 Interrelationships of Job, Duties, Tasks and Elements

An element is the smallest division of behavior that has practical meaning to instructional designers (for example, verify that all automatic actions have occurred).

Conditions refer to on-the-job conditions that significantly influence performance of a task (for example, carrying out immediate actions of emergency operating procedures without reference to procedures).

A cue is an occurrence or state of affairs that determines when the job incumbent performs a particular task (for example, a pressurizer low level alarm along with other indications would be the cues to implementation of the loss-of-primary- coolant emergency operating procedure).

Standards refer to the acceptable quality of performance of a task (for example, the operator should carry out all steps of a particular procedure in correct sequence within 10 minutes).

Because this job task analysis was intended to be equally applicable to all licensed ROs and SROs, it was important that the analysis be maintained at a generic plant level. Therefore, rather than being defined at the plant specific level, tasks and elements were generalized to be applicable to all plants; for example, an element of a particular task for a particular plant might be to "implement emergency procedure number xx after recognizing the symptoms of a loss-of-coolant accident" while the associated generic element would be "carry out appropriate actions after recognizing plant conditions requiring implementation of emergency operating procedures."

Figure 2.4 shows the steps used in developing the RO and SRO job task analysis. Step 1, development of a data-collection plan, was completed by first identifying job information that was expected to be available at each plant or training center and then conducting a literature review of published RO and SRO job analyses. This data-collection plan identified the following as appropriate sources of site information:

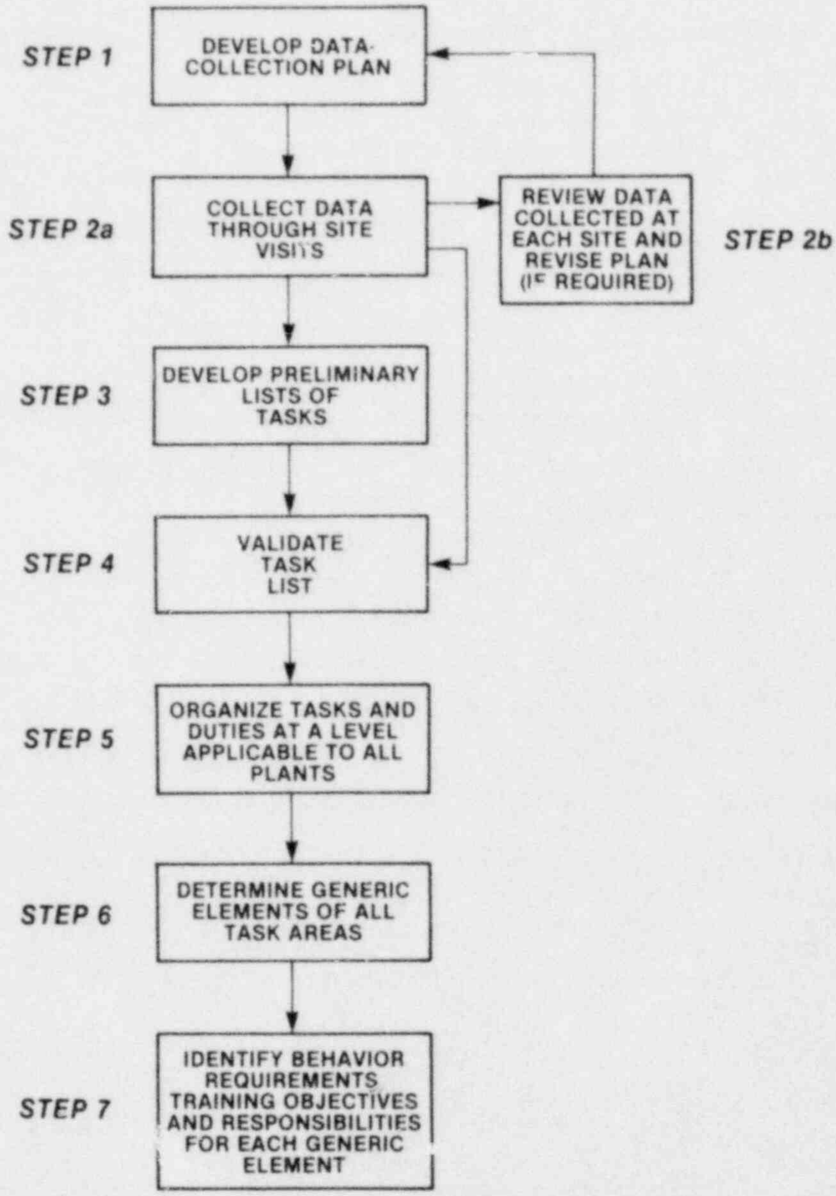

Figure 2.4 Task Analysis Flowpath

- o Individual interviews with RO and SRO licensed personnel,
- o Emergency, abnormal and normal operating procedures,
- o Emergency Plan,
- o Administrative procedures,
- o Surveillance and maintenance procedures,
- o Technical specifications,
- o RO and SRO job descriptions and
- o Observation of operators in control rooms and simulators.

In addition, literature review indicated that reports describing the Three Mile Island-Unit 2 accident (2, 3, 4, 5) and other RO and SRO job-related studies would be valuable information sources.

Step 2a, collecting data through site visits, was coordinated by checklists developed in Step 1. Upon completion of each site visit, this data-collection plan (checklists) was reviewed on the basis of information collected at previous sites, and changes were made as appropriate. Appendices G and H contain these checklists.

From the data collected at early site visits, preliminary lists of duties and tasks were developed (Step 3). Thus, at subsequent site visits, this list could be validated through interviews with licensed operators, comparison of job descriptions, procedures, etc. Upon completion of all site visits, further validation of the duties/tasks listing was conducted by a more in-depth comparison between individual plant data, as well as a review of applicable literature (Step 4).

Given a validated list of duties and tasks, Step 5 involved organizing these duties and tasks into related areas. Figure 2.5 shows this organization. Next followed Step 6, the development of a set of generic elements from the aggregate elements of each task area.

In Step 7, behavior requirements and training objectives were identified for each generic element.* For each behavior requirement, it was determined whether this requirement was necessary for both ROs and SROs or SROs only.

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*Behavior requirement classifications were developed by Berliner and others (6).

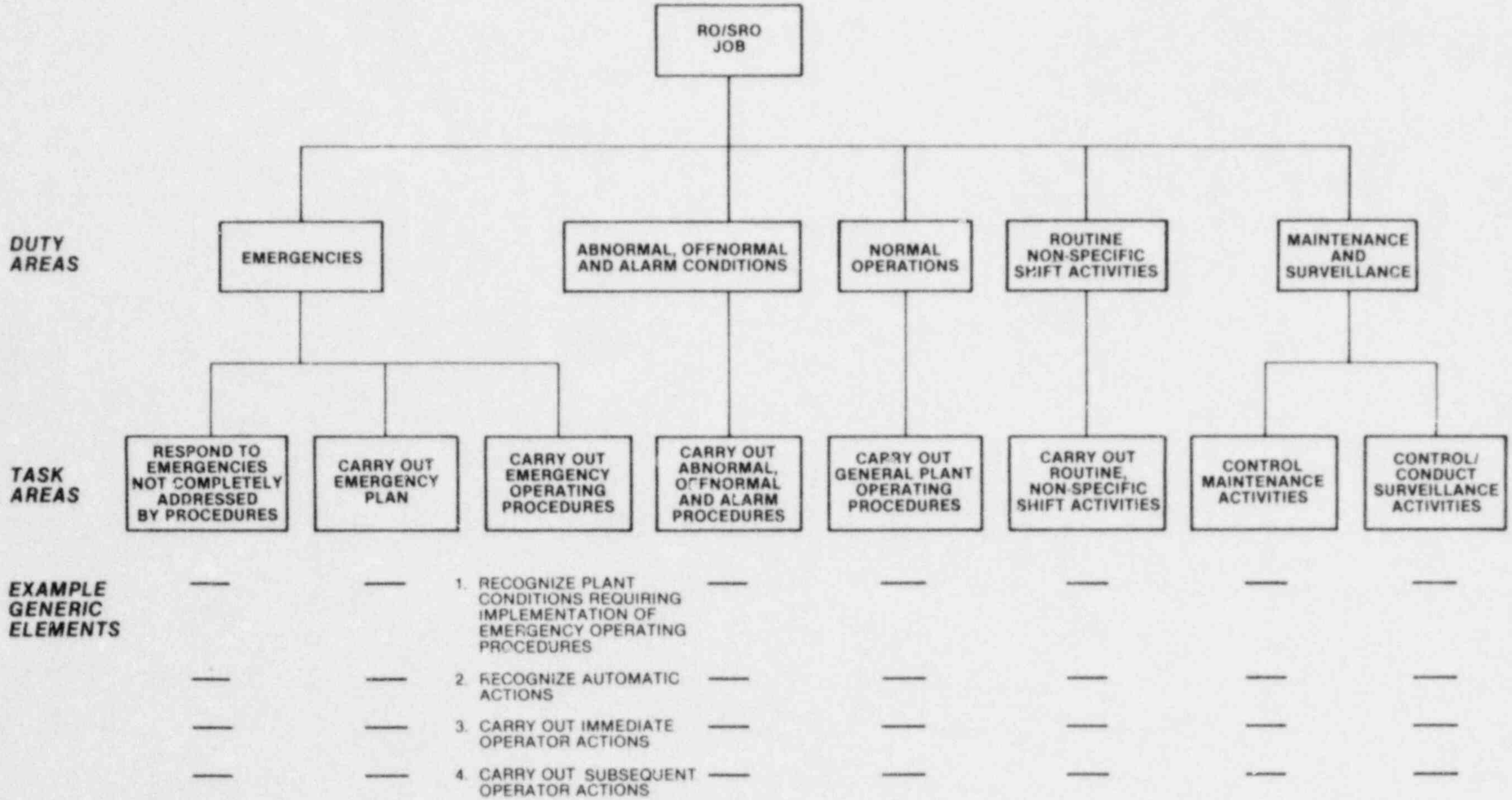

Figure 2.5 Identification of RO/SRO Duty and Task Areas

2.2.2 Job Task Analysis Results

Table 2.1 shows job task analysis results for one task area (emergency operating procedures). The job task analysis results for the remainder of the task areas are presented in Appendix A. As an aggregate, these tables provide complete RO and SRO job requirements. As indicated earlier, this job task analysis will be an essential reference in subsequent sections for evaluating RO and SRO training programs, personnel selection practices, licensing requirements and advancement prerequisities.

TABLE 2.1
EXAMPLE TASK ANALYSIS RESULTS
(TASK: CARRY OUT EMERGENCY OPERATING PROCEDURES)

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Recognize plant conditions requiring implementation of emergency operating procedures.	Perceptual Processes			Operator should recognize all conditions requiring implementation of emergency operating procedures without reference to plant procedures.
	- Identify cues requiring implementation of emergency operating procedures. [Note: any one of five (5) senses may identify symptoms.]	X		
	Cognitive Processes			
	- Determine applicable emergency operating procedure.	X		
2. Recognize automatic actions.	Perceptual Processes			Operator should recognize automatic actions associated with all plant emergencies without reference to procedures.
	- Locate and read indicators, and annunciators.	X		
	- Identify display meanings and relationships.	X		
	Cognitive Processes			
	- Compare and verify indications.	X		
3. Carry out immediate operator actions.	Perceptual Processes			Operator should carry out, for all plant emergency conditions, immediate operator actions without reference to applicable procedures.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	- Locate controls.	X		
	- Identify technical specifications limiting conditions for operations.	X		
	Cognitive Processes			
	- Compare and verify indications.	X		
	- Coordinate actions of all shift personnel.		X	
	- Analyze plant conditions.	X		
	- Maintain good judgment and problem-solving performance under stressful and/or physically hazardous environment.	X		

TABLE 2.1 (continued)
EXAMPLE TASK ANALYSIS RESULTS
(TASK: CARRY OUT EMERGENCY OPERATING PROCEDURES)

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
3. Carry out immediate operator actions (continued)	Cognitive Processes (continued)			
	- Establish priorities.		X	
	- Maintain overall perspective; do not become totally involved in a single operation.		X	
	Communication Processes			
	- Inform appropriate personnel.	X		
	- Direct actions.	X		
	- Receive verbal reports.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters (pressures, levels, etc.).	X		
	- Take manual (backup) control of normally automatic functions.	X		
	- Operate controls.	X		
4. Carry out subsequent operator actions.	Perceptual Processes			Operator should carry out, through reference to applicable procedures, subsequent operator actions of all emergency operating procedures.
	- Locate and read indicators and annunciators.	X		
	- Identify display meaning and relationships.	X		
	- Locate controls.	X		
	- Identify technical specifications limiting conditions for operation.		X	
	Cognitive Processes			
	- Maintain good judgment and problem-solving performance under stressful and/or physically hazardous environment.	X		

TABLE 2.1 (continued)
EXAMPLE TASK ANALYSIS RESULTS
(TASK: CARRY OUT EMERGENCY OPERATING PROCEDURES)

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
4. Carry out subsequent operator actions. (continued)	Cognitive Processes (continued)			
	- Compare and verify indications.	X		
	- Establish priorities.		X	
	- Coordinate actions		X	
	- Maintain overall perspective; do <u>not</u> become totally involved in a single operation.		X	
	- Analyze plant conditions.	X		
	- Determine additional equipment and/or support required.		X	
	- Determine steps or procedures required to recover from emergency.		X	
	Communication Processes			
	- Inform personnel.	X		
	- Direct actions.	X		
	- Receive verbal reports.	X		
	- Recall personnel.		X	
	- Recommend action to appropriate authorities.		X	
	- Receive advice from STA and other technical personnel.		X	
	- Maintain written logs/reports.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters (pressure, levels, etc.).	X		
	- Take manual (backup) control of normally automatic functions.	X		
	- Operate controls.	X		

2.3 PERFORMANCE PREDICTIVE INDICES

2.3.1 Purpose

The objective of selection and advancement practices is to ensure a safe and competent operating staff. One means of helping assure this objective is to use all available information sources, both qualitative and quantitative, to determine the criteria by which these selection and advancement practices should be conducted. Qualitatively, a job task analysis (Section 2.2) and the development of training program criteria (Section 2.4) provide the inputs in determining selection and advancement criteria (see Figure 1.2). Quantitatively, the identification of historical information that is signficantly related to operator performance may provide additional supporting information with which to determine, evaluate and recommend selection and advancement criteria. The analysis of this historical information was the primary objective of this study on performance predictive indices.

Along with this analysis of performance-related variables, an attempt was made to validate the NRC licensing examination by assessing the relationship between test scores and performance on the job. The existence of a positive relationship between test scores and operational performance is important to both the utility and the Nuclear Regulatory Commission, since this relationship would provide increased assurance that licensed operators can safely and competently operate their plant.

2.3.2 Method

To provide the empirical information to determine possible selection and advancement criteria, data were collected from the records of all reactor operators and senior reactor operators at seven sites* visited. A criterion-referenced approach (that is,

*Necessary information was not available at two of the nine sites.

identification of differences between known groups of performers) was used to compare individuals who vary in their levels of job proficiency. The criterion measure of performance was a categorization of all control room operating personnel into above-average, average and below-average performance categories. It was expected that various quantitative differences (for example, one group of individuals having more years of experience than another group) exist between individuals who vary in their performance. These differences would provide the quantitative input into selection and advancement criteria. In addition, the Nuclear Regulatory Commission's licensing examinations were correlated with the performance classification to assess the relationship between scores on the tests and levels of performance.

At each of the seven sites, the Operations Supervisor or Assistant Operations Supervisor rated his operating personnel in one of three categories with reference to their levels of job performance (above average, average, below average). While some subjectivity was unavoidable, direction was given to those performing the placement to help standardize the criteria by which personnel were classified. Although there was a potential for biased ratings (that is, difficulty in extricating prior knowledge about an individual that could affect his group placement), the data did not indicate this was the case.

Background information which was available and which may aid in determining selection and advancement criteria is listed in Table 2.2. Each of the variables was analyzed in reference to the performance categorization; for example, if the frequency of individuals with a college education was signficantly greater in the above-average category, then it would be desirable to consider selecting individuals with college backgrounds. In the same manner, the other variables were assessed with respect to their relationship to the performance categorization.

2.3.3 Data Collection

All personnel data came from reactor operator and senior reactor operator training and background records. Information was obtained for 196 individuals at 7 sites, distributed into the performance categories as shown in Table 2.3. Licensing examination results were provided by the NRC Operator Licensing Branch.

TABLE 2.2
SELECTION AND ADVANCEMENT VARIABLES

AGE

MILITARY EXPERIENCE

- NAVY NUCLEAR
  - RATE
- OTHER NUCLEAR
- OTHER MILITARY

COLLEGE

- YEARS

NON-LICENSED (AUXILIARY OPERATOR) NUCLEAR POWER PLANT EXPERIENCE

NON-NUCLEAR POWER PLANT EXPERIENCE

YEARS AS REACTOR OPERATOR AT PRESENT SITE

YEARS AS REACTOR OPERATOR AT OTHER SITES

YEARS AS SENIOR REACTOR OPERATOR AT PRESENT SITE

YEARS AS SENIOR REACTOR OPERATOR AT OTHER SITES

REQUALIFICATION EXAMINATION SCORES

TABLE 2.3
DISTRIBUTION OF ROs AND SROs BY PERFORMANCE CATEGORY

LICENSE HELD	BELOW AVERAGE	AVERAGE	ABOVE AVERAGE	TOTAL
RO	23	39	17	79
SRO	22	61	34	117

2.3.4 Statistical Analysis

Two major statistical techniques were used to evaluate this information; Chi-Square tests and F-tests.

For all categorical dichotomous variables, such as military/non-military, college/non-college, etc., contingency tables were constructed and Chi-Square tests used to assess whether there was a relationship between the performance categorization and the frequency of individuals having that experience. For example, Chi-Square tested whether being classified in the above-average performance group was related to prior experience (college, military, Navy nuclear).

For interval-level data, such as age, years of experience, test scores, etc., one-way Analysis of Variance design (with the performance categories constituting the factor) was used to assess whether differences existed between the mean values of the three performance categories. For each variable, the null hypothesis that there are no differences was tested against the alternate hypothesis that significant differences do exist among the three categories.

2.3.5 Results

2.3.5.1 Selection and Advancement Variables

Table 2.4 summarizes the analyses and findings conducted on the selection and advancement variables. Column 2 of the table indicates whether the variable has implications for selection, advancement or both. The statistic column (Column 3) lists the test conducted for that variable. Chi-square was used if the data were dichotomous and the F-test, associated with the Analysis of Variance design, was used if the data were continuous. In most cases, three tests were conducted for each variable (Column 4); one for the total sample (ROs and SROs combined), one for reactor operators only, and one for senior reactor operators only. In instances where the sample size was insufficient for the test, only the total sample was used. Column 5 indicates whether or not the test yielded significant results. A test was statistically significant if the differences among the three performance groups could have occurred by

TABLE 2.4
SUMMARY OF SEL CTION AND ADVANCEMENT ANALYSES

(1) VARIABLE	(2) PURPOSE	(3) STATISTIC	(4) SAMPLE	(5) SIGNIFICANT
COLLEGE EDUCATION	Selection	Chi-square	Total ROs SROs	No No No
MILITARY EXPERIENCE	Selection	Chi-square	Total ROs SROs	No No No
NAVY NUCLEAR EXPERIENCE	Selection	Chi-square	Total ROs SROs	No No No
NAVY NUCLEAR EXPERIENCE (without fossil power plant experience)	Selection	Chi-square	SROs	No
NAVY NUCLEAR RATE	Selection	Chi-square	Total	No
FOSSIL POWER PLANT EXPERIENCE	Selection	Chi-square	Total SROs	No Yes
YEARS FOSSIL POWER PLANT EXPERIENCE	Selection	F	Total SROs	No No
YEARS AS AO	Selection/Advancement	F	Total ROs SROs	No No Yes
YEARS AS RO	Advancement	F	Total ROs SROs	No Yes No
MEAN REQUALIFICATION SCORE	Advancement	F	Total ROs SROs	No No No
AGE	Selection/Advancement	F	Total	No

chance in less than 1 out of 20 occurrences. In other words, differences between groups would occur at least 95 percent of the time. Detailed statistical information is presented in Appendix B.

It was expected that some variables would relate to performance. Column 5 of Table 2.4 shows that three variables were statistically significant. One of the variables was significant for the sample of reactor operators (years as a reactor operator) and two for the sample of senior reactor operators (fossil power plant experience and years as an auxiliary operator).

Years of experience as a reactor operator were significantly related to performance for the sample of reactor operators. The longer an RO has been a reactor operator, the greater his proficiency. Since an SRO cannot be expected to be proficient in his job without first being proficient as an RO, years of experience as an RO have implications for advancement to the SRO position. Figure 2.6 shows the breakdown of years of experience as a reactor operator for the three performance groups. As can be seen, 60 percent of those with 1 year or less experience were rated as <u>below average</u>, while only 6 percent with 1 year or less experience were rated above average. Examination of the second column reveals that 30 percent of those with 2 or less years of experience were rated as below average and only 5 percent rated above average. Half of the reactor operators with 3 years of experience were above-average performers. Only when a reactor operator has more than 2 years of experience do his chances of becoming an above-average performer improve.

An inverse relationship exists between the SRO performance categorization and whether an SRO had previous fossil power plant experience. The frequencies for each category are shown in Table 2.5. As can be seen, a higher percentage of individuals <u>without</u> fossil power plant experience were placed in the above-average performance category. From this, it can be inferred that having fossil power plant experience does not necessarily contribute to being a more proficient reactor operator.

Above-average senior reactor operators had a mean higher number of years as an auxiliary operator than did the below-average SROs. Figure 2.7 shows the averages for the three performance groups along with the percentages of each group broken down by years of experience as an auxiliary operator. While there is little difference

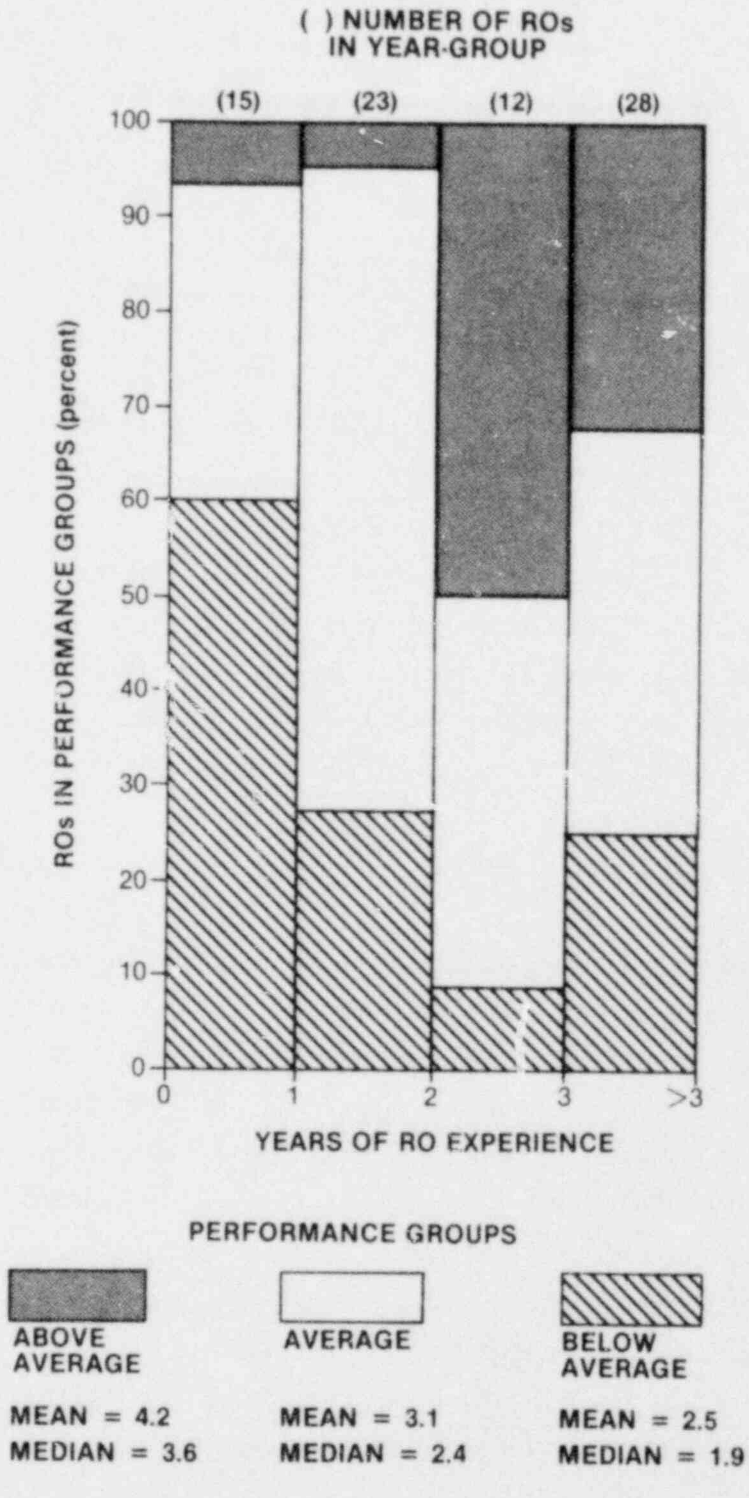

Figure 2.6 Performance Ratings for Years of Experience of ROs

TABLE 2.5
SRO PERFORMANCE CATEGORIZATION BY FOSSIL/NON-FOSSIL POWER PLANT EXPERIENCE

EXPERIENCE	PERFORMANCE RATING		
	BELOW AVERAGE	AVERAGE	ABOVE AVERAGE
FOSSIL POWER PLANT	10 (35%)	13 (45%)	6 (20%)
NON-FOSSIL POWER PLANT	12 (13%)	48 (55%)	28 (32%)

between average and above-average performance groups, a significant difference exists between below-average performers and the other two performance groups. Senior reactor operators with greater than 1 year of experience as auxiliary operators tended to be better performers.

2.3.5.2 NRC Licensing Examination

The F-test associated with the Analysis of Variance design and point-biserial correlations were used to analyze the data. The analyses conducted on mean scores for each examination section and total scores for both ROs and SROs failed to provide any evidence of a relationship between test scores and the performance criterion. Mean scores for each section by performance group are presented in Table 2.6. Point-biserial correlations were computed between the below- and above-average performance groups for those sections that had a difference in the expected direction (for example, the above-average performance group having a higher mean score than the below-average group). The largest correlation was 0.29 for Section E (Safety and Emergency Systems) of the RO examination; however, this correlation was not statistically significant at a 95-percent confidence level.

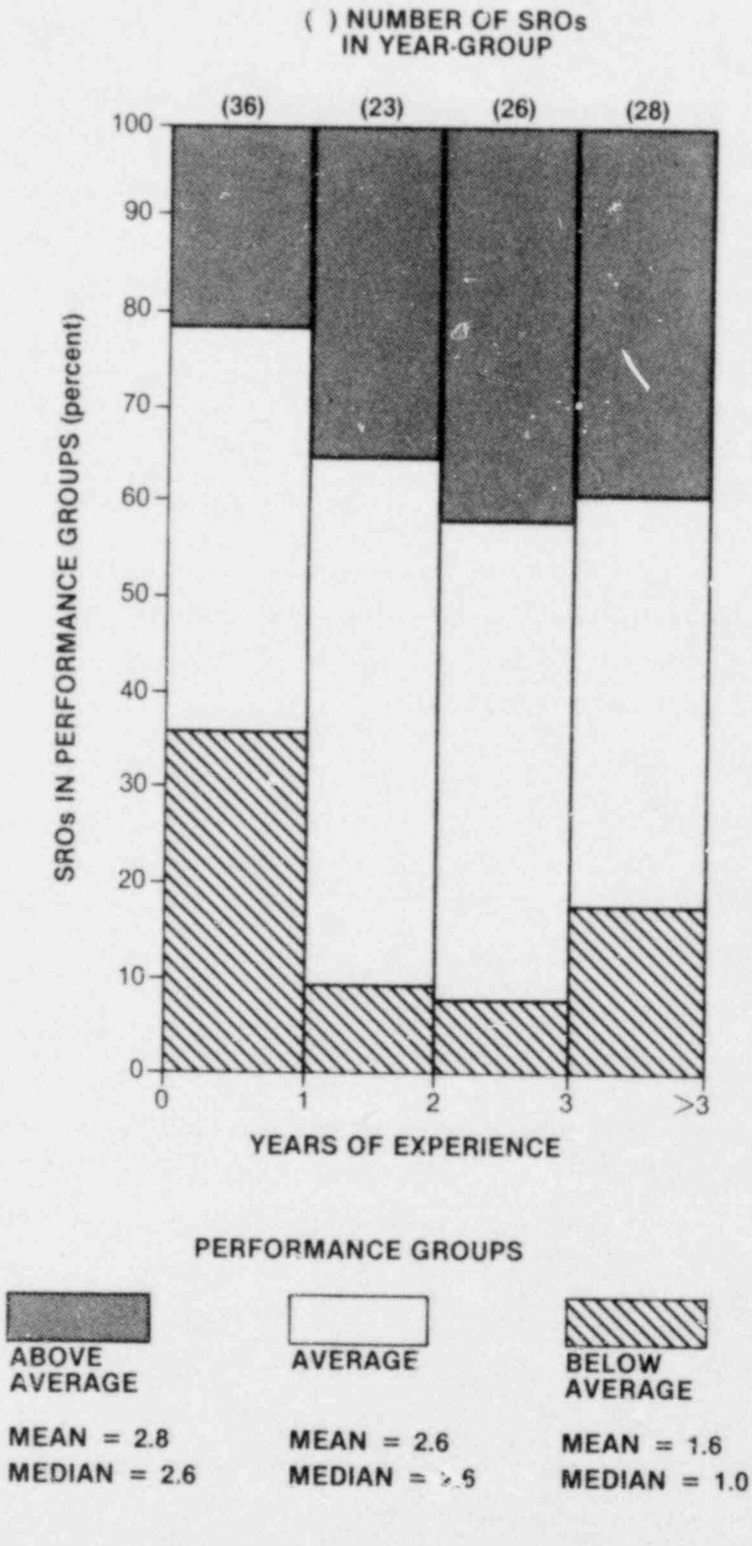

Figure 2.7 SRO Performance Ratings for Years of Experience as AO

TABLE 2.6
MEAN LICENSING EXAMINATION SCORES

RO PERFORMANCE GROUPS	EXAMINATION SECTIONS							
	A	B	C	D	E	F	G	TOTAL
BELOW AVERAGE	84.6	87.7	83	83	82.8	75.5	82.6	82.7
AVERAGE	82.2	85.4	82.8	84.8	82.6	79.3	79.7	82.9
ABOVE AVERAGE	87.1	87.5	86.2	85.2	88.7	78.5	83.3	85.2

SRO PERFORMANCE GROUPS	MEAN RO EXAM SCORES	EXAMINATION SECTIONS					
		H	I	J	K	L	TOTAL
BELOW AVERAGE	83.2	84.4	84.1	75.7	85.6	82.4	81.8
AVERAGE	83.0	82.2	85.2	80.0	83.3	82.9	82.9
ABOVE AVERAGE	85.1	81.3	83.5	80.3	82.3	81.4	81.2

2.3.6 Conclusions

Table 2.2 lists the variables that were analyzed relative to performance. Three variables were found to be empirically related to performance. For the sample of ROs, years as a reactor operator significantly differentiated between below-average and above-average performance groups. Of the ROs with 1 year or less of licensed experience, 60 percent were rated as below-average performers. For SROs, the average number of years as an auxiliary operator (AO) was greater for above-average performers than for the below-average group. Of the SROs with 1 year or less of AO experience, 37 percent were rated as below-average SRO performers. For SROs, having previous fossil power plant experience was inversely related to performance (individuals who had fossil power plant experience were not categorized as above-average performers as frequently as those who did not).

No statistically significant relationship between RO and SRO examination scores and operator performance was found.

2.4 REACTOR OPERATOR AND SENIOR OPERATOR LICENSE TRAINING

Initial training programs for RO and SRO license candidates are categorized as two types: "cold" and "hot." "Cold" programs provide training for personnel who will sit for NRC license examinations before initial fuel loading. Following initial criticality of the reactor, training of new RO and SRO candidates is conducted in "hot" programs. Hot license training programs are also called "replacement training." These two general types of programs are addressed separately in this section. Since hot training programs were in progress at all reactor sites visited and constitute the majority of information collected, these practices are discussed first.

2.4.1 RO and SRO Hot License Training

2.4.1.1 Training Requirements

Industry Standards. The "American National Standard for Selection and Training of Nuclear Power Plant Personnel," ANSI/ANS-3.1-1978 (7) (a revision of the initial American National Standard N18.1-1971) specifies that candidates for NRC hot examinations shall complete technical training in the following subject areas:

RO Level

- o Principles of reactor operation,
- o Design features of the nuclear power plant,
- o General operating characteristics of the plant,
- o Instrumentation and control systems,
- o Safety and emergency systems,
- o Standard and emergency operating procedures and
- o Radiation control and safety provisions.

SRO Level

- o Reactor theory,
- o Handling and disposal of, and hazards associated with, radioactive materials,

- o Specific operating characteristics of the nuclear power plant,
- o Fuel handling and core parameters and
- o Administrative procedures, conditions and limitations.

These subject areas are the same as the seven topic areas of the NRC written RO licensing examination and the five topic areas of the SRO written examination.

In addition to specifying these areas of technical training, ANSI/ANS-3.1-1978 requires that candidates participate in a program of on-the-job training that involves:

- o Manipulation of the nuclear power plant controls during day-to-day operation and during at least two startups and shutdowns of the reactor and
- o Informal programs of self-study and counseling from more experienced personnel.

These startup and shutdown requirements may be satisfied by use of an appropriate reactor simulator.

A draft proposed revision to ANSI/ANS-3.1-1978 published in December 1979 (8) expands these training program requirements to include the following phases:

- o Nuclear power plant fundamentals,
- o Plant systems,
- o Plant operations,
  - Simulator and
  - Control room operation,
- o Review and
- o Utility certification.

Table 2.7 describes in detail the requirements of this proposed revised standard for each of these phases. This training program is designed for individuals with no previous training and experience and is permitted to vary in composition based on a candidate's experience and training.

TABLE 2.7
ANSI/ANS-3.1-1978 DRAFT REVISION LICENSE TRAINING REQUIREMENTS

PROGRAM PHASE	INSTRUCTIONAL SETTING	COMPOSITION
I. NUCLEAR POWER PLANT FUNDAMENTALS	Classroom	• Principles of reactor operation - Atomic structure and radioactivity - Nuclear reaction and the fission process - Neutron behavior and control of the fission process - Core thermal hydraulic design • Design features of the nuclear power plant • General operating characteristics of the nuclear power plant • Reactor instrumentation and control systems • Radiation control and safety provisions • Fundamentals of heat transfer, thermodynamics and fluid flow related to transient analysis • Instruction in mathematics, electricity, mechanics and other theoretical/engineering subjects in support of the above areas
II. PLANT SYSTEMS	Classroom	• Plant instrumentation and control system • Safety, fire and emergency systems • Primary and secondary mechanical systems • Electrical systems • Plant auxiliary and support systems • Plant-protection systems • Fuel-handling systems • Waste-processing systems • Integrated plant operation and casualty response • System and component malfunctions
	Plant Observation	• Planned systematic observation training on accessible plant equipment • Four weeks of observation time with the plant at 20 percent power or greater • Emphasis on system observation, local plant control, system interactions and indications

TABLE 2.7 (continued)
ANSI/ANS-3.1-1978 DRAFT REVISION LICENSE TRAINING REQUIREMENTS

PROGRAM PHASE	INSTRUCTIONAL SETTING	COMPOSITION
III. PLANT OPERATIONS	Control Room	• Observe plant operation and operating practices • Manipulate controls under direct supervision of a licensed operator • Checkoff list of minimum operations to perform or observe
	Simulator	• Practice manipulating controls • Participate in training sessions that include 27 manipulations listed in this draft revision • Examinations while operating at power with plant malfunctions and during reactor startup
IV. REVIEW	Classroom/ Plant	• Self-study review of all previous phases • Preparation for utility certification and NRC examinations
V. UTILITY CERTIFICATION	Classroom/ Plant	• Oral examinations • Written examination

This 1979 revision would also require technical instruction for SRO candidates in four subject areas in addition to the five listed in ANSI/ANS-3.1-1978. These additional subjects include the following:

- o Chemistry,
- o Operating philosophy, use of procedures, shift and relief turnover and verification of system status,
- o Fundamentals of heat transfer, thermodynamics, fluid flow and dynamics as related to transient analysis and
- o Responsibilities during emergency conditions.

Training in the following supervisory skills would also be required for SRO candidates:

- o Leadership,
- o Interpersonnel communication,
- o Command responsibilities and limits,
- o Motivation of personnel,
- o Problem analysis,
- o Decisional analysis and
- o Administration requirements for the particular supervisory position.

The "American National Standard for Nuclear Power Plant Simulators for Use in Operator Training," ANSI/ANS-3.5-1979, (9) establishes the minimum requirements for simulators used in operator training and requalification programs. This standard includes minimum criteria for degree of simulation and performance and functional capability of the control room instrumentation and controls. Criteria for use of these simulators are not addressed in this standard. In addition, simulators used in operator training programs prior to the effective date of this standard (January 29, 1979) are not required to conform to its requirements. ANSI/ANS-3.5-1979 specifies requirements in the following specific areas:

- o General requirements,
  - Simulator capabilities for normal plant evolutions and plant malfunctions,
  - Control room environment,

- Systems to be simulated and the degree of completeness and
- Simulator training capabilities, including initial conditions, malfunctions, control features and instructor interface,

o Performance criteria and
  - Steady-state operation and
  - Transient operation

o Simulator updating requirements.

Federal Regulations and NRC Guidance. Regulatory documents relating to operator license training fall into two categories: current requirements and proposed and planned requirements. The following documents are included in these two categories:

Current Requirements

o Regulatory Guide 1.8
o 10 CFR Part 55
o NUREG-0094
o NRR, H.R. Denton letter dated March 28, 1980

Proposed and Planned Requirements

o Proposed revision to Regulatory Guide 1.8
o Proposed revision to 10 CFR Part 55
o NUREG-0660

Current Requirements. Regulatory Guide 1.8, "Personnel Selection and Training," (10) accepts the criteria for training of RO and SRO license candidates contained in ANSI N18.1-1971, which was revised in 1978 by ANSI/ANS-3.1-1978.

10 CFR Part 55, "Operators' Licenses," (11) does not list any specific requirements for initial training of hot license candidates, but does indicate that training is required. Detailed descriptions of this training (courses of instruction, number of hours of training, startup and shutdown experience) are required to be submitted with license applications.

NUREG-0094, "NRC Operator Licensing Guide," (12) provides more information on the content and administration of the regulations of 10 CFR Part 55. Appendix F provides specific training requirements that must be satisfied for an RO license applicant to become eligible for a license examination that does not include an actual reactor startup demonstration. These training requirements include:

- o Lectures - Five hundred hours on subjects listed in ANSI N18.1-1971 (revised by ANSI/ANS-3.1-1978).
- o On-the-job training - Three months (minimum), which includes manipulation of the nuclear power plant controls during day-to-day operation.
- o Power operation - Participation in reactor and plant operation at power levels of at least 20 percent.
- o Reactivity changes - Manipulation of controls during five significant reactivity changes.
- o Simulator training - One week (minimum); to include receipt of a certification attesting to the applicant's ability to:
  - Manipulate the controls and keep the reactor under control during a reactor startup,
  - Predict instrument response and use the instrumentation during a reactor startup,
  - Follow the facility startup procedures and
  - Explain alarms and annunciators that may occur during this operation,
- o Review and evaluation - Forty hours (minimum); to include review, audit examinations and evaluation of the applicant.

Since most facilities do not use an actual reactor startup demonstration for licensing, these requirements currently comprise the most detailed NRC guidance for utility hot license training program composition.

On March 28, 1980, the NRC Office of Nuclear Reactor Regulation (NRR) issued a letter (13) to all power reactor applicants and licensees specifying the following additional requirements for all hot license training programs:

- o On-the-job training - Three months of training on shift as an extra person in the control room (required for RO candidates and SRO candidates),
- o Training in heat transfer, fluid flow and thermodynamics,
- o Training in the use of installed plant systems to control or mitigate an accident in which the core is severely damaged and
- o Increased emphasis on reactor and plant transients.

These additional requirements were made effective on August 1, 1980.

In summary, current federal requirements and NRC guidance for RO and SRO license training programs originate from several sources. These requirements and their sources are summarized in Table 2.8.

Proposed and Planned Requirements. A proposed revision to Regulatory Guide 1.8 was published in February 1979 by the NRC Office of Standards Development (14). This proposed revision endorses the ANSI/ANS-3.1-1978 requirements for initial training of license candidates.

In May 1980, the NRC Office of Standards Development published a proposed revision of 10 CFR Part 55, "Operators' Licenses" (15). This proposed revision would add an Appendix B to 10 CFR Part 55 which would establish the following additional RO and SRO license training requirements:

- o Simulator training - Demonstrate an ability to satisfactorily operate a simulator that simulates the type of facility, type of control room, type of steam generator and number of loops of the facility for which a license is requested.

- o Instruction - Receive instruction in the revised subject areas (thermodynamics, heat transfer and fluid flow) of the written RO and SRO examinations.

- o On-the-job training - Three months of training on shift as an extra person in the control room manipulating facility controls and performing duties that would be performed by an RO or SRO licensed operator (required for RO and SRO candidates).

In summary, this proposed revision to 10 CFR Part 55 would incorporate the requirements of the March 28, 1980, NRR letter and require simulator training for all license candidates. The simulator used would have to satisfy certain minimum requirements.

In May 1980, the NRC issued NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident" (16). This action plan specifies the new training requirements, implemented by the March 28, 1980 NRR letter and listed in the proposed revision to 10 CFR Part 55, as planned improvements to upgrade licensed operator training. In addition, this plan will require that in-plant drills be included in utility training programs by July 1, 1981.

TABLE 2.8
FEDERAL REGULATIONS AND NRC GUIDANCE FOR LICENSE TRAINING

SOURCE	REGULATORY GUIDE 1.8	10 CFR PART 55	NUREG-0094	NRR LETTER, MARCH 28, 1980
INDUSTRY STANDARD ENDORSED	ANSI N18.1-1971 (revised by ANSI/ANS-3.1-1978)			
REQUIREMENT	Technical training on seven subject areas of NRC RO written license examination Technical training on five subject areas of NRC SRO written license examination On-the-job training which includes manipulations of controls and at least two startups and shutdowns (may be accomplished on a simulator)	Training sufficient to certify that applicant can operate controls in a safe and competent manner	Five-hundred hours of lecture Three months of on-the-job training Operation at power (>20 percent) Five reactivity changes Simulator startup certification Forty hours of review	Three months on shift (RO and SRO) Training in heat transfer, fluid flow and thermodynamics Training to control or mitigate an accident with a severly damaged core Increased emphasis on transients

2.4.1.2 RO Hot License Training Practices

To satisfy the requirements of industry standards, federal regulations and NRC guidance, the practices of utilities visited could be categorized in two groups. The first group used a central training center with satellite training organizations at the individual reactor sites. The second group conducted all training under the cognizance of the training organization at the reactor site. Most of the utilities visited provided some of this initial training instruction at the SRO level as well as the RO level. Figure 2.8 shows the composition of the unlicensed and license training programs for operators at the nine facilities visited.

Nuclear power stations F and H (Figure 2.8) used the central training center concept. For auxiliary operators, these utilities employed a lengthy, formal training program consisting of classroom, on-the-job and research reactor training, mostly conducted at the central training center. These programs were designed not only to provide personnel with the training necessary to function as non-licensed auxiliary operators, but also to provide instruction in some of the more fundamental areas of RO license training (for example, nuclear physics, instrumentation and control, reactor theory, radiation protection, etc.). As a result, formal RO license training programs for these utilities (mostly conducted at the reactor site) were usually shorter (Figure 2.8), concentrating on plant-specific areas of RO knowledge (for example, primary and secondary systems, operating procedures, simulator training, control room practice, etc.).

The remaining seven nuclear power stations visited used programs of the second type. The non-licensed operator programs were of varying lengths and relied heavily upon on-the-job training of auxiliary operator candidates. As a result, the focus of these non-licensed operator programs was on training operators in the skills and knowledges necessary for AO positions. The fundamental areas of RO license training were taught in the RO license training course, resulting in more lengthy training programs for RO candidates (Figure 2.8).

Both training concepts included the phases of license training shown in Table 2.7, namely:

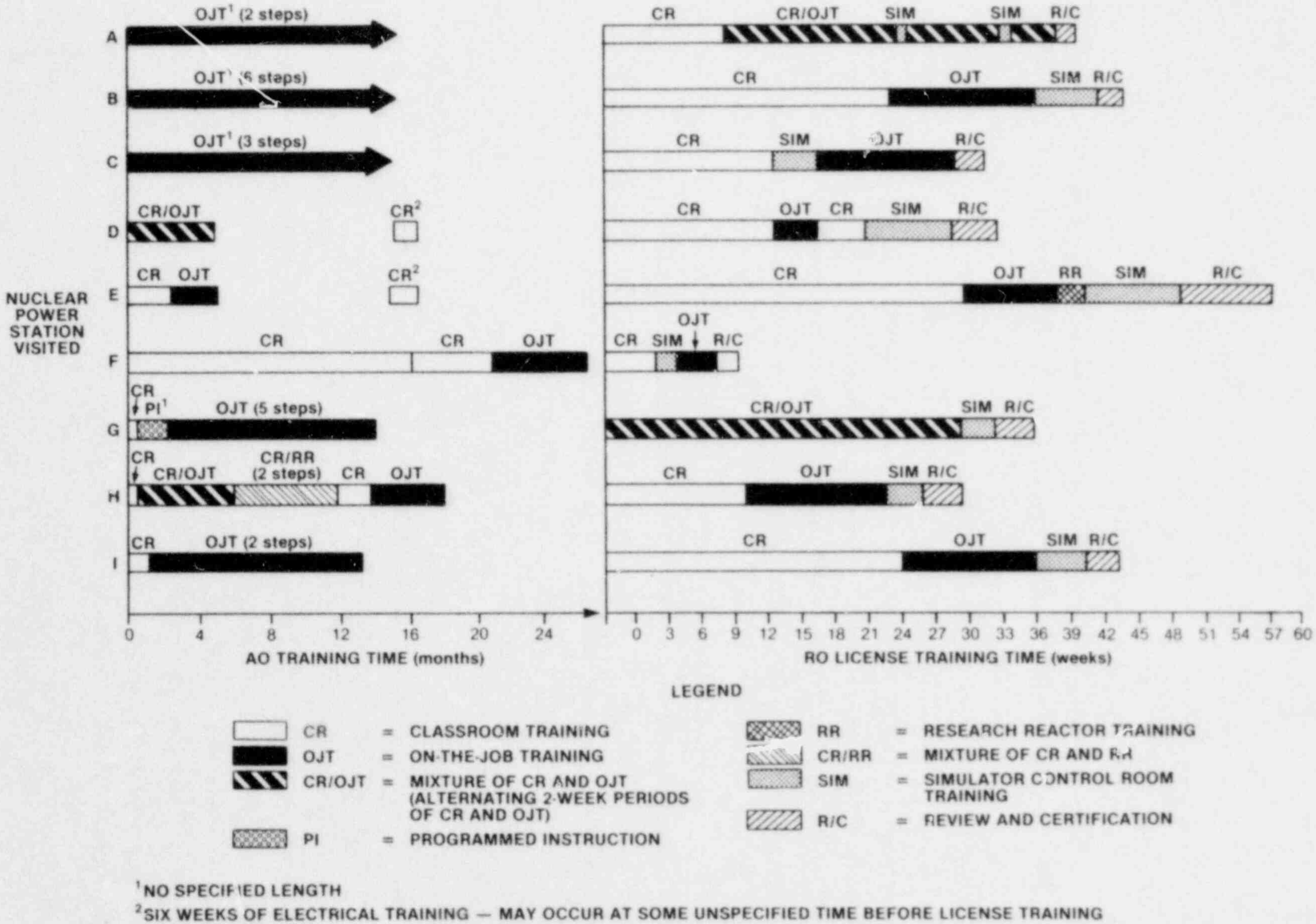

Figure 2.8 Operator Training Programs

I. Nuclear Power Plant Fundamentals,

II. Plant Systems,

III. Plant Operations,

IV. Review and

V. Utility Certification.

This section discusses training practices of each phase, except utility certification. Certification practices are addressed in Section 2.5.3, "Certification of RO Candidates."

Fundamentals. In all cases, nuclear power plant fundamentals training was conducted in a classroom instructional setting. This instruction consisted predominantly of lectures (using slides and/or transparencies) and video tapes. Table 2.9 lists subjects that were taught by most facilities during this phase of training. The utilities that employed a central training facility concept provided this training at the central facility, using their own materials and instructors. More than half of the remaining seven reactor sites visited used outside training contractor materials or instructors or both to help provide this training. Full participation in this phase was not required of all license candidates at all facilities. Some personnel were permitted to bypass portions of this phase based on previous experience and training. Lesson or lecture plans were used by all facilities during this phase, although the degree of detail and formality of these plans varied widely.

Plant Systems. This phase of hot license training was conducted principally in the classroom setting, supplemented by periods of in-plant tours or shift training to permit familiarization with systems. Classroom instruction averaged approximately 15 weeks, covering primary, secondary and auxiliary systems, integrated plant operations and malfunctions. Required plant observation time was provided by two principal methods. One technique was to alternate 2 weeks of classroom systems training with 2 weeks of shift training. During the shift training, the RO candidate would concentrate on the operation of systems covered in the previous 2 weeks of classroom training. The second technique completed all classroom training first. The trainee would then participate in one comprehensive period of on-the-job training to complete plant systems observation training and control room observation training requirements.

TABLE 2.9
SUBJECTS COVERED DURING NUCLEAR POWER PLANT FUNDAMENTALS PHASE

Mathematics
Classical physics
Basic atomic physics
Basic nuclear physics
Radiation
Radiation control
Health physics
Reactor theory
Reactor kinetics
Reactor control
Basic instrumentation and control
Basic electrical theory
Electro-mechanical systems
General primary plant operating characteristics
General secondary plant operating characteristics
Heat transfer
Thermodynamics
Fluid flow
Water chemistry
Print reading
Core hydraulics
Nuclear instruments
Design features
Radioactive waste
General plant operating procedures

Plant Operations. This phase of training consisted of two distinct parts: on-the-job training in the reactor plant control room and training on a control room simulator. The combination of these two parts composed the practical training given to RO candidates.

The on-the-job training was generally for 12 weeks, but varied in the manner in which it was conducted. A broad spectrum of practices for controlling the composition and quality of training received during this period was observed. Techniques employed to monitor this training included combinations of the following:

- o "Task lists" (practical factors lists, qualification cards, etc.)
- o Weekly or biweekly reviews of progress by training department personnel,
- o Periodic written and oral examinations and
- o SS, SCO and CRO evaluations of trainee performance.

Task training varied from very informal programs (trainees were provided a brief list of suggested topics to review while on shift) to the use of detailed task lists. These task lists enumerated several tasks that were required to be performed or simulated and several oral examinations that were required to be given by operating staff personnel. The purpose of these lists was to ensure that an RO candidate knew how to perform certain operations and possessed adequate knowledge in other areas (for example, systems operations, reactor plant surveillance, general and emergency operating procedures, etc.). RO candidates were required to obtain signatures of operating staff personnel to verify satisfactory performance and knowledge. At the reactor sites visited, the most comprehensive task list was originated from a job task inventory for reactor operators and listed performance, simulation and knowledge requirements inside and outside the control room; however, most on-the-job training programs were not as formal or as well documented.

All reactor sites visited used a full-scope control room simulator to supplement hot license plant operations training. These utilities followed one of four practices:

1. Leased time on a simulator operated by a reactor plant vendor or another utility and supplied their own instructors to conduct the training,

2. Purchased a simulator training program operated by a reactor plant vendor (Some utilities sent an instructor with a group of trainees, although the instruction was conducted by the simulator staff.),

3. Conducted training using their on-site simulator or

4. Sent trainees to simulator training at a utility-operated central training center.

Control room training conducted at simulator facilities varied from 1 to 8 weeks. During these control room training periods, the simulator was usually employed approximately 50 percent of the time (4 hours of simulator and 4 hours of classroom each day). Simulator training sessions could be categorized as demonstration, practice or exercise sessions.

Since all reactor sites visited used this simulator training to satisfy the reactor startup certification requirements of Appendix F, NUREG-0094, "NRC Operator Licensing Guide" (Section 2.4.1.1), (12) major emphasis was placed on reactor startup training in all simulator training programs. For programs lasting only 1 week, this certification training consumed the majority of the training time available. Longer programs devoted more time to system and component malfunction and reactor plant casualty training. Table 2.10 provides for comparison a list of training conducted on malfunctions and casualties during representative simulator programs of 1, 3 and 4 weeks.

Review. This phase usually consisted of 2 to 4 weeks of self-study with some classroom lectures and plant "walk-through" training. Portions of the final utility certification process were generally completed during this period.

2.4.1.3 SRO Hot License Training Practices

All reactor sites visited used an SRO license training program that was much shorter (approximately 2 months) than the RO training program. Training Supervisors interviewed felt this time was satisfactory since their normal practice was to teach the RO hot license training course at a combined RO and SRO level. All programs focused on the five areas of the NRC senior operator written examination:

TABLE 2.10
MALFUNCTIONS AND CASUALTY TRAINING DURING TYPICAL HOT LICENSE SIMULATOR PROGRAMS

MALFUNCTION OR CASUALTY COVERED	SIMULATOR TRAINING PROGRAMS (length)				
	J[1] (1 week)	K[1] (3 weeks)	L[2] (1 week)	M[1] (3 weeks)	N[2] (4 weeks)
Reactor coolant pump malfunction or trip	X	X	X	X	
High pressure coolant injection inoperable					X
Relief valve failure		X	X	X	X
Loss-of-coolant accident		X		X	
Solid operations		X			
Reactor coolant pump vibration	X				
Control rod drive system failure	X	X	X	X	X
Reactor manual control malfunction					X
Rod worth minimizer failure					X
Rod position indication system failure					X
Rod block monitor failure					X
Control rod drop	X		X		
Control rod stuck	X		X	X	
Control rod accumulator system malfunction			X		
Nuclear instrument failure	X		X	X	X
Reactor protection system failure					X
Reactor trip		X	X	X	X
Instrumentation failures		X		X	
Letdown system control failures	X			X	
Steam generator level control failure	X			X	
Spray valve failure				X	
Engineered safety feature bus trip				X	

[1] PWR simulator
[2] BWR simulator

TABLE 2.10 (continued)
MALFUNCTIONS AND CASUALTY TRAINING DURING TYPICAL HOT LICENSE SIMULATOR PROGRAMS

MALFUNCTION OR CASUALTY COVERED	SIMULATOR TRAINING PROGRAMS (length)				
	J[1] (1 week)	K[1] (3 weeks)	L[2] (1 week)	M[1] (3 weeks)	N[2] (4 weeks)
Main steam leak	X	X			X
Main steam rupture		X		X	
Steam generator tube leak		X		X	
Feedwater pump trip		X		X	
Condensate/feedwater system malfunction	X	X	X	X	X
Main feedwater system rupture				X	
Loss of condenser vacuum				X	
Reactor water cleanup system failure	X				X
Turbine generator malfunctions	X		X	X	X
Electro-hydraulic control system failure					X
Loss of all power		X		X	
High drywell pressure					X
Primary containment isolation	X				X
Charging pump trip	X				
Volume control tank valve control failure	X				
Boron recovery system failures				X	
Residual heat removal pump trip				X	
Approximate total number of malfunctions and casualties performed	14	30	14	55	45

[1] PWR simulator
[2] BWR simulator

- o Reactor theory,
- o Radioactive material handling, disposal and hazards,
- o Operating characteristics,
- o Fuel handling and core parameters and
- o Administrative procedures, conditions and limitations.

Table 2.11 indicates the instructional methods employed by the nuclear power stations visited in conducting SRO license training.

TABLE 2.11 SRO TRAINING METHODS

INSTRUCTIONAL METHOD	NUCLEAR POWER STATIONS VISITED								
	A	B	C	D	E	F	G	H	I
Self-study	X	X	X	X	X	X	X	X	X
Classroom instruction						X		X	
On-the-job training as an SRO trainee in the control room		X						X	
Task lists	X	X			X			X	
Simulator training at the SRO level								X	

Self-study was the most widely used method for preparation for the SRO examinations. In some cases, self-study was the only technique employed. As a result, formal classroom instruction was used much less often than during RO license training.

At the time of these site visits, on-the-job training as an SRO trainee in the control room was not widely used. After these visits, a new NRC requirement for SRO candidates to receive 3 months of on-shift training as an extra man on shift was implemented (13).

Some utilities used task lists to ensure that SRO candidates achieved certain in-plant training requirements. These task lists varied widely in the number of requirements and subject areas. Simulator training for SRO candidates was used at one of the sites visited. In this case, the training was tailored to the SRO level with emphasis on analyzing casualty conditions and developing supervisory skills.

2.4.1.4 NRC Hot License Training Practices

NRC responsibilities relating to RO and SRO hot license training programs rest with the Operator Licensing Branch (OLB) and Office of Inspection and Enforcement (IE).

Section 13.2, "Training," of the NRC Standard Review Plan (SRP) (17) assigns to OLB the responsibility of reviewing plant personnel training programs which are described in the Preliminary Safety Analysis Report (PSAR) and Final Safety Analysis Report (FSAR). The "Areas of Review" section of the SRP lists in detail specific requirements for inclusion in the training program descriptions for "initial appointees to the plant staff." As a result, these requirements are tailored for review of cold license training programs (rather than hot programs) and are discussed in Section 2.4.2.3, "NRC Cold Training Practices."

The only stated requirement for hot license training programs is contained in the "Evaluation Findings" section of the SRP. This section requires that the OLB reviewer verify that utility plans for replacement training conform to the regulatory position, or equivalent, and that the utility commitment to replacement training will be incorporated in the "Administrative Controls" section of the applicant's technical specifications. A review of the technical specifications of the facilities visited indicated that this later requirement was satisfied in most cases by the inclusion in the technical specifications of a statement similar to the following: "Retraining and replacement of station personnel shall be in accordance with Section 5.5 of ANSI/ANS-3.1-1978, 'Selection and Training of Nuclear Power Plant Personnel.' "

In practice, the OLB reviews the hot license training programs described in the PSARs and FSARs in many of the same areas that are specified for cold program review, but that are applicable to hot programs as well. These areas include:

- o Proposed subject matter of each classroom course (course description, duration, teaching organization),
- o Reactor operations experience training by simulator (length and simulator used),
- o Details of on-the-job training and
- o Means for evaluating the training program effectiveness.

The acceptance criterion is conformance to the requirements of the following documents:

- o Regulatory Guide 1.8, "Personnel Selection and Training,"
- o 10 CFR Part 55, "Operators' Licenses" and
- o NUREG-0094, "NRC Operator Licensing Guide."

Utilities are not required by regulations to obtain NRC approval of changes to the hot license program following approval of the FSAR. As a result, the OLB does not evaluate the training received by a hot license applicant against the FSAR when approving the license examination application.

Following approval of the hot license training program in the FSAR, IE assumes the responsibility for periodic audits of training conducted at the reactor sites. The quality of training conducted at reactor plant vendor operated training centers is the responsibility of OLB.

IE audit responsibilities are further divided between on-site inspectors and inspectors from the regional offices. Training audit requirements for on-site IE representatives relating to hot license training include attendance at two training lectures semiannually and verification that lesson plan objectives were met (one or both of these two lectures may be requalification lectures). This requirement was initiated in April 1980.

Although detailed requirements exist in IE procedures for regional inspector audits of utility requalification programs and general and non-licensed employee training programs, no requirements currently exist to conduct periodic audits of hot license training programs. Regional IE inspectors are required to verify annually that general training (for example, radiological health and safety, security, fire protection) for licensed employees is in conformance with technical specifications and quality assurance (QA) program requirements. A formal report of each regional IE audit is filed and a report of corrective action is required from the utility. Requalification program audit requirements are discussed in Section 2.7.1.3.

Fourteen routine IE training audit reports for the facilities visited were reviewed. Each report indicated that a review of general employee training, non-licensed personnel training and licensed operator requalification training had been conducted. None of these reports indicated that the hot license training program had been reviewed. One report, however, identified a problem relating to hot license training records while conducting an audit of requalification training. Interviews with IE and OLB personnel indicated that occasionally problems in hot license programs are identified during IE audits of requalification training and copies of these reports are provided to the OLB.

OLB audits of vendor operated training centers are conducted on an informal basis approximately every 2 years. A review of training practices is conducted with training center personnel by an OLB examiner. No formal acceptance criteria exist for this review and no written reports are required.

2.4.2 RO and SRO Cold License Training

Cold license training programs provide the necessary training for personnel who will sit for NRC license examinations prior to the initial fuel loading of a nuclear power plant. These programs are similar in many respects to hot programs, but must account for the fact that it is not possible for trainees to perform actual plant operations at power. When describing requirements and practices, this section will focus on the differences between cold and hot programs.

2.4.2.1 Training Requirements

Industry Standards. When addressing the required training of candidates for NRC cold examinations, ANSI/ANS-3.1-1978, "Selection and Training of Nuclear Power Plant Personnel," considers two situations - training the staff for the initial unit at a site and training candidates for subsequent units at a site. For the initial unit, this standard requires the same technical training as that for hot programs, with the additional requirement that the candidate be engaged in the day-to-day activities of procedure preparation, construction check out and preoperational testing at the facility for approximately 1 year prior to fuel loading. This 1-year time requirement is permitted to vary depending on the experience of the license applicant.

Another principal difference between hot and cold training requirements is prior operating experience. Applicants for cold examinations must have had extensive operating experience at a reactor facility that is generally classified as comparable in complexity and operating characteristics. ANSI/ANS-3.1-1978 presents four methods for satisfactorily demonstrating this experience; any one of these is sufficient. The four methods are:

1. Experience demonstrated by obtaining certification of satisfactory completion of an NRC-approved training program which utilizes a nuclear power plant simulator as part of this program.

2. Experience demonstrated by holding or having held a reactor operator's license at a comparable licensed reactor facility. Experience at any nuclear power reactor is considered to be comparable experience. However, previously licensed individuals should participate in a short course utilizing a nuclear plant simulator similar to the facility for which the applicant will be seeking a license.

3. An applicant's satisfactory completion of an NRC-administered written examination and operating test at a comparable licensed reactor facility without issuance of a reactor operator's or senior reactor operator's license.

4. A determination of appropriate experience obtained at a comparable reactor facility not subject to NRC licensing, e.g., reactor facilities operated by the military service or ERDA-owned reactors.

Operators who hold licenses on the first unit at a site and who apply for licenses on subsequent units based on a waiver of examination must satisfy the following additional requirements:

1. Participate in a training program that familiarizes them with the differences between the units and the interaction of the units.

2. Have been actively engaged in a licensed capacity at the first unit for a period not less than three months. This requirement does not apply when a multiple unit license examination is to be taken.

3. Have performed competently and safely as a licensee on the first unit.

The draft proposed revision to ANSI/ANS-3.1-1978 currently undergoing review would include the following requirements for cold license training in addition to those for hot programs (Table 2.7):

1. Participation in a laboratory course at a research reactor during which the candidate shall perform 10 reactor startups,

2. Participation in the plant preoperational testing program to gain control room operating experience and

3. Performance of practical work assignments that may include plant operating procedure preparation and verification, preoperational testing of plant systems and participation in a hot functional testing program, providing instruction on plant systems to the remainder of the group.

Federal Regulations and NRC Guidance. Regulatory Guide 1.8, "Personnel Selection and Training," and its February 1979 proposed revision endorse, respectively, the requirements for cold license training presented in ANSI N18.1-1971 and ANSI/ANS-3.1-1978.

10 CFR Part 55, "Operators' Licenses," addresses the fact that administration of an operating test, which requires manipulation of the reactor, is not possible prior to initial criticality. To account for this, the OLB may administer a simulated operating test under the provisions of this regulation, if the following requirements are met:

1. There is an immediate need for the applicant's services.

2. The applicant has had extensive actual operating experience at a comparable reactor.

3. The applicant has a thorough knowledge of the reactor control system, instrumentation and operating procedures under normal, abnormal and emergency conditions.

4. The reactor control mechanism and instrumentation are in such condition as determined by the Commission to permit effective administration of a simulated operating test.

As a result, requirements 2 and 3 impact on the utility's cold license training program.

NUREG-0094, "NRC Operator Licensing Guide," provides additional guidance relating to these four requirements for administration of simulated operating tests to cold license applicants. Specifically, it provides NRC's definition of "extensive actual operating experience at a comparable reactor." Although more definitive guidance is provided, the four methods presented for satisfying this experience requirement are the same as those presented in ANSI/ANS-3.1-1978. It is considered reasonable to obtain this actual operating experience 24 months prior to the cold license examination.

The training requirements, implemented by the March 28, 1980 NRR letter to power reactor applicants and licensees, are applicable to cold as well as hot license training programs (see Section 2.4.1.1).

In a similar manner, the additional RO and SRO license training requirements contained in the May 1980 proposed revision to 10 CFR Part 55 (Section 2.4.1.1) would be applicable to cold as well as hot programs. In cases where it is impractical to obtain 3 months of shift training (for example, prior to initial criticality) and there is an immediate need for an applicant's services, the NRC would consider a waiver of this requirement to be replaced by unique training designed to accommodate the circumstances.

2.4.2.2 RO and SRO Cold License Training Practices

With a few exceptions, utility cold license training programs are similar to the program presented in Section 2.4.2.1 and in Table 2.7.

Phase I, Nuclear Power Plant Fundamentals, typically includes a 1- to 3-week period of training on a training or research reactor. These training and research reactors permit operational training in subjects such as core loading and unloading, reactor startups and shutdowns, reactivity effects and measurement, delayed neutron effects and nuclear instrumentation. Students perform 10 reactor startups. The total time period for this fundamentals phase is approximately 11 weeks.

Phase II, Plant Systems, is a lecture series on primary and secondary systems design characteristics. This phase takes from 6 to 10 weeks.

Phase III, Plant Operations, includes simulator programs that are usually longer than those for hot training. These programs varied from 8 to 12 weeks at the training centers visited. Table 2.12 presents a comparison of different characteristics of these programs. This training is supplemented by observation training that involves the day-to-day operation of a nuclear power plant.

In addition to these phases, cold license applicants must participate in an on-site training program that consists of classroom training and practical work assignments. These practical work assignments include plant operating procedure preparation, preoperational testing of plant systems, hot functional testing, etc. The minimum time required in this phase is 6 months.

2.4.2.3 NRC Cold License Training Practices

Initial approval of utility cold license training programs is conducted by the OLB through its reviews of a facility's Preliminary and Final Safety Analysis Report. Section 13.2, "Training," of the NRC Standard Review Plan requires that these license program descriptions include the following:

For the PSAR:

1. The proposed subject matter of each course, the duration of the course (approximate number of weeks in full time attendance), the organization teaching the course or supervising instruction, and the position titles for whom the course is given.
2. Reactor operations experience training by nuclear power plant simulator or assignment to a similar plant, including length of time (weeks), and identity of simulator and plant.
3. A commitment to conduct an onsite formal training program and on-the-job training before the initial fuel loading.
4. Any difference in the training programs for individuals who will be seeking licenses prior to criticality pursuant to Section 55.25 of 10 CFR Part 55 based on the extent of previous nuclear power plant experience. Experience groups should include the following:

a. Individuals with no previous experience.

b. Individuals who have had nuclear experience at facilities not subject to licensing.

c. Individuals who hold, or have held, licenses for comparable facilities.

5. The means for evaluating the training program effectiveness for all employees. For license applicants this includes the means to be employed to certify that each applicant has had extensive actual operating experience.

TABLE 2.12
COLD LICENSE SIMULATOR TRAINING PROGRAMS

PROGRAM CHARACTERISTIC	TRAINING CENTER				
	J	K	L	M	N
1. Total length (weeks)	8	8	12	9	12
2. Length of pre-simulator classroom phase (weeks)	0	2	3	2	4
3. Length of classroom/simulator combination phase (weeks)	7	5	-	5	8
4. Length of simulator/plant tours combination phase (weeks)	-	-	6	-	-
5. Use of plant tours to supplement training			X	X	
6. Simulator training (excluding certification examination) (approximate number of hours)	132	100	116	84	140
7. Startup certification examination	X	X	X	X	X
8. Single comprehensive written examination	X				X
9. Mock NRC RO written examination		X	X	X	
10. Mock NRC SRO written examination			X	X	
11. Mock NRC oral examination	X	X	X	X	X

Additional requirements for the FSAR:

1. A syllabus or equivalent course description for the proposed subject of each course.

2. The details of the onsite training program, including a syllabus or equivalent course description, the duration of the course (approximate number of weeks in full time attendance), the organization teaching the course or supervising instruction, and the positi~ ~itles for which the course is given. The program should distinguish between classroom training and on-the-job training, before and after the initial fuel loading.

Requirements also exist for review of other initial training programs that are not part of cold license training (for example, fire brigade training, general employee training). As with the hot training programs, the acceptance criterion is conformance to the requirements of Regulatory Guide 1.8, 10 CFR Part 55 and NUREG-0094.

In addition to approving reactor facilities' PSARs and FSARs, the OLB approves the segment of cold license training conducted at reactor vendor training centers. Part of this formal evaluation is approval of the simulator for use in that cold program. This evaluation is conducted before the simulator is put into use. No periodic formal reviews of these programs are conducted, but training centers are required to submit changes to these programs to the OLB for approval.

Applications for cold license examinations are reviewed to verify that actual training conducted was in conformance to the utility commitments specified in the FSAR. This practice is different from that followed for hot license applicants, since the OLB does not review hot license applications against the FSAR.

Before issuance of a facility operating license, IE conducts an inspection of operating staff training. This inspection is started from 12 to 4 months before the issuance of the operating license and must be completed before facility licensing. The objectives of this inspection as stated in the IE inspection procedure include the following:

- Confirm that the licensee has trained the operating staff.
- Confirm that a continuing program of training is being conducted.
- Verify that the replacements receive training or have the experience equivalent to that required for originally selected personnel.

During the course of this inspection, the following items, among others, are verified to have been established:

- A documented training program consistent with the FSAR commitments,
- A documented general employee training program that provides training in areas such as administrative controls, security, safety, fire fighting and emergency plan.
- On-the-job training requirements for reactor operator and other personnel and
- Assignment of responsibilties for administering and evaluating training programs.

Implementation of these training programs, which include cold license training, are verified through training record reviews and personal interviews.

2.4.3 Initial Training Practices of Other Organizations

2.4.3.1 Foreign Utility Training Practices

Great Britain*

As described in Section 2.5.1.4, personnel selected for training as nuclear plant operators (AO, RO and SRO) in Great Britain already have received postgraduate technical training in engineering (or its equivalent). Therefore, these trainees have received technical training at the college level in mathematics, physical sciences and engineering before beginning the utility's operator training program. Before being assigned to a shift as an AO, trainees must satisfactorily complete a 16- to 18-week course that includes formal (classroom and simulator) and on-the-job training. This training is separated into three phases:

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*The information on the training of reactor operators in Great Britain was provided by the Central Electricity Generating Board, "Nuclear Power Training Center Course Description," (18) and P.B. Myerscough, "Station Manager Takes the Responsibility in Britain," Nuclear Engineering International (19).

1. Introduction to nuclear power (4 weeks at the training center),

2. Plant familiarization (6 to 8 weeks at the plant) and

3. Formal course work on the specific plant (5 to 7 weeks at training center).

The introduction to nuclear power course includes the following:

- o Basic nuclear and reactor physics,
- o Heat transfer and thermal performance,
- o Plant and reactor kinetics,
- o Nuclear reactor systems,
- o Chemistry,
- o Metallurgy,
- o Health physics and environmental considerations and
- o Simulator training on a generic simulator to learn fundamentals of reactor kinetics.

Upon successful completion of this cou. .ie trainee completes a familiarization period at the plant which includes projects established by the training center.

Tne final reriod of the initial formal training program is plant-specific training, including classroom, laboratory and plant-specific simulator sessions. This training includes:

- o Plant-specific systems,
- o Instrumentation,
- o Plant performance,
- o Fuel characteristics and cycle,
- o Operating procedures,
- o Emergency and fault operations,
- o Maintenance and modification procedures and
- o Chemistry and health physics operations.

The curriculum of this training program is under continual scrutiny and updating in response to plant needs. A review board, comprised of senior managers from the nuclear stations serviced by the training center, ensures that the program meets station needs.

Upon completion of this formal training program, the trainee receives more on-the-job-training at the plant before being appointed to a shift position (AO) by the station manager.

Other than ongoing requalification training (which is described in Section 2.7.1.4), no other formal training is required for advancement to RO or SRO, although there are job experience requirements (for example, minimum of 7 years of experience to become a Shift Supervisor).

It is noted that this training program is <u>not</u> mandated by a government regulatory agency but is controlled and implemented by government utilities.

West Germany*

West Germany has training and qualification programs for nuclear power plant personnel, including operators, that are covered by guidelines developed by an industry association, the Technical Association of Large Power Plant Operators (VGB). An acceptance examination is administered by a federal government regulatory agency (Chamber of Industry and Commerce). These examinations are given at the RO level and the SS level. The VGB also operates the Kraftwerksschule (power plant school), which is a central facility providing classrooms, simulators and instructors.

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*The information on West Germany's nuclear power plant training and qualification programs was obtained from O. Schwarz and A. Schlegel, "Combining Theory and Practice in West Germany," (20) and "Kraftwerksschule e.v. Nuclear Power Plant - Simulator Center Description" (21).

Initial training for prospective ROs involves 28 to 36 months of coordinated practical and theoretical training. About 3 months of this time (590 classroom hours) is theoretical training with the remainder being provided at the power plant. Control room simulators are used for initial training. These simulators are not plant specific and the VGB does not feel that plant-specific simulators are necessary. Two basic simulator courses are used during the initial training period, depending upon the experience of students. The first course is 4 weeks and concentrates on correct procedures during startup, shutdown and load operation. This course is designed for shift personnel without operational experience in nuclear power plants. The second course, designed for personnel with prior nuclear experience, is 4 weeks and concentrates on training for abnormal, offnormal and emergency events. As in U.S. simulator programs, each training day is divided between 4 hours of classroom or seminar instruction and 4 hours of practical training on the simulator.

Candidates for Shift Supervisor receive an additional year of full-time, formal training including theory and simulator training. During simulator training, the emphasis is not on practicing procedures but rather on diagnosing new operational situations.

Canada*

Canada has an equivalent to the U.S. NRC in the Atomic Energy Control Board (AECB) of Canada, a federal government regulatory agency. The Canadian utilities are province (state) operated while most U.S. utilities with nuclear power plants are owned by private shareholders. The only Canadian utility at this time with any significant nuclear generating capacity is Ontario Hydro. While the AECB administers licensing examinations to operators, the AECB does not specify training requirements. Therefore the training program described here has been developed and implemented by Ontario Hydro.

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*Information on Ontario Hydro nuclear plant operator training was provided by B. J. Pannell and F. R. Campbell, "Three Mile Island - A Review of the Accident and Its Implications for CANDU Safety," (22) and A. R. Howey, "Ontario Hydro Hires Staff Centrally" (23).

The Ontario Hydro operator training program is 24 months with the first 5 months of formal training at a central training center followed by 19 months of training at the nuclear station where station-specific systems training, in-plant training (outside the control room) and checkouts as well as routine evolutions on-shift are conducted. All shift operations training includes courses in each of the following topics:

- o Management,
- o Science fundamentals,
- o Equipment and systems,
- o Control and mechanical maintenance skills,
- o Specific station systems,
- o Specific station equipment and systems in-plant training and check-outs and
- o Safety and radiation protection training.

Upon successful completion of the 24-month training program, trainees are designated as AOs. After 1 to 2 years of experience, individuals may be chosen for RO training, which lasts between 12 and 18 months, of which 6 months are spent under instruction in the control room. This RO training program involves training in the same eight areas as identified above. During this time, the trainee also receives 9 weeks of plant-specific simulator training.

2.4.3.2 U.S. Navy Training Practices

Initial nuclear training programs for U.S. Navy officers and enlisted personnel are described in detail in a statement presented by Admiral H.G. Rickover to the House of Representatives Subcommittee on Energy Research and Production (24) and in NUREG/CR-1280, "Power Plant Staffing" (25). This information is summarized in this section.

Initial nuclear training before reporting onboard nuclear-powered ships consists of two phases:

1. Six months of formal academic instruction at U.S. Naval Nuclear Power School and
2. Six months of operational training at land-based Naval reactor prototypes.

Nuclear Power School training consists of approximately 700 hours of classroom instruction in the following areas:

Enlisted Personnel	Officers
Mathematics	Mathematics
Physics	Physics
Heat transfer	Heat transfer
Fluid flow	Fluid flow
Chemistry	Chemistry
Radiological fundamentals	Radiological fundamentals
Materials	Materials
Reactor plant systems	Reactor plant systems
Reactor principles	Reactor dynamics
Reactor plant operations	Aspects of reactor plant operations
Specialized in-rate instruction on plant systems	Core characteristics
	Electrical engineering

Officer instruction is conducted at a higher level than that for enlisted personnel. Topical guides for each subject regulate the subject by specifying the material to be covered, the order of topics covered, time allotment and examination requirements. Lesson plans, which include learning objectives, are developed from these topical guides.

Reactor prototype training consists of four phases -- classroom, transition, in-hull and proficiency. During the course of instruction, officers and enlisted personnel receive lectures and on-the-job instruction, stand watches under instruction and qualify on the watch stations they would normally stand onboard ship. The classroom phase lasts approximately 5 weeks and concentrates on plant primary and secondary systems, chemistry and radiological controls. During the transition phase, trainees begin shift rotation which includes systems training and standing watches under instruction. Systems training is principally self-study followed by oral examinations. A qualification card with required signatures to verify accomplishment of knowledge and performance requirements is used to record student progress and help ensure uniform training. During the in-hull phase, watchstanding practice continues and leads to final qualification on the watch. This watchstanding practice is supplemented with seminars and training exercises. Operations training includes reactor and steam plant startups, shutdowns, complicated operations and casualty drills. The process for final qualification is discussed with certification practices in Section 2.5.3.4. During the proficiency phase, the watchstander gets practice as the person on watch at the station. This experience is supplemented with lectures and task training to complete the prototype training period.

The Navy nuclear program does not use any reactor plant simulators. As stated by Admiral H. G. Rickover in reference 24, this policy is based on a belief that effective training cannot be achieved on a simulator since it does not train people to react to the real situation at all times. It is felt that, if personnel are trained with a simulator, they tend to expect that there will be no consequences as a result of their actions. Naval reactors use a strong management approach and a high degree of involvement by exercising a great deal of control over the content and conduct of Nuclear Power School and prototype training. This control includes selection of candidates, approval of the curriculum at Nuclear Power School, approval of qualification guides for use in practical training, requirements for the conduct of drills and evolutions, and continuing reviews of the effectiveness of this training.

2.4.3.3 Federal Aviation Administration Practices

Since the Federal Aviation Administration (FAA) is a civilian regulatory agency with responsibilities analogous to those of the NRC, the FAA's degree of involvement in airline pilot training programs was considered to be of interest. FAA training requirements and practices are reported in this section and are listed in detail in Title 14, "Aeronautics and Space," of the Code of Federal Regulations (26). The FAA categorizes aircraft crewmember training into five types:

1. Initial training - The training required for crewmembers who have not qualified and served in the same capacity on an aircraft.

2. Transition training - The training required for crewmembers who have qualified and served in the same capacity on another aircraft.

3. Upgrade training - The training required for crewmembers who have qualified and served as second in command on a particular aircraft type, before they serve as pilot in command on that aircraft.

4. Differences training - The training required for crewmembers who have qualified and served on a particular type aircraft, when the FAA finds differences training is necessary before a crewmember serves in the same capacity on a particular variation of that aircraft.

5. Recurrent training - The training required for crewmembers to remain adequately trained and currently proficient for each aircraft, crewmember position, and type of operation in which the crewmember serves.

For each type of training conducted the FAA involvement includes the following:

- Certification of pilot schools,
- Certification of ground and flight instructors,
- Approval of training programs and
- Evaluation and approval of simulators.

Pilot schools receive a 2-year certification which may be renewed after a satisfactory evaluation by the FAA that the school continues to meet certification requirements. Schools are required to satisfy FAA criteria in the following areas:

- Personnel,
- Aircraft and airports,
- Chief instructor qualification,
- Ground trainers and training aids,
- Briefing and training facilities,
- Training course outline and curriculum,
- Operating rules and
- Maintenance of records.

FAA certification of ground and flight instructors is discussed in the context of Section 2.10, "License Training Instructors."

For each training program, the FAA approves the curriculum. This process consists of an initial and final approval and includes the following steps:

1. To obtain initial and final approval of a training program, or a revision to an approved training program, each school must submit to the FAA:

   a. An outline of the proposed or revised curriculum, that provides enough information for a preliminary evaluation of the proposed training program or revision; and

   b. Additional relevant information that may be requested by the FAA.

2. If the proposed training program or revision complies with regulations, the FAA grants initial approval in writing after which the school may conduct the training under that program. The FAA then evaluates the effectiveness of the training program, samples the end product, and advises the school of deficiences, if any, that must be corrected.

3. The FAA grants final approval of the proposed training program or revision if the school shows that the training conducted under the initial approval. . .ensures that each person who successfully completes the training is adequately trained to perform that person's assigned duties.

The requirements for these training program curricula are specified in detail in Title 14, Code of Federal Regulations and amplified in FAA advisory circulars.

As an example, 14 CFR Part 135 (26) specifies training curricula requirements for air taxi operators and commercial operators. The stated objectives of the FAA evaluation process for these programs are to:

1. Ensure the quality of the training program,

2. Place emphasis on training to a predetermined level of proficiency in an aircraft, simulator or other training device, thus eliminating reliance on a specified number of hours in the flight training curriculum,

3. Encourage establishment of effective quality control in the training program (27).

The typical curriculum submitted for FAA review includes the following:

- Statement of purpose,
- Training objectives,
- Qualification requirements,
- Subjects and time allotment for ground training,
- Areas of emphasis in flight training and times devoted to each,
- Detailed descriptions of normal, abnormal and emergency maneuvers to be performed,
- Description of the conduct of training,
- Detailed outline of each subject area of ground training,
- List of examinations to be conducted,
- For each item of required performance in flight training, an indication of whether this performance will be conducted in a simulator or an aircraft and
- List of all training devices, mockups, systems trainers, procedures trainers or other training aids that will be used (27).

In addition, specific requirements for crewmember training in the areas of emergencies and handling of hazardous materials are specified in federal regulations.

The following indicators are used by the FAA in evaluating the effectiveness of the training programs (27):

1. The results of written tests and oral examinations.
2. The professional qualifications of the instructors with respect to teaching techniques and knowledge of the subject.
3. The adequacy of the training facilities, aids, equipment, and material. In general, these items should satisfactorily provide for the particular training involved and be utilized in such a manner as to achieve desired training results.
4. The adequacy and effectiveness of audio visual training systems that use voice, slides, and/or movie film for presenting to a class of students, or to an individual student, instructions on aircraft systems and other related subjects.
5. The proficiency, knowledge, and professional ability of check airmen or supervisors that examine and determine the competency of flight crewmembers and flight attendants.

The FAA evaluates and approves each aircraft simulator used in a training course. As specified in 14 CFR Part 135, the simulator must be specifically approved for:

- o The type aircraft and, if applicable, the particular variation within type for which the training is being conducted and
- o The particular maneuver procedure or crewmember function involved.

FAA Advisory Circular 121-14B, "Aircraft Simulator and Visual System Evaluation and Approval," (28) provides detailed guidance to be used in the evaluation and approval of simulators. This guidance addresses the required degree of fidelity between the simulator and the actual aircraft as well as the operational and performance characteristics. Some simulators (for example, those used for air carriers and commercial operators of large aircraft) require quarterly evaluations to ensure continuing fidelity. In summary, the FAA requires the use of aircraft-specific simulators (rather than generic simulators) and approves the required maneuvers and other practical training that is to be conducted on each simulator. Maneuvers and other practical training not approved for conduct on a simulator must be conducted in aircraft.

2.4.4 Evaluation of License Training Practices

2.4.4.1 Determination of RO/SRO Training Content and Instructional Settings

Section 2.2 described the generic RO and SRO job task analysis that was conducted. This analysis was not an end in itself, but rather served as a basis for the identification of necessary content areas of RO and SRO training programs. Once the content areas were defined, appropriate instructional settings (classroom, in-plant and simulator) were determined. This determination of necessary content areas and appropriate instructional settings formed the training program criteria against which license training programs were evaluated.

Figure 2.9 shows the methodology used in developing content area and training setting requirements. Step 1 used the behavior requirements from the RO and SRO job task analysis to determine appropriate training objective categories. This step was necessary

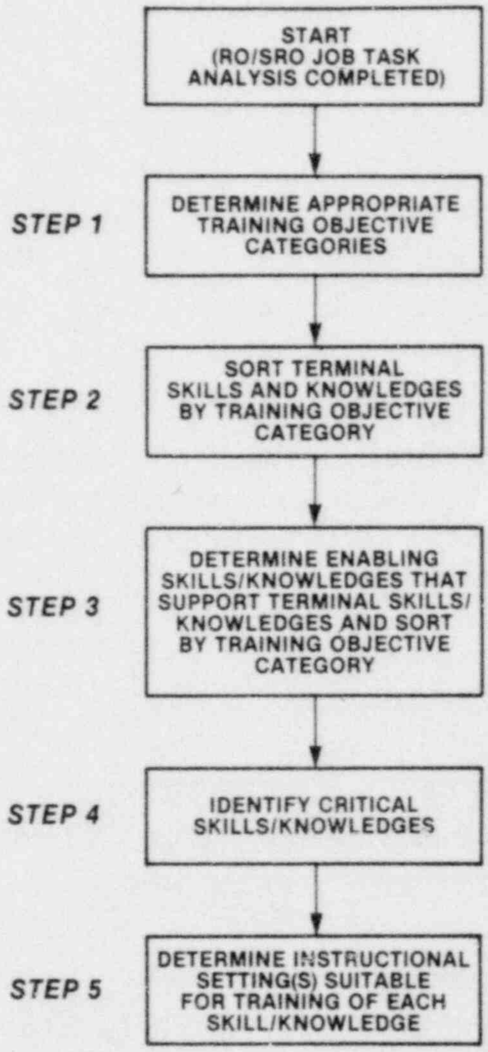

Figure 2.9 Methodology for Identification of Training Content and Instructional Setting

to provide a means to sort the skills and knowledges required for RO and SRO positions into functional areas. (This sort also aided in identification of appropriate instructional settings, as discussed later in this section.) The training objective categories selected are shown in Table 2.13.

Step 2 involved sorting all RO and SRO behaviors (terminal skills and knowledges) required (as identified through the job task analysis) into the appropriate training objective category. Terminal skills and knowledges are those behaviors the RO and SRO must possess to perform satisfactorily in the job. There are other enabling skills and knowledges that must be learned to enable the RO and SRO to learn the terminal skills and knowledges. For example, a terminal skill and knowledge for an SRO is to calculate radiation dose rates; enabling skills and knowledges are knowledge of health physics principles and mathematics. Table 2.14 is an example of a training objectives worksheet that provides RO and SRO skills and knowledges sorted under the category of "operation and functioning of equipment/systems." Note that many of these skills and knowledges were identified through more than one duty area as indicated in column 9. (These duty areas and their associated task areas and generic elements are identified in Table 2.15. This table includes a cross reference to the applicable section of the job task analysis of Appendix A.) The skills and knowledges are identified as either applying to "RO and SRO" or to "SRO only."

Once all terminal skills and knowledges had been categorized, Step 3 involved a review of all terminal skills and knowledges to identify associated enabling skills and knowledges. Once these were identified, they were also sorted by training objective category.

It is realized that the individual RO and SRO skills and knowledges are not all of equal importance in ensuring plant safety. Hence, it is desirable to identify which skills and knowledges are critical to plant safety and thus should receive greater training emphasis and have higher performance standards (Step 4, Figure 2.9). Inadequate operator performance under emergency conditions can have more severe consequences than similar performance in other duty areas. In addition, all normal and abnormal conditions, if degraded through operator error or equipment failures or both, would eventually become emergency conditions before affecting the health and safety of the public. Therefore, an operator's ability to perform all behaviors related to emergency conditions is central to ensuring plant and public safety. As a result, the required skills and knowledges

TABLE 2.13
CATEGORIES OF TRAINING OBJECTIVES

1. PRINCIPLES OR THEORIES
2. COMMUNICATION SKILLS
3. PRINCIPLES OF MANAGEMENT AND LEADERSHIP
4. APPLICATION OF CONCEPTS AND PRINCIPLES
5. REASONING AND PROBLEM-SOLVING ABILITIES
6. PROCEDURAL COMPLIANCE
7. EXECUTION OF TEAM SKILLS
8. OPERATION AND FUNCTIONING OF EQUIPMENT/SYSTEMS
9. MANUAL OR MANIPULATIVE OPERATIONS

TABLE 2.14
EXAMPLE TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: OPERATION AND FUNCTIONING OF EQUIPMENT/SYSTEMS)

SKILLS AND KNOWLEDGES REQUIRED (1)	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT? (6)	RO AND SRO (7)	SRO ONLY (8)	DUTY AREA (9)
	CLASS-ROOM (2)	IN-PLANT (3)	PLANT SPECIFIC SIMU-LATOR (4)	GENERIC SIMU-LATOR (5)				
1. Locate and read indicators and annunciators.		C	C		Yes	X		Emergencies
		C	C		No	X		Abnormal, normal, routine, maintenance and surveillance
2. Identify display meanings and relationships.		C	C	C	Yes	X		Emergencies
		C	C	C	No	X		Abnormal, normal, maintenance and surveillance
3. Locate controls.		C	C		Yes	X		Emergencies
		C	C		No	X		Abnormal, normal
4. Compare and verify indications.			C	C	Yes	X		Emergencies
			C	C	No	X		Abnormal, normal, routine
5. Locate and operate portable equipment (air samplers, radiation monitors, dosimeters, respirators, etc.).	P	C			Yes	X		Emergencies
6. Operate plant computer.		C	C		No	X		Routine
7. Observe actions of a trainee (on shift).		C			No	X		Routine
8. Identify and locate components in the plant.		C			No	X		Routine, maintenance and surveillance
9. Identify that components are properly isolated/positioned.	P	C			No	X		Maintenance and surveillance
10. Know all technical specifications limits and bases related to equipment/systems.	C				Yes	X		Emergencies
11. For all primary secondary, electrical and instrumentation systems, understand: o Purpose, o Functions, o Operation, o Interrelationships, o Limitations and o Design basis.	C				Yes	X		All duty areas

P - suitable for partial training of designated skill or knowledge; other setting required to ensure complete training
C - suitable for complete training of designated skill or knowledge

TABLE 2.15
RO/SRO TASK ANALYSIS SUMMARY

DUTY AREAS	TABLE NO.*	TASK AREAS AND GENERIC ELEMENTS
Emergencies	A.1	Carry Out Emergency Actions not Completely Addressed by Procedures A.1.1 Recognize conditions as indicative of an emergency condition A.1.2 Carry out appropriate actions
	A.2	Carry Out Procedures of Emergency Plan A.2.1 Recognize conditions requiring implementation of the emergency plan A.2.2 Carry out applicable actions of emergency plan
	A.3	Carry Out Emergency Operating Procedures A.3.1 Recognize plant conditions requiring implementation of emergency operating procedures A.3.2 Recognize automatic actions A.3.3 Carry out immediate operator actions A.3.4 Carry out subsequent operator actions
Abnormal, offnormal and alarm conditions	A.4	Carry Out Procedures for Abnormal, Offnormal or Alarm Conditions A.4.1 Recognize a condition requiring implementation of these procedures A.4.2 Know the automatic actions associated with these conditions and determine whether these actions have occurred A.4.3 Carry out immediate operator actions A.4.4 Carry out subsequent operator actions
Normal operations	A.5	Carry Out General Plant Operating Procedures A.5.1 Recognize which procedure(s) are applicable to the required evolution A.5.2 Establish initial conditions A.5.3 Carry out steps of procedure
Routine, non-specific shift activities	A.6	Carry Out Routine, Non-Specific Shift Activities A.6.1 Conduct shift turnovers A.6.2 Control routine liquid and gaseous radioactive waste releases A.6.3 Operate the plant computer A.6.4 Maintain logs and other routine written reports A.6.5 Complete Plant Incident Reports and other reports on abnormal occurrences A.6.6 Coordinate shift activities to ensure safe, efficient conduct A.6.7 Prepare and approve temporary instructions and changes to instructions on shift A.6.8 Provide training for plant personnel A.6.9 Comply with applicable station administrative directives A.6.10 Maintain proper core physics A.6.11 Conduct valve and switch lineup checks
Maintenance and surveillance	A.7	Control Shift Maintenance Activities A.7.1 Review proposed maintenance actions A.7.2 Establish plant conditions suitable for conduct of maintenance, and tag out appropriate components A.7.3 Approve proposed maintenance activities A.7.4 Upon completion of maintenance actions, review retest requirements A.7.5 Establish plant conditions suitable for conduct of retest A.7.6 Approve the conduct of retest A.7.7 Conduct or monitor retest including approval of results A.7.8 Return system or component to service
	A.8	Control/Conduct Surveillance Tests A.8.1 Review proposed surveillance tests A.8.2 Establish plant conditions suitable for conduct of surveillance and tag out components (if required) A.8.3 Approve conduct of surveillance tests A.8.4 Conduct or assist technicians in conduct of surveillance test A.8.5 Determine whether completed Surveillance Test results are satisfactory

*Table in Appendix A that addresses that task area.

associated with responding to emergencies were judged to be "critical requirements." In the example training objectives worksheet (Table 2.14), the skills and knowledges considered to be critical requirements are identified in column 6. A similar approach was used to identify all critical skills and knowledges in the remaining training objective categories (Table 2.13).

The final step of this procedure for identifying content areas and instructional settings (Step 5, Figure 2.9) involved the identification of appropriate instructional settings for the training of each skill and knowledge. Four instructional settings are currently being used by utilities (as evidenced from field survey trips) and were therefore selected as the alternatives for this step. These settings are indicated in columns 2 through 5 of the training objectives worksheet (Table 2.14) and are described below.

- o <u>Classroom</u>. Includes lectures, seminars, programmed instruction and self-study.

- o <u>In-Plant</u>. Includes the use of any plant equipment for training, including the control room, fixed equipment outside the control room and portable equipment located in operating spaces. "Walk-through" training and actual operation of some equipment would be permitted, as long as these operations would <u>not</u> impact on the plant's ability to maintain its electrical load condition. (This limitation is placed on this setting since it is consistent with the limitation placed on actual in-plant training at all reactor sites visited.)

- o <u>Plant-Specific Simulator</u>. Intended to be a control room simulator that provides high fidelity to the actual plant in terms of system responses, instrumentation, controls and equipment locations.

- o <u>Generic Simulator</u>. Intended to be a control room simulator that has system responses generally similar to those of the actual plant; instrumentation, controls and equipment locations need not be similar.

Final selection of instructional settings was based on several factors, including:

- o The nature of the learning objective
  - Motor or perceptual skill
  - Cognitive process (information retrieval, intellectual skill)
- o Equipment and material considerations
  - Fidelity requirements
  - Mobile or stationary equipment
  - Equipment availability
- o Task complexity
  - Suitability for self-instruction
  - Suitability of job performance aids (procedures)
  - Necessity of supervision
  - Necessity of formal instruction
- o Trainee input characteristics
  - Prerequisite skills and knowledges.

A setting marked with a "C" in Table 2.14 would be suitable for the complete training of the designated skill or knowledge. A setting marked with a "P" would only be suitable for partial training and would require another setting (so marked) to ensure complete training of the skill or knowledge.

The results of the application of this methodology for identifying training content and instructional settings (Figure 2.9) to all training objective categories (Table 2.13) are presented in Appendix C. These results constitute the training program criteria. The utility programs surveyed were evaluated individually against these criteria. The results of this evaluation are presented in Section 2.4.4.2.

2.4.4.2 Evaluation of Utility License Training Practices

For each of the required RO and SRO skills and knowledges listed on the training objectives worksheets (Appendix C) each utility replacement training program was reviewed for the training applied to the development of that skill or knowledge. This review included the non-licensed operator training programs as well as the RO and SRO programs and the simulator training programs used by each of the nine reactor sites visited. If more than half (five or more) of the reactor site programs reviewed lacked complete training of an individual skill or knowledge, this skill or knowledge was considered a deficient area. (A deficiency in a majority of the programs reviewed was considered to indicate a possible industry-wide deficiency.) For the cases where in-plant training was not sufficiently formal (no detailed task lists were used or specific requirements listed) to assure achieving a specific skill or knowledge, credit for training in that area was not given. A summary of the results of this analysis is presented in Table 2.16. Some key points of interest are the following:

- Of the 79 required RO and SRO skills and knowledges (Appendix C), 41 were deficient.

- Of the 41 deficient areas, 19 were "critical skills and knowledges" by the definition discussed in Section 2.4.4.1. The total number of critical skills and knowledges was 44.

- Approximately half of the deficient areas (21 of 41) were "SRO only" skills and knowledges and were not required for RO license candidates.

- Almost all (19 of 21) of these "SRO only" skills and knowledges required either simulator or in-plant instructional settings for complete accomplishment.

- Six of the nine training objective categories (Table 2.13 and Appendix C) were deficient in training in that more than half of the required skills and knowledges in each category were deficient. These six deficient training objective categories were:

  - Communications skills,
  - Principles of management and leadership,
  - Application of concepts and principles,
  - Reasoning and problem-solving abilities,
  - Execution of team skills and
  - Manual or manipulative operations.

TABLE 2.16
EVALUATION OF RO AND SRO TRAINING PROGRAMS

TRAINING OBJECTIVE CATEGORY	TOTAL NUMBER OF REQUIRED SKILLS AND KNOWLEDGES	NUMBER OF SKILLS AND KNOWLEDGES DEFICIENT IN TRAINING*	NUMBER OF RO AND SRO SKILLS AND KNOWLEDGES	NUMBER OF RO AND SRO SKILLS AND KNOWLEDGES DEFICIENT IN TRAINING*	NUMBER OF SRO ONLY SKILLS AND KNOWLEDGES	NUMBER OF SRO ONLY SKILLS AND KNOWLEDGES DEFICIENT IN TRAINING*	TOTAL NUMBER OF CRITICAL SKILLS AND KNOWLEDGES	NUMBER OF CRITICAL SKILLS AND KNOWLEDGES DEFICIENT IN TRAINING*
1. Principles or Theories	10	0	10	0	0	0	10	0
2. Communication Skills	15	10	10	5	5	5	5	4
3. Principles of Management and Leadership	5	5	3	3	2	2	1	1
4. Application of Concepts and Principles	9	6	4	2	5	4	2	0
5. Reasoning and Problem-Solving Abilities	13	7	8	3	5	4	8	5
6. Procedural Compliance	9	4	4	1	5	3	4	2
7. Execution of Team Skills	2	2	0	0	2	2	2	2
8. Operation and Functioning of Equipment/Systems	11	3	11	3	0	0	7	1
9. Manual or Manipulative Operations	5	4	5	4	0	0	5	4
TOTALS	79	41	55	21	24	20	40	19

*A skill or knowledge was considered deficient in training if more than half of the training programs reviewed lacked training in this area.

- The three training objective categories in which most or all replacement programs provided training were:
  - Principles or theories,
  - Procedural compliance and
  - Operation and functioning of equipment/systems.

A rather obvious conclusion from these analysis results is that existing RO and SRO replacement training programs generally do not provide training that is tailored to all of the responsibilities and performance standards of these individuals. When viewed collectively, the principal focus of these programs is in the knowledge areas relating to operating procedures, plant equipment and systems, and fundamental principles or theories.

The reason for this situation is apparent from interviews with utility training and operations supervisory personnel, training center supervisors and OLB personnel. Most utilities had never taken a formal approach to training program development; that is, development of a training program from a formal RO and SRO job task analysis. Instead, training programs developed from a necessity to respond to the NRC RO and SRO examination categories. The current industry standard for training, ANSI/ANS-3.1-1978, still lists only these seven RO and five SRO license examination subject areas as the principal content areas for license training programs. The supervisory personnel interviewed generally agreed that training programs in the past were designed to assist the RO and SRO candidates in preparing for the license examinations and not necessarily to provide these candidates with the required skills and knowledges to perform their jobs in a completely satisfactory manner.

Of the facilities visited, only one site had previously conducted a review of RO and SRO functional requirements and had made an attempt to factor these requirements into the training program. Although it is still in progress and has not yet addressed all RO and SRO duty and task areas, this review was the most extensive effort conducted in this area by any utility visited. This facility is identified as utility H in Figure 2.10. As shown in this figure, this facility provided far more complete training of required RO and SRO skills and knowledges than did any other utility.

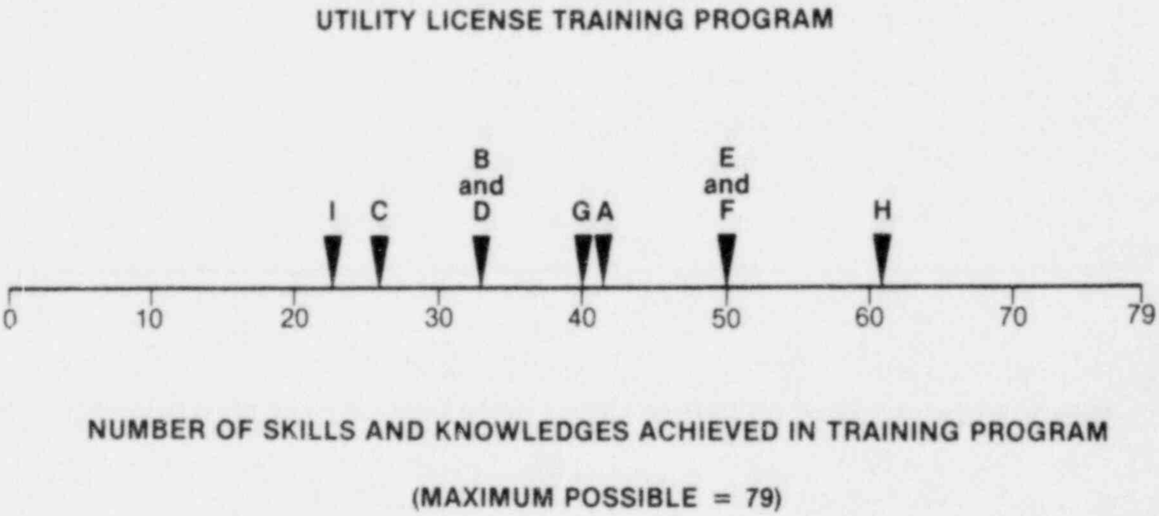

Figure 2.10 Number of Required RO and SRO Skills and Knowledges Achieved in Training Programs Reviewed

After identifying the skills and knowledges that were deficient in training, the training objectives worksheets of Appendix C and the applicable tables of Appendix A were used to identify the related RO and SRO job task areas. This approach identified the following task areas (see Table 2.15 or Appendix A for a complete list) as receiving generally inadequate emphasis in replacement training programs:

- o Carry out procedures of Emergency Plan,
- o Carry out routine, non-specific shift activities and
- o Control shift maintenance activities.

The cause of training deficiencies in these three task areas was a general inadequacy in in-plant training requirements. All utilities conducted classroom training on procedures relating to the execution of the Emergency Plan. Most utilities, however, failed to require any on-the-job training or participation in drills requiring use of the Emergency Plan during the in-plant portion of license training. As a result, license candidates were not assured of gaining the required skills and knowledges, in addition to procedural knowledge, before licensing, that was necessary for proper execution of the plan in their new positions (RO or SRO).

Table 2.15 and Appendix A list 11 task elements under the area titled, "Carry Out Routine, Non-specific Shift Activities." Task training conducted on shift through the use of task lists, qualification cards or practical factor lists was usually too informal or incomplete to assure adequate training on the majority of these task elements. Although it would not be unreasonable to assume that a trainee might become familiar with the skills and knowledges required for completion of these routine tasks, only a formal on-shift training program can assure that all trainees acquire all of these skills and knowledges.

In many cases, deficiences in training under the RO and SRO task area titled, "Control Shift Maintenance Activities" (Table 2.15 and Appendix A) are also due to the existence of informal, on-the-job training practices that omitted these task elements.

As indicated previously in Section 2.4.1.3, "SRO Hot License Training Practices," most nuclear power stations visited relied heavily on self-study as an instructional method for SRO training. Table 2.10 shows that on-shift training and simulator training at the

SRO level were used infrequently. As indicated previously in this section and Table 2.16, 21 of the 41 skills and knowledges judged to be deficient in training were identified as "SRO only" skills and knowledges (Appendix C). Amost all (19 of 21) of these "SRO only" skills and knowledges with training deficiencies require either simulator or in-plant instructional settings for complete training. The comparison of these analysis results with current practices for SRO license training indicates two general deficiencies in SRO replacement training practices: the lack of appropriately designed on-the-job training for SRO candidates and the need for simulator training at the SRO level to develop the skills and knowledges required of supervisory shift operating personnel (SCOs and SSs).

As indicated in Section 2.4.1.2, "RO Hot License Training Practices," and Section 2.4.2, "RO and SRO Cold License Training," a major portion of hot and cold license programs are devoted to classroom training. The classroom training time was mostly devoted to providing instruction in nuclear power plant fundamentals, plant systems and operating procedures. In most cases, less than 1 week was devoted to more advanced integrated plant topics such as:

- o Transient response,
- o Accident identification,
- o Accident analysis,
- o Decision and problem-solving techniques,
- o Objectives of emergency and abnormal operating procedures,
- o Emergency situations not covered by emergency procedures,
- o Techniques to mitigate accidents involving core damage and
- o Causes and effects of major plant incidents.

In some cases, most of these topics were not covered at all.

As indicated in Section 2.4.1.2 and 2.4.1.3, classroom training consisted of a mixture of lectures and self-study. Lesson and lecture plans used for this phase of training varied widely. At one end of the spectrum, no lesson plans were used and the hot license course was conducted from a list of topics. One facility used lecture script sheets that provided an outline of the lecture. These script sheets varied widely in format and content and, in some cases, were merely pages copied from a text. One utility was in the process of developing lesson plans and had none available for review. Most of the remaining reactor sites used lesson plans that contained the following basic sections:

- o List of references,
- o List of course materials,
- o Learning objectives of the lesson and
- o Detailed outline of the lesson.

All training centers visited used lesson plans which, as a minimum, contained these sections.

A common deficiency at most of the facilities visited that used lesson plans was the inadequate stating of the learning objectives to be attained after completion of a topic. A properly stated objective contains three parts: a specific behavior that can be observed and measured, the conditions under which the behavior is to be conducted and a standard for acceptable performance.

The stating of learning objectives is of paramount importance to learning. It reveals to the student what is or will be expected of him after instruction. This expectancy provides motivation to learn. The stating of objectives also puts into perspective the material that will be presented, thus increasing motivation.

Most utilities had no formal methods for evaluating the following aspects of their classroom training:

- o Effectiveness of courses,
- o Currency and accuracy of materials and
- o Adequacy of overall classroom curriculum for providing operators with the information related to the skills and knowledges required to meet their job requirements.

An evaluation of classroom training practices would not be complete without a discussion of the facilities used to conduct this training. Facilities at training centers were excellent, resulting in an environment highly conducive to learning. This type of training environment also existed at most of the reactor sites visited. A few of these sites, however, conducted training in an environment which indicated an apparent lack of higher management interest in training. Some of the deficiencies noted at these sites included:

- o Insufficient classroom space,
- o Absence of suitable areas for conducting self-study,
- o Temporary facilities (trailers) or
- o Absence of lavatory facilities.

The "Plant Operations" phase of license training (Table 2.7) is designed to provide the license candidate with the necessary practical training in nuclear power plant operations. As discussed in Section 2.4.1.2, this is accomplished through the use of on-the-job training and control room simulator training. Previously in this section, it was pointed out that on-shift training programs generally lacked the formality and completeness to assure adequate training in RO and SRO task areas and elements that did not lend themselves to instruction on control room simulators. A review of simulator training programs also pointed out inadequacies in these practices used to supplement the plant operations phase of training.

The minimum length of 1 week for RO and SRO replacement simulator training as specified in appendix F of NUREG-0094 is not adequate to provide the operator with required reactor controls training. The training objectives worksheets of Appendix C list 24 RO and SRO skills and knowledges that require a control room simulator to provide complete training (assuming that the actual plant cannot be manipulated for training). These worksheets and the applicable tables of Appendix A show that these skills and knowledges are required to ensure satisfactory operator performance in the following related task areas of the RO and SRO job task analysis:

- o Carry out emergency actions not completely addressed by procedures,
- o Carry out emergency operating procedures,
- o Carry out procedures for abnormal, offnormal or alarm conditions and
- o Carry out general plant operating procedures.

As pointed out in Section 2.4.1.2, "NRO Hot License Training Practices," during these 1-week simulator programs, the major emphasis is placed on accomplishing the reactor startup certification requirements of NUREG-0094. As a result, little time is available for conducting training in the RO and SRO task areas relating to emergency actions not completely addressed by procedures, emergency operating procedures, abnormal, offnormal or alarm conditions, or other general plant operating procedures. As shown in Table 2.10, significantly fewer malfunctions are performed in these 1-week programs as compared to longer programs.

Some of the longer simulator training programs included an operational examination that measured a candidate's ability to perform under abnormal, offnormal and casualty conditions; however, these programs did not provide any certification of a candidate's ability to perform in these situations, because none is required by current regulations or NRC guidance. In addition, no programs indicated that training under multiple casualty conditions was a required part of the curriculum, although interviews with simulator training staff personnel indicated that this is occasionally done for some training programs. No logical basis was established for selection of malfunction combinations other than the opinion of the simulator instructor.

As indicated in Appendix C, it was determined that 14 RO and SRO skills and knowledges required a plant-specific simulator to achieve complete training. This determination was based on an initial assumption that in-plant training requiring plant manipulations could not be conducted (see Section 2.4.4.1) and that the classification of the skill or knowledge required one or more of the following behavioral processes:

- o Perceptual,
- o Cognitive,
- o Communication and
- o Motor.

Perceptual processes that could not be taught in plant due to operational limitations would require a plant-specific simulator for complete training. These processes include timely identification of cues, symptoms and indications of meanings, searching for and receiving information, and location of components, indications and controls. Hence, a simulator that closely resembles the plant control room in terms of system responses, instrumentation, controls and equipment locations would be required.

Most cognitive processes can be taught completely on a generic simulator. Since these processes involve activities such as information processing, problem solving and decision making, there usually is no need for a close resemblance to the physical characteristics of the plant control room. A generic simulator with system responses, symptoms and control effects generally similar to those of the actual plant would be sufficient.

Communication processes would not require a simulator for complete training because in-plant training could be adequate and not require plant manipulation.

Motor processes would require a plant-specific simulator for complete training because these processes involve manipulation of controls while observing plant indications and responses. Training on motor processes would, therefore, require a close resemblance to the physical characteristics and controls of the actual control room.

Table 2.17 lists the 14 RO and SRO skills and knowledges and their related task areas (from Table 2.15 and Appendix A) that require a plant-specific simulator to achieve complete training. Alternative settings or combinations of settings were evaluated. Recommended alternative instructional setting(s) is(are) provided in Table 2.17. It is also indicated whether or not the alternative setting or combination of settings is suitable for achieving complete training of a skill or knowledge and the special requirements that are necessary.

The general problem areas that have been addressed thus far in this section are directed towards RO and SRO replacement training programs. Since cold license programs are similar in many respects to these hot programs, most of these problems can be considered applicable to both types of programs. The principal difference between hot and cold programs, as pointed out in Section 2.4.2, "RO and SRO Cold License Training," is the manner in which plant operations training is conducted. The key differences are the requirements for participation in an NRC-approved simulator training program (if needed to satisfy requirements for "extensive operating experience") and participation in practical work assignments in plant that include preoperational testing of plant systems and hot functional testing.

TABLE 2.17
RO AND SRO SKILL AND KNOWLEDGES REQUIRING PLANT-SPECIFIC SIMULATORS

SKILL OR KNOWLEDGE REQUIRED	CRITICAL SKILL OR KNOWLEDGE?	RELATED RO OR SRO TASK AREA (TABLE 2.15)	PROCESS	ALTERNATIVE INSTRUCTIONAL SETTING(S)*	ALTERNATIVE SETTING(S) SUITABLE FOR COMPLETE TRAINING?	REMARKS
1. Identify cues (one or more indicators) of an emergency condition.	Yes	A.3.1	Perceptual	GS + IP	Yes	Plant drills (walk-through) to augment generic simulator training would be necessary for complete training.
2. Determine that cues are not completely addressed by any single procedure.	Yes	A.1.1	Cognitive	GS (see remarks)	Yes	Generic simulator used must permit use of actual plant procedures to provide complete training.
3. Identify cues as indicative of an abnormal, offnormal or alarm condition.	No	A.4.1	Perceptual	GS + IP	Yes	Plant drills (walk-through) to augment generic simulator training would be necessary for complete training.
4. Diagnose abnormal condition/operation of plant components.	No	A.4.1	Cognitive	GS + IP	No	Generic simulator is satisfactory for diagnosing abnormal condition and operation of components generic to actual plant. In-plant walk-through drills will provide partial training relating to other components.
5. Coordinate actions of two or more procedures.	Yes	A.1.2	Cognitive	GS (see remarks)	Yes	Generic simulator used must permit use of actual plant procedures to provide complete training.
6. Given any applicable cues, determine required procedures of emergency operating procedures.	Yes	A.3.1	Cognitive	GS (see remarks)	Yes	Generic simulator used must permit use of actual plant procedures to provide complete training.

*GS - generic simulator
IP - in plant

TABLE 2.17 (continued)
RO AND SRO SKILLS AND KNOWLEDGES REQUIRING PLANT-SPECIFIC SIMULATORS

SKILL OR KNOWLEDGE REQUIRED	CRITICAL SKILL OR KNOWLEDGE?	RELATED RO OR SRO TASK AREA (TABLE 2.15)	PROCESS	ALTERNATIVE INSTRUCTIONAL SETTING(S)*	ALTERNATIVE SETTING(S) SUITABLE FOR COMPLETE TRAINING?	REMARKS
7. Determine steps or procedures for recovery from emergency.	Yes	A.3.4	Cognitive	GS (see remarks)	Yes	Generic simulator used must permit use of actual plant procedures to provide complete training.
8. Identify technical specification conditions for operation without reference to procedures.	Yes	A.1.2 A.3.3	Perceptual	GS	Yes	Generic simulator used must be sufficiently similar to the actual plant to permit use of plant technical specifications without modification.
	No	A.4.3	Perceptual	GS	Yes	
9. Carry out actions of abnormal, offnormal and alarm procedures in proper sequence through reference to procedures.	No	A.4.2 A.4.3 A.4.4	Perceptual Cognitive Communication Motor	GS (see remarks)	Yes	Generic simulator used must permit use of actual plant procedures to provide complete training.
10. Carry out all evolutions addressed by normal operating procedures in proper sequence through reference to procedures.	No	A.5.1 A.5.2 A.5.3	Perceptual Cognitive Communication Motor	GS (see remarks)	Yes	Generic simulator used must permit use of actual plant procedures to provide complete training.
11. Position components (valves, switches, etc) during emergencies, abnormal, offnormal and alarm conditions, and all evolutions addressed by normal operating procedures.	Yes	A.1.2 A.2.2 A.3.3 A.3.4	Motor	GS + IP	No	Plant drills (walk-through) would be necessary to augment generic simulator training; however, complete training would still not be achieved.
	No	A.4.3 A.4.4 A.5.2 A.5.3	Motor	GS + IP	No	Plant drills (walk-through) would be necessary to augment generic simulator training; however, complete training would still not be achieved.

*GS - generic simulator
IP - in plant

TABLE 2.17 (continued)
RO AND SRO SKILLS AND KNOWLEDGES REQUIRING PLANT-SPECIFIC SIMULATORS

SKILL OR KNOWLEDGE REQUIRED	CRITICAL SKILL OR KNOWLEDGE?	RELATED RO OR SRO TASK AREA (TABLE 2.15)	PROCESS	ALTERNATIVE INSTRUCTIONAL SETTING(S)*	ALTERNATIVE SETTING(S) SUITABLE FOR COMPLETE TRAINING?	REMARKS
12. Control system parameters (pressure, temperature, level, etc.) during emergencies, abnormal offnormal and alarm conditions and all evolutions addressed by normal operating procedures.	Yes	A.1.2 A.2.2 A.3.3 A.3.4	Motor	GS + IP	No	Plant drills (walk-through) would be necessary to augment generic simulator training; however, complete training would still not be achieved.
	No	A.4.3 A.4.4 A.5.2 A.5.3	Motor	GS + IP	No	Plant drills (walk-through) would be necessary to augment generic simulator training; however, complete training would still not be achieved.
13. Take manual (backup) control of normal automatic functions during emergencies, abnormal, offnormal and alarm conditions and all evolutions addressed by normal operating procedures.	Yes	A.1.2 A.2.2 A.3.3 A.3.4	Motor	GS + IP	No	Plant drills (walk-through) would be necessary to augment generic simulator training; however complete training would still not be achieved.
	No	A.4.3 A.4.4 A.5.2 A.5.3	Motor	GS + IP	No	Plant drills (walk-through) would be necessary to augment generic simulator training; however, complete training would still not be achieved.
14. Operate nonautomatic controls during emergencies, abnormal offnormal and alarm conditions, and all evolutions addressed by normal operating procedures.	Yes	A.1.2 A.2.2 A.3.3 A.3.4	Motor	GS + IP	No	Plant drills (walk-through) would be necessary to augment generic simulator training; however, complete training would still not be achieved.
	No	A.4.3 A.4.4 A.5.2 A.5.3	Motor	GS + IP	No	Plant drills (walk-through) would be necessary to augment generic simulator training; however, complete training would still not be achieved.

*GS - generic simulator
IP - in plant

As indicated in Section 2.4.2, these cold license simulator training programs are significantly longer than corresponding hot license simulator programs. A comparison of these hot and cold simulator programs showed that cold programs provided much more training time on general plant operating procedures (other than plant startup-related procedures), procedures for abnormal, offnormal or alarm conditions, and emergency operating procedures. Also, these longer programs provided more operational examinations and more sessions on unannounced casualties.

In many respects, the ability to manipulate plant systems during functional testing and the longer, more comprehensive simulator programs make the current cold programs more effective than hot programs in achieving the objectives of practical training. The principal disadvantage of current hot programs is that, with the exception of satisfying the five reactivity manipulation requirements of Appendix F of NUREG-0094, a license candidate might receive little opportunity to conduct significant plant operations, develop manual or manipulative skills, or participate in abnormal, offnormal or emergency operations if the reactor is "base loaded" during the in-plant training period. This situation, combined with a 1-week simulator course whose principal emphasis is reactor startup training, can result in a significant void in necessary plant operations training.

2.4.4.3 Evaluation of NRC License Training Practices

NRC practices relating to initial license training can be categorized into two functional areas:

- o Initial approval of cold and hot programs and
- o Auditing of training practices.

<u>Initial Approval of Cold and Hot Programs</u>. The initial approval of cold and hot license training programs, conducted as part of the PSAR and FSAR approval process, uses criteria which lack depth and clarity. As shown in Table 2.8, until recently, the criteria consisted of the requirements of Regulatory Guide 1.8, 10 CFR Part 55 and NUREG-0094. These requirements fail to provide any more depth for technical training than a listing of the 12 subject areas of the NRC written RO and SRO license

examinations. Similarly, on-the-job and simulator training requirements lack any significant detail. Depending on an applicant's previous experience, simulator training is not actually required for all license applicants.

Recent training requirements implemented by the NRR letter of March 28, 1980, provide an example of a better approach to promulgating training requirements. Although this letter did not correct the problems concerning depth of requirements listed above, it did, for the first time, provide <u>detailed</u> training requirements in two subject areas:

- o Heat transfer, fluid flow and thermodynamics and
- o Use of installed plant systems to control or mitigate an accident in which the core is severly damaged.

In specifying these new requirements, the NRR letter presented important training objectives, such as concepts to be covered, working knowledge required of trainees, calculations that trainees should be able to perform, design limits and bases of importance, and procedures and methods with which each trainee should be familiar. Although the necessity for inclusion of any particular item in the criteria for these two subject areas might be debated, the fact that this approach is an obvious departure from previous NRC practices is important.

The nonspecific nature and generality of industry standards, regulations and NRC guidance in the past has resulted in a program approval process which is highly subjective in nature and is based on an outline review by the OLB. Just as most utilities have never taken a formal analytical approach to determine the specific functional requirements, responsibilities and performance standards of ROs and SROs at their plants and then designed their training programs in light of these requirements, so has the NRC never taken a similar approach to define detailed training program approval criteria that are generic to all programs. As a result, utility programs can vary widely in program content and still meet minimum requirements. If, during the conduct of these programs, the candidate is taught how to pass the NRC examination rather than how to be a satisfactory operator, then successful completion of the licensing process will not provide the assurance that an operator is adequately trained.

Auditing Training Practices. Current NRC auditing practices are not adequate for ensuring effective initial training of licensed operators. Licensed operator replacement programs (hot), once approved in the FSAR, may be changed by the utility with no requirement for NRC approval of that change. No audits are required of licensed operator replacement programs and only one audit is conducted of the cold training program. This audit only verifies the documentation of the training program to be consistent with FSAR commitments and the existence of requirements in certain training areas (for example, on-the-job training). This cold program audit does not evaluate how well the training is conducted or the adequacy of utility requirements for different phases of training (for example, on-the-job training). Since there are no audits required for hot license training programs, the conduct of this program could be totally unsatisfactory for achieving training objectives. OLB or IE might not ever be aware of this problem, because review of a license candidate's application would show accomplishment of the program outline. Although on-site IE representatives are now required to attend two lectures (either initial training or requalification training) to verify that training objectives of the lecture are met, this practice in no means constitutes a comprehensive review of the effectiveness and conduct of license training programs.

The informal OLB reviews of training center practices have no formal criteria. No reports are filed that would document that a given training center is conducting effective training or that would indicate that license training programs, originally approved when a simulator became operational, are still adequate years later.

The current practice of exercising split responsibility between OLB and IE for operator training casts doubt on the effectiveness of this practice. No single organization within the NRC is fully responsible for licensed operator initial or requalification training. OLB is responsible for utility and training center program approval, training center program audits and audits of utility requalification examinations. IE is responsible for cold program audits and periodic audits of requalification programs (less the annual requalification examination). No organization is responsible for auditing licensed operator replacement programs. Given that hot and cold program approval criteria are general and require a great deal of subjectivity in the approval process, a separate organization responsible for monitoring practices following this approval is not likely to apply the same rationale in evaluating acceptable practices.

To help evaluate the effectiveness of this practice of dual responsibility, all utility training supervisors were asked to characterize the auditing practices of IE and the OLB. All these training supervisors characterized IE audits as nothing more than document reviews to check practices against commitments, providing little if any constructive criticism of utility training practices. Although OLB utility audits include only the requalification examinations, all training supervisors felt that the audits conducted by OLB were much more constructive and provided useful feedback.

In summary, the NRC exercises little control over training conducted to prepare personnel for licensed operator positions. The existing situation of division of responsibility between organizations within the NRC results in having no single organization responsible for the adequacy of license training. Criteria for approval of license training programs are largely subjective and are not based on any in-depth, systematic determination of training program requirements.

2.4.5 License Training Conclusions and Recommendations

Since the accident at Three Mile Island, a number of analyses of the accident (2, 3, 4, 5) have indicated the impact of deficiencies in operator license training programs on the course of the accident. As a result, the industry and the NRC have been responding to an increased awareness of the importance of operator training on plant and public safety.

In the review of license training programs and the interviewing of numerous operations and training staff personnel, a broad spectrum of practices was identified. Some organizations have created impressive, comprehensive programs that exceed any current existing requirements and reflect an obvious corporate management commitment to operator license training. At the other end of the spectrum are organizations that are apparently interested only in satisfying minimum requirements. It is with consideration of all these utility and training center practices and NRC practices that the following conclusions and recommendations relating to operator license training are presented.

2.4.5.1 Conclusions

1. Initial license training programs used by utilities to train RO and SRO candidates are undergoing a period of revision and change. Many programs are being lengthened and made more formal and comprehensive in nature. Training supervisors responsible for these programs feel a need for more definitive guidance for their revision and more specific requirements for their content. Most of these individuals feel a need for NRC leadership in helping define these requirements more clearly. Individuals responsible for license training are professional, hard-working and genuinely interested in providing quality training services. As a result of a general shortage in the industry of personnel with operations experience, most utility training departments are understaffed in light of their training obligations. Therefore, training assistance from outside sources (for example, training service contractors) is frequently used. Most contracted training deals with non-plant-specific subject areas, such as nuclear power plant fundamentals.

2. License training programs have been designed around the NRC license examination categories and not from any systematic approach to defining the required functions, responsibilities and performance standards of RO and SRO licensed operators. Accordingly, the principal focus of current programs is in the knowledge areas relating to operating procedures, plant equipment and systems and fundamental principles or theories. As a result, these training programs are somewhat limited in their ability to provide complete training of required skills and knowledges in the following training objective categories:

   - o Communication skills,
   - o Principles of management and leadership,
   - o Application of concepts and principles,
   - o Reasoning and problem-solving abilities,
   - o Execution of team skills and
   - o Manual or manipulative operations.

3. Utilities and training centers place a commendable effort into classroom training in the subject areas of nuclear power plant fundamentals, plant systems and plant operating procedures. In proportion to this effort, however, classroom training generally lacks necessary emphasis in more advanced integrated plant topics such as:

- o Transient response,
- o Accident identification,
- o Accident analysis,
- o Decision-making and problem-solving techniques,
- o Objectives of emergency and abnormal operating procedures
- o Emergency situations not covered by emergency procedures and
- o Techniques to mitigate accidents involving core damage.

4. Although the current 3-month requirement for RO and SRO on-the-job training is considered adequate, current on-shift training practices generally lack the formality and completeness to assure adequate training in RO and SRO job performance areas that do not lend themselves to instruction on control room simulators. A well-designed, comprehensive program of on-the-job training is even more important for utilities that do not use a plant-specific simulator. A systematic approach of first defining practical training objectives and then designing on-the-job training and simulator training programs to accomplish these practical training objectives (considering the limitations of each method) is not followed.

5. SRO training programs that prepare RO licensed individuals for SRO licensed positions are generally given inadequate emphasis. Most training is self-study with little emphasis applied to developing supervisory skills. Based on the determination of SRO training content from the job task analysis conducted in this study, it is concluded that SRO candidates need a structured program of control room simulator training to develop SRO skills and knowledges. This type of simulator training, however, is seldom employed in current SRO license training programs.

6. Present control room simulators are effective tools for conducting practical training. With typical constraints on the use of actual nuclear power plants for training, a control room simulator is, in fact, the only method currently available for conducting effective training in many of the required RO and SRO skills and knowledges identified in analyses conducted during this study.

Further analysis indicates that some skills and knowledges that could be completely taught on plant-specific simulators also have alternative instructional settings suitable for complete training. These alternative settings would include generic simulators (with certain requirements for similarity to the actual plant) in combination (in some cases) with plant "walk-through" drills.

For some required skills and knowledges, however, analysis indicates that a plant-specific simulator would be necessary to achieve complete training. These skills and knowledges include:

- o Diagnosing abnormal conditions or operations of actual plant components that are not simulated in the generic simulator used and

- o Using motor processes during emergencies, abnormal, offnormal and alarm conditions, and all evolutions addressed by normal operating procedures. These processes include:
  - Positioning components (valves, switches, etc.),
  - Controlling system parameters (pressure, temperature, level, etc.),
  - Using manual (backup) control of normal automatic functions and
  - Operating controls that are not automatic.

7. More emphasis in simulator training should be placed in training to a predetermined level of proficiency rather than reliance on a specified number of hours in the simulator. Simulator training programs are generally too short to permit training in all the required skills and knowledges which, by necessity, must be taught during simulator training. No objective determination is made of material to be covered and priorities to be assigned. Limitations on simulator time (sometimes caused by utilities only attempting to satisfy minimum NRC requirements for simulator training and other times caused by the short supply of simulators) can result in training deficiencies such as the following:

   - o Insufficient experience in dealing with multiple casualties,
   - o Inadequate training in carrying out emergency actions not completely addressed by procedures,

- o Insufficient experience in carrying out all the plant's emergency operating procedures,
- o Failure to practice the major general plant operating procedures and procedures for key abnormal, offnormal or alarm conditions and
- o Inadequate development of diagnostic skills by exposure to unannounced casualties.

Although properly conducting a reactor startup is only one of a large number of operational requirements for the RO, it is the only one for which an operational examination is required.

8. The NRC does not use a strong management approach in regulating RO and SRO license training. Utilities develop training programs with little definitive guidance or direction. These programs are approved by the NRC in a process that uses subjective criteria with few specific requirements. This combination of utility and NRC practices has resulted in a broad spectrum of training programs with little standardization and varying degrees of comprehensiveness and effectiveness. Only cold license programs are addressed in regulations; hot license programs are not addressed. No NRC requirements exist for the use of simulators during training, and simulator training is not required in all programs. Just as the industry has never conducted an in-depth, systematic determination of training program requirements, so has the NRC never conducted a similar determination of training program acceptance criteria.

9. No single organization within the NRC is responsible for the adequacy of license training. The current situation of the existence of highly subjective requirements with little detail in combination with the split responsibility between the OLB and IE organizations casts doubt as to the effectiveness of this arrangement. The OLB approves hot and cold training programs based on the review of an outline. No requirements exist for auditing licensed operator replacement (hot) training programs. Cold license training programs are audited by IE on a one-time-only basis. There are no requirements that this audit evaluate the quality or depth of training received. The OLB reviews training center practices; however, there are no required periodic intervals for this review and no evaluative criteria. Following this review, no reports are filed that might record problems for subsequent followup.

2.4.5.2 Recommendations

1. Utilities should be required to conduct a formal assessment of RO and SRO license training programs. Programs should be revised accordingly to ensure that they provide training to license candidates in all of the terminal and enabling skills and knowledges required for the performance of their jobs. The recommended way to conduct this assessment is through development of a training program from a plant-specific job task analysis.

   The generic job task analysis approach (for example, the approach used in this study) is appropriate for <u>evaluation</u> of RO and SRO training programs and development of <u>content</u> <u>areas</u> of RO and SRO training programs; however, this generic approach would not be suitable as the <u>sole</u> basis for the development of a training program for a particular plant because the generic approach does not provide the information necessary to develop job performance measures. For example, the time standard for completion of each task in a job task analysis is not identified at the generic level.

   It is noted that this conclusion is in conflict with item B.2 of Task I.A.2 of NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," (16) which states that such a job task analysis is "amenable to a generic approach" and that "INPO could perform a task analysis for these positions used throughout the industry." On the other hand, a generic job task analysis could serve as the basis for implementation of plant-specific job task analyses. INPO or other organizations throughout the industry could provide guidance on the methodology for conducting the plant-specific analysis and development of training programs from the analysis results.

   In conclusion, two alternatives appear suitable for conducting this assessment of license training programs:

   a. Each utility conduct its own job task analysis and training program development tailored to its specific plants using guidance provided by INPO (where necessary) or

b. INPO (or other organizations such as reactor plant vendors) conduct generic job task analyses suitable for expansion to the plant-specific level by utilities. Similarly, training program content areas identified from the generic analysis could be used for development of facility training programs.

2. Utilities should be required to significantly upgrade and formalize on-the-job training requirements. A program with detailed requirements that uses a "task list," "qualification card" or "practical factor" approach should be required. The emphasis in this phase of training should be in assuring that the terminal skills and knowledges that license candidates must learn in plant are individually accounted for and evaluated by appropriate licensed operators. RO and SRO on-the-job training requirements should be separately delineated.

   The approach used by the U.S. Navy is considered adequate for adaptation to commercial plants. The completion of a plant-specific job task analysis will identify functional requirements for RO and SRO licensed personnel. Those requirements suitable for control room simulator training should be factored into that phase of the training program in a formal manner. Requirements not suitable for simulator training would be included in the list of on-the-job requirements. Based on the type of control room simulator used by the facility (generic or plant-specific), the necessity for certain simulated plant operations, including drills, to provide complete training of all functional requirements would be determined.

3. Utilities should be required to upgrade their SRO license training programs to provide more emphasis on SRO functional requirements, leadership and management, and development of supervisory skills. On-the-job training requirements should be detailed and formalized (see Recommendation 2). SRO license training programs should include control room simulator training that emphasizes casualties and development of supervisory skills.

   As a minimum, formal training in the following supervisory skills listed in the December 1979 proposed revision of ANSI/ANS-3.1 should be required:

- o Leadership,
- o Interpersonnel communication,
- o Command responsibilities and limits,
- o Motivation of personnel,
- o Problem analysis,
- o Decisional analysis and
- o Administration requirements for the particular supervisory position.

Two alternatives appear suitable for conducting the required simulator training:

a. A group of SRO candidates could be sent to receive their "SRO simulator package" as part of their SRO license training course or

b. The "SRO simulator package" could be included in the last requalification simulator training period before the anticipated licensing of an SRO candidate. In this case, it might prove desirable to establish a maximum allowable time requirement between receipt of SRO simulator training and completion of the SRO license training program to ensure continuity of the entire SRO training program.

4. Certain improvements in classroom training should be made. Utilities should be required to provide more emphasis in classroom training on advanced integrated plant topics such as:

- o Transient response,
- o Accident identification,
- o Accident analysis,
- o Decision and problem-solving techniques,
- o Objectives of emergency and abnormal operating procedures,
- o Emergency situations not covered by emergency procedures,
- o Techniques to mitigate accidents involving core damage and
- o Causes and effects of major plant incidents.

Classroom training techniques should be reviewed by utilities for adequate formality to assure satisfactory training of all operators. This evaluation should be conducted by higher level plant management outside the training department (for example, the Plant Operations Review Committee) and should include a determination of the adequacy of lesson plans and facilities. Programs should be developed for periodic evaluation of the effectiveness of training provided, including:

- o Effectiveness of course conduct,
- o Currency and accuracy of materials and
- o Adequacy of overall classroom curriculum for providing operators with the information related to the skills and knowledges required to meet their job requirements.

Using licensed operators to assist in this evaluation is considered advantageous since it would permit recent operating experience to be factored into this process.

5. The NRC should require control room simulator training for all hot and cold license training programs. Although establishment of minimum time requirements for simulator training is both desirable and necessary, emphasis should be placed on training to a predetermined level of proficiency in the simulator, rather than reliance on a specified number of hours in the simulator. Simulator certification requirements should be expanded to include performance of:

   - o General plant operations in addition to reactor startup,
   - o Emergency operating procedures,
   - o Procedures for abnormal, offnormal or alarm conditions,
   - o Emergency actions not completely addressed by procedures, including multiple casualties and
   - o Unannounced casualties for the purpose of evaluating diagnostic skills.

   The NRC should establish minimum time requirements for simulator programs based on consideration of the training objectives required to be accomplished during simulator training and the operational experience of candidates. Training objectives would be deduced from a generic job task analysis such as the one conducted in this study. Categories of prior operating experience such as those used for approval of current cold license programs could be used. Based on a comparison of required training objectives and prior operating experience, estimated minimum time periods for simulator instruction necessary to accomplish training objectives for each category of experience could be developed. The current minimum length of 1 week for hot license simulator training should definitely be increased.

6. The NRC should establish requirements for the use of simulators in training control room operators. A long-range goal should be adopted to require that all plants conduct training on a simulator specific to the plant.

   Establishing requirements for the use of simulators in training could be implemented by NRC approval of an appropriate industry standard (for example, ANSI/ANS-3.5-1979). All simulators used to train control room operators should be required to conform to these requirements, regardless of the age of the simulators. Requirements should be established for maintaining the simulator current with changes to the reference plant.

   For facilities with no plant-specific simulator currently available, a date should be established for requiring one to be in operation. In the interim, each of these facilities should submit to the NRC for approval a plan for providing the training in RO and SRO skills and knowledges that cannot be acquired by the use of a generic simulator. Expectations are that this plan would require more in-plant training, including drills for license candidates. Facilities that use generic simulators should provide a licensed operator during this training to evaluate trainees' performance and to identify to trainees differences between the simulator responses and controls and those of their plant.

   New facilities should be required to conduct cold license training on a plant-specific simulator.

   Three alternatives appear feasible for the construction of these simulators:

a. Each utility could have a plant-specific simulator constructed at its site and operated by on-site training department personnel,

b. Larger utilities could establish central training centers with all their simulators at this central location operated by training center personnel or

c. Some utilities could enter into a cooperative effort and construct a regional training center which would include plant-specific simulators for the member utilities. These regional training centers would maintain a permanent training staff.

Each alternative appears to be equally satisfactory for the purpose of providing effective plant-specific practical training as long as the minimum standards for use of these simulators are maintained in each approach. Utilities selecting Alternative b might find standardization of their control room designs to be desirable. For some special cases, a waiver of this plant-specific simulator requirement might be appropriate. Such waivers must be based on adequate assurances that all required RO and SRO skills and knowledges can be taught completely by an alternative technique.

7. The NRC should develop license training program approval criteria based on a determination of training content requirements derived from RO and SRO functional requirements. A generic job task analysis would be the basis for a systematic approach to development of these criteria. These criteria should include a comprehensive listing of detailed items such as:

 - Subjects and concepts required to be covered,
 - Working knowledge required of trainees,
 - Calculations that a trainee should be required to perform,
 - Procedures and methods with which each candidate should be familiar,
 - Basic on-the-job training requirements that a candidate must perform and
 - Specific evolutions and practical training required during simulator instruction.

The NRC could conduct the complete development of these criteria, including the generic RO and SRO job task analyses. An alternative would be to use generic task analyses developed by INPO or other suitable organizations as a basis or approve INPO recommendations for these criteria. The point of emphasis in this recommendation is that these criteria should be significantly more detailed than current criteria and be based on a comprehensive assessment of RO and SRO performance requirements, including required terminal and enabling skills and knowledges.

8. The NRC should assign all operator training responsibilities to one organization within the NRC. This organization would conduct all functions, such as operator training program approvals, audits and evaluations of practices and licensing of operators, that are currently divided between OLB and IE. It is recommended that this organization be the OLB because the personnel in this organization are the recognized authorities within the NRC on industry operator training and requalification practices. (Chapter 4 provides further recommendations concerning organization of the NRC operator licensing program.)

9. The NRC should upgrade its audit programs to include hot as well as cold license training. The emphasis of these audits should be expanded from their current verification that utility commitments to conduct training have been met. Emphasis should also be placed on adequacy of facility internal requirements for training and actual conduct of training. Providing feedback to facilities on methods for improving their training practices should be a goal of this program. These audits should be formal and include training centers. Establishment of a formal accreditation program with periodic reviews could achieve several of the objectives intended by this recommendation.

10. The NRC should adopt a practice similar to that of the FAA in approving control room simulator training programs. Utilities should be required to submit to the NRC a list of detailed training objectives and specific practical training intended to be accomplished during simulator training. The NRC should evaluate the proposed simulator to be used in the program for its capability of providing complete training relative to the actual facility of the utility. For deficient areas noted,

utilities should be required to indicate how they intend to supplement the simulator training with in-plant training.

11. The NRC should require that hot and cold license programs submitted for review in the FSAR be developed from a fully detailed, systematic approach. Requirements for submittal of program descriptions in the SRP should be much more detailed than existing descriptions and include additional areas such as:

    - Statement of purpose,
    - Detailed list of training program objectives,
    - Detailed list of RO and SRO terminal and enabling skills and knowledges that the program is designed to achieve,
    - Certification requirements that a license candidate must achieve to complete the program,
    - Areas of emphasis during on-the-job training and time devoted to each,
    - Techniques for formal administration of on-the-job training,
    - Descriptions of all normal, abnormal and emergency conditions in which practical training is to be performed,
    - Detailed outline of each subject to be taught in classroom training, including concepts taught, working knowledge requirements, calculations required, and other detailed requirements for trainees, and
    - Description of practical training goals and a detailed discussion of how the combination of on-the-job and simulator training will accomplish each goal.

    If the NRC is to adopt more detailed criteria for approval of these programs, then more comprehensive descriptions of the content of these programs will be necessary to permit complete evaluation.

12. The NRC should adopt a strong management approach to license training, similar to that employed by the FAA and the U.S. Navy. The NRC should become more involved in the content and conduct of training by:

- Providing detailed guidance for training program construction,
- Accrediting or certifying training departments or approving INPO accreditation,
- Establishing well-defined instructor qualifications,
- Conducting approvals of training programs based on more detailed justification that all RO and SRO skills and knowledges will be achieved,
- Evaluating periodically the quality of instruction and conduct of the program,
- Approving simulators for use in a program based on detailed criteria that evaluate the overall combination of on-the-job and simulator training against an established list of practical training requirements,
- Approving any changes to training programs other than those necessary to keep the program current with plant design and
- Using the efforts of INPO in generating improvements in existing programs.

2.5 SELECTION, SCREENING AND CERTIFICATION OF REACTOR OPERATOR AND SENIOR OPERATOR CANDIDATES

2.5.1 Selection of RO Candidates

Selection of candidates to participate in reactor operator license training is a process which occurs partially during initial selection for hiring (for example, meeting minimum education requirements) and partially during selection for RO license training (for example, meeting minimum experience requirements). Since all of the applicable industry standards and regulatory requirements must be satisfied prior to RO licensing, they will be addressed collectively in this section. Requirements and practices applicable to utility certification of medical fitness of license candidates will be addressed in Section 2.5.3, "Certification of RO Candidates."

2.5.1.1 Selection Requirements

Industry Standards. The "American National Standard for Selection and Training of Nuclear Power Plant Personnel," ANSI/ANS-3.1-1978, provides the following criteria for selection of operators to be licensed by the NRC:

> Education. High school diploma or equivalent.
>
> Experience. Two years' power plant experience of which one year is nuclear power plant experience. Six months of the nuclear experience shall be at the plant for which the operator seeks a license or on a similar unit. Six months' experience credit may be granted if related technical training or equivalent experience warrant.
>
> Physical. High degree of manual dexterity.
>
> Personal. High degree of mature judgment.

This standard is the revision of the initial American National Standard N18.1-1971. A draft proposed revision to ANSI/ANS-3.1-1978 published in December 1979 is currently undergoing review. This proposed revision would increase operator experience requirements (3 years of power plant experience of w'ich 1 year is at the nuclear power plant for which the operator will hold a license) and require 6 months of duties as a non-licensed operator.

Federal Regulations and NRC Guidance. The only regulatory document currently in effect that addresses the issue of initial selection of personnel is Regulatory Guide 1.8, "Personnel Selection and Training." This guide accepts the criteria for selection of personnel contained in ANSI N18.1-1971, which was revised in 1978 by ANSI/ANS-3.1-1978.

A proposed revision to Regulatory Guide 1.8 was published in February 1979 by the NRC Office of Standards Development. This proposed revision endorses ANSI/ANS-3.1-1978 requirements for minimum qualifications of licensed operators, although it contains several modifications to ANSI/ANS-3.1-1978 requirements for the selection and training of other nuclear power plant personnel.

In May 1980, the NRC Office of Standards Development published a proposed revision to 10 CFR Part 55, "Operators' Licenses." This proposed revision would require that a license applicant hold a high school diploma or General Education Development Program Certificate. In addition, it specifies experience requirements that are the same as those listed in the December 1979 proposed revision to ANSI/ANS-3.1-1978 - namely:

- Three years of power plant experience
- One year of experience at the facility for which the operator is seeking a license and
- Six months of duties as a non-licensed operator.

Under this revision, waivers may be requested for the requirements for the 1 year of experience at the facility for which a license is sought or the 6 months of non-licensed operator experience when it is impractical to meet these requirements.

2.5.1.2 Utility Selection Practices

Selection of candidates for RO license training was a two-step process in all cases. Some utility selection criteria were satisfied during the initial selection for employment. The remainder were satisfied when the operator was selected to enter the license training program. The aggregate criteria are addressed in this section.

Selection practices varied among utilities with respect to the number and types of techniques. Combinations of the following methods were used:

- o Medical examinations,
- o Interviews,
- o Background checks,
- o Aptitude and achievement tests,
- o Psychological screening,
- o Personality inventories,
- o Technical screening examinations,
- o Operator performance rankings and
- o Operator seniority rankings.

Table 2.18 on page 2-109 indicates the various combinations of selection methods used at the reactor sites visited. This fold-out table is provided as a reference for use in the following discussion of these methods.

Medical Examinations and Interviews. Certain selection practices were standard. All utilities surveyed require the passing of a physical examination as a prerequisite to employment. An additional medical examination was given as part of the utility certification of an operator for the license examination (Section 2.5.3). All utilities conducted interviews as part of the initial selection process. These interviews were conducted by a personnel administrator and usually the operations supervisor or assistant operations supervisor. These interviews assessed, to some extent, the individual's suitability for the job, including background information, interests and expectations. All utilities conducted some form of psychological screening, either through an interview with a psychiatrist or in conjuction with a self-report inventory (psychological test).

Background Checks. The collection and investigation of background information varied to some extent among the utilities visited. In all cases, an application form with basic background information was required. Several utilities used personnel investigative services such as Equifacts or Fidel-A-Facts to substantiate background information including police, court and credit records.

Aptitude Tests. Aptitude testing practices varied from none at all to the administration of lengthy batteries. In general, utilities that relied on individuals with prior nuclear experience (most notably Navy nuclear experience), either did not use aptitude tests or used singular instruments, such as the General Physics Corporation Basic Mathematics and Science Test (BMST) (29). The BMST is primarily a 90-question achievement test that measures an individual's knowledge and exposure to mathematics (including algebra, trigonometry and geometry) and the physical sciences (physics and chemistry). Other utilities used various combinations of the following tests:

- o Differential Aptitude Test (DAT)
- o General Aptitude Test Battery (GATB)
- o Personnel Tests for Industry (PTI)
- o Minnesota Clerical Test (MCT).

The Differential Aptitude Test (DAT) (Psychological Corporation) (30) yields eight scores in such areas as verbal reasoning, numerical ability, mechanical and abstract reasoning and clerical speed. The DAT was developed originally for use in counseling at the secondary school level. A significant amount of validity information is available for various purposes. The majority of this information concerns predictive validity in terms of high school achievement, both for academic and vocational concentrations.

Another multiple aptitude test battery used is the General Aptitude Test Battery (GATB) (U.S. Employment Service) (31). The battery measures 9 aptitudes with 12 tests. The aptitudes measured include general learning ability, verbal and numerical aptitude, form perception, and finger and manual dexterity. The entire battery requires approximately 2-1/2 hours. The U.S. Employment Service has constructed and developed much normative data and research for various occupational groups.

As a contrast to these multiple aptitude test batteries, some utilities utilized the Personnel Tests for Industry (PTI) (Psychological Corporation) (31). The PTI consists of a 5-minute verbal test and a 20-minute numerical test. The test appears to be dependable, but may be more suitable for screening personnel for low-level jobs (for example, janitors, messengers, etc.).

In combination with other tests, the Minnesota Clerical Test (MCT) (Psychological Corporation) (31) was also used. This test consists of two subtests, number comparison and name comparison. Both are rather homogeneous in their measurement of speed and accuracy in perceiving details.

Procedures for validating these tests varied. Several utilities relied on the test developer to validate the tests used while others had extensive research programs in progress. The validation of aptitude tests, for the purpose of selection, is necessary to meet equal employment opportunity legislation (Chapter 60 "Office of Federal Contract Compliance, Equal Employment Opportunity Commission").

Psychological Screening. All utilites conducted psychological screening interviews. Those utilities that used psychological inventories used them as preliminary screening tools with in-depth followup interviews. The Minnesota Multiphasic Personality Inventory (MMPI) (Pyschological Corporation) (32) was the most widely used instrument for this purpose. The MMPI consists of 550 items yielding scores on 10 clinical scales. The scales include such dysfunctions as hypochondria, depression, hysteria, paranoia, schizophrenia and others. The MMPI is the most researched self-report inventory available and has been used for all types of purposes and settings. Computerized scoring and profile information are now available.

Another instrument which was used is the Sixteen Personality Factor Questionnaire (16 PF) (Institute for Personality and Ability Testing) (32). The 16 PF consists of 187 items and requires approximately 1 hour to complete. This test is not as clinically oriented as the MMPI and provides measures on such traits as reserved versus outgoing, affected by feelings versus emotionally stable, humble versus assertive, relaxed versus tense, etc. Utilities that used the 16 PF followed up individuals who showed signs of undesirable traits with either the MMPI or a psychological interview or both.

An instrument which was being used similarly is the Thurstone Temperament Schedule (TTS) (Science Research Associates) (33). This instrument is geared toward differentiating between groups of normal (well-adjusted) people. The test is composed of 140 items covering 7 scales such as sociable, reflective, stable, dominant, etc. As with the 16 PF, utilities prescreened individuals, and those who scored positively or an undesirable trait were administered the MMPI or referred for an in-depth interview.

In a sightly different approach, one utility used the Guilford-Zimmerman Temperament Survey (GZTS) (Sheridan Psychological Services) (31) as a supplement to the MMPI. The GZTS is a 300-item test measuring such traits as general activity, restraint, emotional stability, etc. As with other inventories used, individuals scoring high on an undesirable trait were referred to in-depth psychological interviews.

Personality Inventories. Personality inventories for assessing the congruence between personal interests and job requirements were used to varying degrees to improve the predictability of performance during training and on the job. Usage varied from none at all (interviews were relied upon solely) to several of the personality inventories already discussed. Although the scales of the MMPI are oriented toward differential diagnosis of pathological dysfunction, the test has been used for predictive purposes in many "normal" settings and is currently used by several utilities. The TTS and 16 PF were also used for this purpose.

Auxiliary Operator Knowledge, Performance and Seniority. In addition to the methods discussed previously, all utilities used, to widely varying degrees, measures of auxiliary operator knowledge, performance and seniority as criteria for selection for license training. Factors considered in judging AO knowledge and performance included various combinations of the following:

- o Performance on a screening examination,
- o Rate of qualification progress as an AO,
- o AO performance evaluations and
- o Training performance records.

Most utilities considered seniority when selecting RO candidates. Some considered it on an equal basis with AO knowledge and performance indicators. At the other end of the spectrum, based on some labor-management agreements, seniority was the sole criterion used for selection.

2.5.1.3 NRC Practices

NRC practices relating to initial selection of operating staff personnel consist of an initial review of utility personnel qualifications requirements specified in Safety Analysis Reports (SARs) and periodic reviews of utility Quality Assurance (QA) programs.

Section 13.1.3, "Qualifications of Nuclear Plant Personnel," of the NRC Standard Review Plan (17) specifies the acceptance criterion for SAR review of qualifications of utility plant personnel. The acceptance criterion is conformance to the requirements of Regulatory Guide 1.8.

Following approval of the Final Safety Analysis Report (FSAR), the QA program of the operating facility is reviewed by the Office of Inspection and Enforcement (IE) on a periodic basis. Every 3 years, as a part of these reviews, IE must verify by review of established administrative controls that minimum educational, experience or qualification requirements have been established for plant personnel positions, including licensed and non-licensed operators. Again, the acceptable criterion for this review is conformance to the requirements of Regulatory Guide 1.8.

2.5.1.4 Foreign Selection Practices

Great Britain (18, 19)

Utilities in Great Britain recruit from two sources: (1) university graduates with engineering degrees who will receive 2 years of post-graduate training and (2) secondary school graduates who will receive special training for about 4-1/2 years. Reference 19 indicates that the end results from both sources are personnel who are felt to have attained a high degree of technical qualification and who have received the equivalent of

TABLE 2.18
UTILITY RO CANDIDATE SELECTION PRACTICES

SELECTION TECHNIQUE EMPLOYED		NUCLEAR POWER STATION VISITED								
		A	B	C	D	E	F	G	H	I
MEDICAL EXAM		X	X	X	X	X	X	X	X	X
INTERVIEWS	Personnel Staff	X	X	X	X	X	X	X	X	X
	Operations Staff	X	X	X		X		X	X	X
BACKGROUND CHECK	Application Check	X	X	X	X	X	X	X	X	X
	Investigative Service			X					X	X
APTITUDE AND ACHIEVEMENT TESTS[1]	BMST		X	X	X	X				
	DAT								X	
	GATB						X			
	PTI								X	
	MCT								X	
PSYCHOLOGICAL SCREENING[2]	Interview	X	X	X	X	X	X	X	X	X
	MMPI					X		X		X
	16PF				X	X	X			
	TTS				X	X		X	X	
	GZTS							X		
PERSONALITY INVENTORIES[2]	MMPI					X		X		
	TTS				X	X		X	X	
	16PF				X	X	X			
AUXILIARY OPERATOR MEASURES	Technical Screening Exam				X		X		X	
	Rate of Qualification Progress							X		
	AO Performance Evaluations	X						X	X	
	Training Performance								X	
	Use of Seniority as a Dominant Factor		X	X	X	X				X

[1]BMST - Basic Mathematics and Science Test (General Physics Corporation)
DAT - Differential Aptitude Test (Psychological Corporation)
GATB - General Aptitude Test Battery (U.S. Employment Service)
PTI - Personnel Tests for Industry (Psychological Corporation)
MCT - Minnesota Clerical Test (Psychological Corporation)

[2]MMPI - Minnesota Multiphasic Personality Inventory (Psychological Corporation)
16PF - Sixteen Personality Factors Questionnaire (Institute for Personality and Ability Testing)
TTS - Thurstone Temperament Schedule (Science Research Associates)
GZTS - Guilford-Zimmerman Temperament Survey (Sheridan Psychological Services)

post-graduate training before receiving further nuclear training for operational responsibilities at nuclear stations.

West Germany (20, 21)

Personnel are selected for reactor operator training from one of the following sources:

- o Skilled workers of a metal or electrical trade with at least 2 years of work experience in the repair and operation of power plant systems and

- o Navy enginemen or navy training with at least 6 months of work experience in the repair and operation of power plant systems.

Canada (22, 23)

Personnel for Canadian (Ontario Hydro) nuclear operating staffs are selected initially from individuals with secondary-school or similar educations and with 2 or more years of relevant industrial experience as assistant operators. Validated selection tests related to the ability to cope with nuclear reactor training are administered to these candidates. In addition, all applicants are interviewed to determine personal characteristics and suitability for the job. The interviewer looks for individuals with self-control, above-average intelligence and the ability to express themselves, particularly orally. The interviewer also looks for people who are reliable and trustworthy and who are self-starters (23).

2.5.1.5 U.S. Navy Selection Practices (24, 25)

Enlisted personnel selected for Navy nuclear training must satisfy the following criteria:

- o Meet minimum age requirements (17 to 26),

- o Pass a physical examination,

- Be a high school graduate or equivalent and have completed one year of algebra in high school or college, having achieved at least a "C" grade or equivalent in that course,

- Demonstrate acceptable academic ability in the areas of math and science as measured by the Armed Services Vocational Aptitude Battery Tests and the Nuclear Field Qualification Test,

- Pass a background investigation of prior arrest records, use of unlawful drugs, evidence of unreliability, recklessness of character, disregard for authority, etc. and

- Satisfactc indicate suitability for the intended job through an interview with an experienced nuclear-trained individual.

2.5.1.6 Evaluation of Practices for Selection of RO Candidates

As indicated in Section 2.5.1.2, selection of candidates for RO license training is a two-step process involving initial selection of candidates for employment and subsequent selection to enter the license training program.

The initial process of selecting candidates to assume non-licensed operator positions serves four major purposes:

- Evaluates prerequisite aptitude,
- Identifies signs of unsuitable personality dysfunction,
- Confirms a satisfactory congruence between applicant interest and job characteristics and
- Ensures physical capability to meet job demands.

The first purpose, evaluation of prerequisite aptitude, answers the question, "Does an individual have the prerequisite aptitude, both mechanical and academic, to attain the skills and knowledges necessary for the performance of the job?" The applicant must be able to successfully complete a training program that will provide the abilities and knowledges necessary for performing that job. Once in a training program, the individual must be able to demonstrate competency in integrating previous material before progressing to more complex subjects.

First, minimum requirements for background education must be satisfied. Current requirements for RO candidates specify a high school diploma or equivalent as a minimum acceptable criterion. A review of current training programs and required training program content developed from a generic RO job task analysis was conducted to evaluate the adequacy of this requirement. It was concluded that a high school diploma or General Education Development Program Certificate does provide adequate background education for acquiring RO-level skills and knowledges. Due to the technical nature of RO license training programs and the reactor operator position itself, the utility should consider applying appropriate emphasis on an operator candidate's performance in high school level mathematics and sciences when hiring new personnel.

In addition to previous academic performance review, additional methods can be used to provide the utility some assurance that a prospective employee will complete training, receive a license and be a competent and safe operator. These include personal interviews, review of past employment performance and aptitude and achievement tests. The use of aptitude tests as a predictive measure of an individual's ability to eventually receive a license must be in accordance with sound testing practices. The tests must be reliable (consistent) and valid for their purpose. Either percentile-rank or standard score norms should be constructed for the population for which the test is being used. The test should yield a probability that the individual will pass the necessary training and receive a license.

As can be seen from a review of Table 2.18, most of the facilities visited recognized the advantages of these techniques and employed one or more of them in the initial selection process. It is reasonable to expect, however, that the highest probability of selecting a successful candidate can be realized by the employment of all these subjective and objective techniques (interviews, previous academic and employment performance review, aptitude and achievement tests) in an integrated program.

The second major purpose of the selection process is to identify signs of unsuitable personality dysfunction. The proper and safe operation of a nuclear reactor calls for a high level of maturity, emotional stability, precise judgment and the ability to synthesize and process information under stressful conditions. These characteristics can be assessed through background investigations (including police and court record checks, credit and employment history), psychological interviews and self-report inventories (psychological tests).

A background investigation can be a key indicator of an undesirable personality trait or habit. This investigation would have to extend beyond a check of references listed on an employment application. To help verify the reliability and stability of an individual, records, such as prior arrest, credit and employment, should be checked. An investigation of appropriate depth might necessitate having an applicant sign a waiver of the Privacy Act, thus permitting the utilities to obtain this information.

The major benefit from the use of self-report inventories is the reduction in resources necessary to assess undesirable traits, a process that otherwise would require lengthy psychological interviews. Instead of interviewing each person, the statements in an inventory are printed and then can be administered individually or to groups. The equivalence of items and the standardization of administration and scoring reduce subjectivity and enable the comparison of scores. Any selection decisions should not be based solely on the results of the test, but on the basis of in-depth clinical diagnosis with supporting documentation from the test. The inventories can be administered to all applicants, with those showing positive signs of dysfunction being referred to in-depth interviews. Such psychological inventories should be reliable and valid, with recently constructed norms (for example, less than 10 years old).

Many tests may measure traits that are not relevant for the purpose or to the population concerned. The masculinity-femininity scale of the MMPI is one such scale. The inclusion of such irrelevant measures may affect the attitudes of those taking the tests and thus affect their scores. Again, while the tests currently in use (16 PF, TTS, and GZTS) may measure appropriate traits, other more efficient and suitable tests may be available. Some possible examples include the Eysenck Personality Inventory (Educational and Industrial Testing Service) and the Edwards Personal Preference Schedule (Psychological Corporation). The optimal use of all available, pertinent tests requires applied research, which would benefit all utilities.

The use of self-report inventories does not preclude or waive the need for psychological interviews for those not showing signs of dysfunction, but reduces the amount of interview time necessary for these individuals. In combination with the use of self-report inventories, this abbreviated psychological interview serves as a rough screening tool to assess overt personality traits.

Although all facilities visited conducted, as a minimum, an employment application check and a psychological interview before hiring prospective licensed operator candidates, background investigations and psychological tests were used to a lesser degree (see Table 2.18). Considering the potential impact on the safe and competent operation of nuclear power plants, programs used by utilities to identify undesirable personality traits should be comprehensive and include all these techniques.

The third purpose of the selection process relates to the congruence between an individual's interests, preferences and goals with the job requirements and characteristics. To safely and competently perform the job, an individual's interests and goals must be in harmony with those working conditions and requirements afforded by the job. A high level of incongruity will be manifested by job dissatisfaction and lack of motivation. Methods that are suitable for confirming congruence between applicant interest and job characteristics include in-depth interviews and self-report inventories (psychological tests, temperament scales and interest inventories).

Interviews conducted for the purpose of evaluating congruence of applicant interest and job characteristics should be conducted by someone on the operations staff familiar with operator job requirements. These interviews provide a subjective basis for decisions by the utility as well as by the applicants, themselves. As shown in Table 2.18, this technique is widely used at the facilities visited. An appropriate personality inventory can aid the utility in supplementing these interviews and add an element of objectivity to the decision process.

The fourth purpose of the initial selection process, to ensure physical capability to meet job demands, was appropriately achieved at all facilities by requiring a physical examination by a medical practitioner.

Following initial selection for employment and assignment to responsibilities of a non-licensed operator, an RO candidate must be selected to participate in RO license training. This second step in the RO selection process involves consideration by the utility of the candidate's experience (power plant, nuclear and non-licensed operator) and a variety of other measures (see Table 2.18).

Industry requirements for practical experience prior to becoming a licensed operator are currently being reviewed by the industry and the NRC. Table 2.19 shows current RO experience requirements, as identified in ANSI/ANS-3.1-1978 and Regulatory Guide 1.8, and new proposed requirements contained in proposed revisions to ANSI/ANS-3.1-1978 and 10 CFR Part 55 and a report prepared for the NRC, NUREG/CR-1280, "Power Plant Staffing" (25) (see Appendix D for a review of this report). As shown in this table, there are no current minimum requirements for non-licensed operator experience before becoming a licensed operator. Proposed revisions to requirements in ANSI/ANS-3.1-1978 and 10 CFR Part 55 would include 6 months of auxiliary operator experience.

The establishment of minimum time requirements for satisfactory performance as a non-licensed operator has three advantages:

- o Provides the operator with an opportunity to become proficient in operations conducted outside the control room before advancing to CRO and to acquire the skills and knowledges needed for performance of RO and SRO functions,

- o Permits a suitable period of evaluation by operations staff personnel prior to final selection for RO license training and

- o Permits the operator to participate in evolutions typical of the different phases of the plant's operating cycle.

Although the facilities visited had varying requirements (if any) for experience as an AO, in practice most of the licensed operators at facilities visited had served in AO positions

TABLE 2.19
EXPERIENCE REQUIREMENTS FOR RO CANDIDATES

EXPERIENCE CATEGORY	EXPERIENCE REQUIREMENTS (years)				
	CURRENT		PROPOSED		
	ANSI/ANS-3.1 (1978)	REGULATORY GUIDE 1.8	NUREG/CR-1280	REVISION TO ANSI/ANS-3.1 (DECEMBER 1979)	REVISION TO 10 CFR PART 55 (MAY 1980)
Total power plant	2	2		3	3
Total nuclear power plant	1	1			
Total at plant for which a license is sought	1/2	1/2	1*	1	1
AO at plant for which a license is sought (or at similar plant)				1/2	1/2

*A similar nuclear power plant would also be acceptable for satisfying this requirement.

for a period of 1 year or longer (see Section 2.3). Since all the facilities operated on a 12- to 18-month refueling cycle, these operators participated in each phase of plant's refueling cycle including:

- o Plant operations under loaded conditions,
- o Shutdowns for maintenance and subsequent startups,
- o Shutdown for refueling,
- o Post-refueling startups and tests and
- o Return to full-load conditions.

This experience can generally be considered transferable between similar plants.

As discussed in Section 2.3, the performance predictive indices study was conducted to determine if there was a statistical relationship between average number of years as an auxiliary operator and performance as an RO and SRO. This study showed that such a relationship existed between SRO performance and years of experience as an AO. A review of the data (see Section 2.3) showed that below-average SROs had a mean of 1.5 years (and median of 1 year) of experience as an AO. In addition, the SROs with 1 year or less of AO experience had a decidedly higher percentage of below-average performers than those with more experience (see Figure 2.7).

Based on the considerations of the advantages of minimum time requirements as an AO and the results of the performance predictive indices study, it appears that such requirements are needed and that 1 year of AO experience should be acquired before licensing.

As shown in Table 2.18, after a candidate's technical competence has been determined, seniority and performance evaluations are the principal measures considered for selecting unlicensed operators for RO training. There are varying opinions of the relative importance of prior performance and seniority in making advancement decisions. Operations and training personnel at facilities that used seniority as the sole criterion for selection indicated that this was due to current labor-management agreements. In general, these individuals felt that this practice has a negative influence on operator motivation and performance. In addition, this practice does not ensure that appropriate personnel are selected for licensed operator training programs and, hence, places an unnecessary burden on operator training, certification and licensing programs to screen marginal candidates. This problem is further compounded when these facilities fail to pursue a practice of actively screening candidates during license training (see Section 2.5.2).

2.5.1.7 Conclusions and Recommendations Regarding Selection of RO Candidates

Conclusions

1. Current requirements for selection of candidates to participate in RO license training consist of minimum criteria for education and experience (basic power plant and nuclear power plant related) and demonstration of mature judgment and manual dexterity. Present utility practices for selection ensure that these requirements are met or exceeded. In most cases, these practices use a combination of methods that evaluate additional utility selection criteria.

2. There are four major purposes of the process used to select potential RO license candidates for employment with a utility. These purposes are to:

   a. Evaluate prerequisite aptitude,

   b. Identify signs of unsuitable personality dysfunction,

   c. Confirm satisfactory congruence between applicant interests and job characteristics and

   d. Assure physical capability to meet job demands.

   Of these purposes, a and c are desirable for the utilities to achieve since they impact on a candidate's ability to complete training (purpose a) and the candidate's chances of becoming a motivated operator and hence being retained by the utility (purpose c). Techniques used to achieve these purposes do not need to be regulated. Failure to satisfactorily achieve purposes b and d, however, can adversely impact plant and public safety. As a result, techniques used to achieve these purposes should be regulated. Comprehensive programs for identifying unsuitable personality dysfunction (similar to those used by several facilities visited) should be required for all nuclear power plants.

3. Based on the results of a generic RO and SRO job task analysis, a study of RO and SRO performance predictive indices, and interviews conducted with operations department and training department personnel at utilities visited, it is concluded that certain minimum operational experience requirements should be met before receiving RO licenses. Before licensing, an RO candidate should have performed the functions of auxiliary operator at the facility for which a license is sought (or at a similar facility) for a period of 1 year.

4. Seniority and performance evaluations while serving in AO positions are the principal measures considered for selecting individuals for RO positions. Operations and training personnel at the facilities that used seniority as the sole criterion for selection generally felt that this practice has a negative influence on operator motivation and performance. In addition, this practice does not ensure that appropriate personnel are selected for licensed operator training programs and places an unnecessary burden on operator training, certification and licensing programs to screen marginal candidates.

5. Based on a review of required training program content developed from a generic RO and SRO job task analysis, it is concluded that a high school diploma or General Education Development Program Certificate provides adequate background education for acquiring RO-level skills and knowledges.

Recommendations

1. As part of the operator selection process, utilities should adopt an integrated program for evaluating a potential employee's aptitude for completing non-licensed (AO) and licensed operator (RO) training. This program should include:

   a. Personal interviews by personnel with plant operations experience,

b. Previous academic and employment performance reviews and

c. Aptitude and achievement tests proven to be reliable and valid for the purpose used.

For the aptitude and achievement tests, percentile-rank or standard-score norms should be constructed for the test population. Development of such a test could be accomplished or sponsored by an organization such as INPO, EPRI, etc. with benefit to all utilities. Several test instruments appear to have potential (BMST, DAT, MCT, etc.). Although the NRC might encourage pursuit of such efforts, it is not an area that requires regulation.

2. The NRC should require that, as part of the operator selection process, utilities employ a program to identify signs of unsuitable personality dysfunction. Such a program should include:

   a. A psychological interview by a psychiatrist or certified psychologist (rather than a medical practitioner). This interview should serve as a rough screening tool to assess overt personality traits.

   b. A self-report inventory (psychological test) administered to all applicants. Those showing signs of dysfunction should be referred to in-depth clinical diagnosis by a psychiatrist or certified psychologist. These tests should be reliable and valid with recent norms.

   c. A background investigation to identify undesirable characteristics indicated by police and court record checks, credit and employment history, etc. It is anticipated that prospective employees for operator positions would be required to sign a waiver of the Privacy Act to permit adequate investigation.

Concerning the requirement for a self-report inventory, the industry could adopt a standard [or revise the current standard for medical certification ANSI N546-1976 (see Section 2.5.3)] approved by the NRC and based on in-depth review of available self-report inventories and their desirability for use with the operator population. This review could be conducted by INPO, ANS, EPRI or anot'.er organization using professional psychological assistance. In addition, a long-range research program to develop such a test suitable for nuclear power plant operators could be undertaken if deemed necessary from this review of available instruments.

3. During initial selection, utilities should adopt a practice of combining in-depth interviews conducted by plant operations personnel with the use of appropriate personality inventories (psychological tests, temperament scales and interest inventories) to evaluate congruence between applicant interests and operator job characteristics.

   Effective application of these techniques will improve the likelihood that the utility will select an individual who will become a satisfied, motivated operator. Achievement of this goal will therefore have a favorable impact on employee retention. This area lends itself to an industry endorsement of an appropriate personality inventory based on review of available instruments or development of a special-purpose inventory. Although the NRC might encourage these efforts, this area is not appropriate for regulation.

4. The NRC should require that, before licensing, an RO candidate should have performed the functions of a non-licensed operator at the facility for which a license is sought (or similar facility) for a period of 1 year.

   This requirement would provide an opportunity for an operator to become proficient in operations conducted outside the control room, acquire skills and knowledges needed for performance of RO and SRO functions (as evidenced from an RO and SRO job task analysis) and participate in evolutions typical of the different phases of the plant's operating cycle. A suitable period of evaluation by operations staff personnel would also be provided. In addition, empirical evidence (results of the performance predictive indices study) supports the need for such a requirement.

   In situations where it is impractical to obtain this experience before licensing, unique qualifications to accommodate the circumstances would be required.

5. Utilities should use a combination of criteria (rather than relying solely on seniority) when selecting non-licensed operators for RO license training. These criteria should include a variety of measures such as:

   - o Technical knowledge,
   - o Rate of qualification progress,
   - o AO performance evaluations,
   - o Training performance and
   - o Seniority.

   Application of these criteria should be directed toward selecting RO license candidates who are most suitable for advancement.

6. The NRC should adopt the education requirements for RO license applicants proposed in the May 14, 1980, draft revision to 10 CFR Part 55 (15). This proposed revision would require that the license applicant hold a high school diploma or General Education Development Program Certificate.

2.5.2 Screening of RO Candidates During Training

As was discussed in detail in Section 2.4, the typical training program for reactor operator license candidates consists of the following phases:

- o Nuclear power plant fundamentals,
- o Plant systems,
- o Plant operations,
  - simulator and
  - control room operation (hot license),
- o Practical work assignments (cold license),
- o Review and
- o Utility certification.

This section addresses the current practices used for tracking student progress during these training phases and the specific screening techniques and steps that are used to identify trainees who should be "disenrolled" from the training program. Utility certification of license applicants at the completion of the course and re-certification upon failure of the NRC examination are discussed in Section 2.5.3.

2.5.2.1 Requirements for Screening RO Candidates

Industry Standards. ANSI/ANS-3.1-1978, "Selection and Training of Nuclear Power Plant Personnel," does not specify screening steps or techniques that should be applied during RO license training; however, the December 1979 proposed revision to ANSI/ANS-3.1-1978 would require the administration of examinations covering the material presented in each phase of the training program. These examinations may be periodic quizzes, phase completion examinations, or both. They also may be oral examinations if the questions are documented and an overall grade of satisfactory or unsatisfactory is assigned. This revision to ANSI/ANS-3.1-1978 also would require that examinations be conducted during the course of simulator training in addition to the final certification examination. These examinations would be required while operating at power with plant malfunctions and while starting up the reactor.

Federal Regulations and NRC Guidelines. Reviews of applicable federal regulations and NRC guidelines (Regulatory Guides, NUREGs, etc.) indicated that no requirements currently exist for the use of screening techniques during operator license training.

2.5.2.2 Utility and Training Center Screening Practices

Utility practices for screening RO candidates during training differed significantly for the nine facilities visited. The spectrum of practices varied from informal programs with no specific screening steps until final certification for the NRC examination to formal programs with specific screening criteria and steps during the course of the program. Table 2.20 on page 2-129 indicates the various combinations of screening techniques that were employed at the reactor sites visited. (This fold-out table is provided as a reference for use in the following discussion of these techniques.)

Periodic Quizzes. All utilities used weekly or biweekly quizzes to track student progress. Criteria for passing these quizzes varied from 70 to 80 percent correct answers. Consistently poor grades on these quizzes usually resulted in special attention being directed toward the trainee. Four basic uses for these quizzes existed:

- o Tracking of student general progress,
- o Initiation of a probation period based on more than one failure,
- o Criteria for advancement to the next phase of training based on an average grade for all quizzes administered in the current phase and
- o Criteria for passing the entire license training program based on a satisfactory average of all quiz grades.

Comprehensive Examinations. One utility required the satisfactory completion of a comprehensive examination at the end of each phase of training as a prerequisite for entry into the subsequent phase.

Formal Progress Review by the Training Supervisor. This screening technique consisted of a formal interview with the trainee by the Training Supervisor at the end of each phase. This interview usually included a discussion of trainee general progress and observed weak areas and the assignment of remedial training if necessary.

Screening Oral Examinations. In the cases where a marginal student was identified on the basis of periodic quizzes or other criteria, one utility required a formal oral examination by two or more persons. This oral examination resulted in a recommendation for a probational assignment or disenrollment from the course.

Instructor Evaluations. Some utilities required periodic instructor evaluations of trainee performance. These evaluations usually provided supportive criteria along with other criteria (for example, quiz or examination failures) for decisions concerning disenrollment or probation.

Probation. Some utilities used a formal probational period as a process for screening trainees. Assignment of this probational period could be as a result of various combinations of:

- Failure of one or more periodic quizzes,
- Failure of any comprehensive examination,
- Poor instructor evaluation of student performance,
- Progress record review by a facility audit board and
- Special oral examination of a marginal trainee.

Probational periods varied from 2 to 4 weeks during which the trainee was usually required to achieve passing results in previous weak areas as well as maintain satisfactory progress in the continuing training program.

Methods used for tracking student progress during simulator training at the six training centers visited consisted of combinations of:

- Weekly or biweekly written quizzes,
- Simulator operational examinations,
- Oral examinations and
- Instructor evaluations of student performance.

The employment of these techniques was largely dependent upon the length of the specific program. Cold license programs (usually at least 8 weeks long) used, as a minimum, both weekly and biweekly quizzes and instructor evaluations of simulator performance to track student progress. The shorter, hot license programs of 1 to 3 weeks usually consisted of little formal evaluation prior to the final certification process at the completion of the course.

All training centers operated by reactor vendors indicated that the training centers had no authority to disenroll a trainee from a program purchased by a utility. All of these centers did make efforts to keep utilities informed of trainee progress and recommended disenrollment when it was felt to be appropriate. These centers did not maintain records of any such disenrollments, although they were described by staff personnel to have occurred "occasionally" or "infrequently."

Utility procedures for disenrolling trainees varied in the following areas:

- o Disenrollment criteria,
- o Timing of disenrollments with respect to the training program sequence,
- o Authority for approval and
- o Action following disenrollment.

Some facilities had no formal criteria for disenrollment. In these cases, recommendation for removal of students from license training was based on a consensus among the training staff that the student's progress was unsatisfactory. Average grades of periodic quizzes were usually the supportive criteria applied to these decisions. Facilities with more formal criteria for disenrollment usually required, in addition to an unsatisfactory average of periodic quiz scores, the satisfaction of one or more of the following criteria:

- o Failure of a special oral screening examination,
- o Failure to achieve satisfactory results during a probational assignment or
- o Failure of a comprehensive written examination.

There were no procedures at any facilities to prohibit disenrollment of candidates at any point during the training program; however, actual practices indicated that some utilities followed a policy of letting marginal trainees complete the entire program before making any decision on disenrollment. In these cases, this decision was a part of the utility certification for the NRC licensing examination. Other utilities followed a policy of more actively screening students during the course of instruction.

Authority for approving disenrollments usually rested with the Operations Supervisor or Plant Superintendent. Most Training Supervisors interviewed indicated that their recommendations for disenrollments usually received full endorsement by these individuals.

Action following disenrollment from the license training program always included return to a previously held position. Most facilities permitted reentry into the license training program at a later date as a function of operator performance, attitude, etc. One utility maintained a policy of usually <u>not</u> permitting reentry into license training.

Operators who failed the NRC examination were required (depending on the facility) to take one of the following courses of action:

- o Reenter the RO license training program at the beginning,
- o Participate in a remedial program and take the NRC examination again following the minimum time period of 10 CFR Part 55,
- o Return to the original position held, without expectation of another opportunity for an NRC examination or
- o Be demoted to a position below the one held prior to entry in the license training program.

Some utilities had no limits on the number of times that the NRC examination could be taken. Other utilities applied limits of either 1, 2 or 3 examinations on their operators.

2.5.2.3 NRC Practices

Since no industry standards, federal regulations or NRC guidelines currently in effect require the screening of candidates during reactor operator license training, the NRC does not review or audit screening practices used by utilities and training centers.

2.5.2.4 Screening of U.S. Navy Operators During Training

As described in detail in references 24 and 25, initial nuclear training for enlisted operators prior to reporting onboard an operating nuclear-powered ship consists of two phases. The first phase is a 6-month period of formal academic instruction at U.S. Naval Nuclear Power School. The second phase consists of 6 months of operational training at one of eight land-based Naval reactor prototypes where the operator completes qualification as a watchstander. In both phases, approval of student disenrollments by Naval Reactors headquarters is required.

TABLE 2.20
UTILITY SCREENING PRACTICES DURING RO LICENSE TRAINING

SCREENING PRACTICES	NUCLEAR POWER STATION VISITED								
	A	B	C	D	E	F	G	H	I
No formal screening steps or prerequisites for entering subsequent training phases	X		X				X		X
Must receive a passing grade on each periodic quiz								X	
Must receive a passing average of all quiz grades	X		X				X		X
Must receive a passing average of quiz grades in one phase prior to advancing to the next phase		X		X	X				
Must pass a comprehensive examination at the end of each phase						X			
Formal progress review by Training Supervisor at the end of each phase		X		X					
Oral examination used to screen marginal trainees		X							
Instructor evaluations of trainee performance					X			X	X
Assignment of probational period to achieve passing results in a weak area		X				X		X	

At Nuclear Power School, a number of techniques are used to track student progress and screen students who would not satisfactorily complete the course. These techniques are described as follows:

> Weekly Quizzes and Biweekly Examinations. Students are not required to pass all of these written examinations, but the results are used to track student progress. If a student fails one of these examinations, an instructor is required to interview the student to analyze his performance and determine appropriate corrective action.

> Probational Period. Consistently poor performance on quizzes or examinations results in the assignment of a probational period with mandatory study requirements and a corrective study program.

> Instructor Interviews. An interview to discuss performance with each student is conducted every 2 weeks.

> Academic Board Oral Examination. Repeated examination failure will result in an oral examination conducted by a board of staff members. This oral examination is used to determine the student's current level of knowledge and potential for completing the course. This board recommends retention or disenrollment.

> Comprehensive Examination. Passing of this 4-hour, written examination is required at the completion of the course. Failure can result in a reexamination or oral examination by an academic board.

Reactor prototype training consists of four phases: classroom, transition, in-hull and proficiency. Screening of trainees is conducted during the first three phases. Final certification of trainees as qualified watchstanders is conducted at the end of the in-hull phase and will be discussed in Section 2.5.3, "Certification of RO Candidates."

The classroom phase is not a formal screening step. Weekly examinations are given to track student progress. Students who fail examinations must participate in a remedial upgrading program and receive instructor counselling. In the case of examination failure or consistently low grades, a biweekly interview by a plant supervisor is required to discuss student progress.

During the transition phase, the trainee begins standing watches under instruction. Each watch is graded. Written examinations are administered at the end of this phase. Examination failure results in assignment of a remedial program. Again, this phase is not used a. a formal screening step.

Formal screening of trainees is conducted during the in-hull phase before final certification as a qualified watchstander. The following criteria are used:

Graded Watches. The trainee must stand a minimum number of satisfactory watches. In addition, before final certification, a satisfactory average of all watch grades is required.

Progress Board Oral Examinations. Each trainee must pass two oral examinations given by a board of prototype staff members at the 50- and 80-percent completion points i the qualification program.

Instructor Oral Examinations. Satisfactory completion of six 2-hour oral examinations from a staff instructor is required. Each exam covers a specific operational area of interest.

Engineering Officer of the Watch Review. Satisfactory completion of a detailed review of integrated plant operations by a staff Engineering Officer of the Watch is required.

Upon satisfactory completion of the above steps, the trainee will begin the final certification process.

2.5.2.5 Evaluation of Practices and Alternatives for Screening RO Candidates During Training

The techniques listed in Table 2.20 are appropriate methods for tracking student progress and are commonly used in formal training programs. A review of Table 2.20 shows that the combinations of techniques used varied significantly between sites visited. Although the use of these different combinations resulted in programs of varying degrees of formality, all programs could be categorized in one of two groups: those that actively screened candidates prior to advancement to the next phase of training and those that did not.

The analysis described in Section 2.4.4.1, where license training program content and instructional settings were determined for a generic RO and SRO job task analysis, demonstrates the importance of each phase of training in developing the required skills and knowledges of licensed operators. Due to the differences in content and instructional settings among the training program phases, failure to acquire a specific skill or knowledge during one phase of training does not imply that an opportunity will be available to acquire it during a subsequent phase. In fact, the contrary is more often true. In addition, since each phase of training builds upon the skills and knowledges acquired in a previous phase, it is necessary that trainees exhibit satisfactory knowledge or performance for each phase.

As discussed in Section 2.5.2.2, "Utility and Training Center Screening Practices," there are many ways to ensure that a candidate has achieved a satisfactory knowledge or performance level before advancing to subsequent training phases. It is important that the utility formally assess this level of knowledge or performance and establish a requirement that it be evaluated as satisfactory before advancement. The criteria used by the utility must be appropriate for the program content and instructional setting(s) used in that phase. Recommendations for guidelines for these acceptance criteria are presented in Section 2.5.2.6.

2.5.2.6 Conclusions and Recommendations for Screening RO Candidates During Training

Conclusions

1. All utilities use appropriate (although varying) techniques for tracking student progress. Most training organizations commendably followed a practice of providing additional support to marginal trainees. There were no indications that acceptance standards are reduced for these individuals.

2. Appropriate emphasis is not given by all utilities to the importance of verifying that trainees have acquired all the skills and knowledges of one phase of training before advancing to the next. Some utilities have developed thorough and well-defined procedures to conduct this evaluation, while others have no procedures. Since each phase of training builds upon the skills and knowledges acquired in a previous phase, it is necessary that license training programs have administrative procedures to evaluate, for each phase, trainee knowledge and performance before advancement to subsequent phases.

Recommendations

1. The NRC should require that, as a part of their license training programs, utilities establish a formal method for certifying satisfactory knowledge and performance for each applicable phase of the programs (for example, the "review phase" is not applicable to this requirement).

The acceptance criteria that a utility should meet would be an evaluation that the techniques employed are suitable for measuring all required skills and knowledges to be acquired in each phase. The following recommendations for guidelines for acceptance criteria are presented:

Phase I - Nuclear Power Plant Fundamentals Phase. Administration of examinations should be required. These could be combinations of periodic quizzes, phase completion examinations or oral examinations. If oral examinations are used, the questions must be documented and the responses evaluated on a numerical scale. Examinations must be scheduled to ensure that all portions of the curriculum are addressed.

Phase II - Plant Systems Phase. Same as Phase I.

Phase III - Plant Operations Phase.

a. Simulator. Examinations that cover the classroom and operations portions should be required. Written or oral examinations are suitable for the classroom portion. Oral and operational examinations should be given for the control room portion. Operational examinations should include:

- o General plant operations in addition to reactor startup,
- o Emergency operating procedures,
- o Procedures for abnormal, offnormal or alarm conditions and
- o Emergency actions not completely addressed by procedures, including multiple casualties.

A final certification operational examination should be required.

b. Control Room Operation (Hot License). Written and oral examinations should be required. Oral quizzes conducted to receive verification signatures from operators for items on a task list, qualification card or practical factor list would require no additional documentation other than a signature verifying satisfactory performance or knowledge.

c. Practical Work Assignments (Cold License). Documentation showing satisfactory participation and accomplishment of these assignments is sufficient.

2. Utilities should be required to maintain a record of trainee performance on all quizzes, phase completion examinations, oral examinations and simulator operational examinations. A summary of candidate performance during each phase of the program should be submitted for review in the application for license.

This practice would identify potential areas of weakness and permit OLB examiners to probe these areas to ensure adequate knowledge before licensing.

Since cases requiring special attention (marginal trainees) will periodically arise, it is further recommended that utilities consider establishing standard procedures for handling these cases. Alternatives for consideration include:

- o Assignment of probational periods,
- o Special oral screening examinations and
- o Procedures for achieving passing results in previously weak areas.

2.5.3 Certification of RO Candidates

As part of the license examination application, the utility must certify to the NRC that an RO candidate has learned to operate the controls in a competent and safe manner. This section addresses the requirements and practices related to this certification process. Practices for certifying medical fitness of license candidates are also discussed.

2.5.3.1 Certification Requirements

Industry Standards. The "American National Standard for Selection and Training of Nuclear Power Plant Personnel," ANSI/ANS-3.1-1978, does not provide guidance to utilities for certifying RO license candidates. The December 1979 proposed revision to ANSI/ANS-3.1-1978 addresses the following three parts of the certification process:

- o Simulator certification examination,
- o Prelicense examination and
- o Final certification by corporate management.

This proposed revision would require that a simulator examination include operating at power with malfunctions and startup of the reactor. The examination would certify the candidate's ability to:

- o Manipulate the controls in a safe and competent manner,
- o Predict instrument response and use the instrumentation available,
- o Follow the facility procedures and
- o Understand alarms and annunciators and take proper action.

A comprehensive prelicense examination administered by the utility would be required to determine the candidate's ability to operate the plant in a safe and competent manner. This revision encourages the administration of oral and written examinations to satisfy this requirement, but does not specifically require either type.

Under this revision, the utility corporate management would conduct the final part of this certification before proposing the candidate for licensing by the NRC. Although the level of corporate management responsible for this certification is not specified, the following general guidance for the conduct of this certification is provided in this proposed revision:

> This certification shall include consideration of successful completion of training, demonstrated abilities, satisfactory health, dependability, stability and trustworthiness. In making this determination, it is not sufficient to review only the training record of the applicant. In addition, the responsible manager shall review or cause to be reviewed less subjective documents such as supervisory evaluations, results of medical examinations and tests, security checks, and sick leave records for patterns indicative of ill health, drug addiction or alcoholism. In addition, the responsible manager should interview each applicant or appoint an appropriate board to perform this function.

The "American National Standard for Medical Certification and Monitoring of Personnel Requiring Operator Licenses for Nuclear Power Plants," ANSI N546-1976(ANS-3.4) (34), establishes the industry standards for "minimum requirements necessary for an examining physician to determine that the physical condition and general health of operators are not such as might cause operational errors." This standard specifies health requirements and disqualifying conditions in the following areas:

- General physical capacities
- Respiratory
- Cardiovascular
- Endocrine
- Nutritional
- Metabolic
- Lymphatic
- Integumentary
- Neurological
- Mental/psychiatric
- Medication
- Laboratory analyses
- Hematopoietic dysfunction
- Malignant neoplasms.

In addition, it specifies that licensed operators receive a medical examination at least biennially.

This standard is the basis for utility certification to the NRC of a license candidate's medical fitness. Under this standard, a licensed medical practitioner designated by the facility can perform all aspects of the examination. This examination includes a review of medical history as well as a physical examination.

Federal Regulations and NRC Guidance. The originating document for certification requirements is 10 CFR Part 55. This regulation requires that, in each application for a license, the facility should provide evidence that the applicant has learned to operate the controls of the reactor in a competent and safe manner. As proof of this, the NRC accepts a certification of an authorized representative of the facility. The following must be included in this certification:

- o Details on courses of instruction administered by the facility licensee,
- o Number of course hours,
- o Number of hours of training and nature of training received and
- o Startup and shutdown experience received.

In addition, a report of a medical examination by a licensed medical practitioner is required.

NUREG-0094, "NRC Operator Licensing Guide," (12) reiterates the requirements of 10 CFR Part 55 for certification. In addition, it requires that an applicant must have manipulated the controls of the reactor through at least two reactor startups and have participated as a member of the control room in several other plant transients. Successful completion of an NRC-approved training program using a simulator can satisfy these manipulation requirements.

The NRR letter of March 28, 1980 (13), to all power reactor licensees provides clarification as to the level of corporate management that is considered appropriate for providing this certification. This letter implemented a requirement that these certifications be signed by the highest level of corporate management responsible for plant operation (for example, the Vice President for Operations).

The May 1980 proposed revision to 10 CFR Part 55 issued by the NRC Office of Standard Development incorporates the requirement of the March 1980 NRR letter concerning the signing of certifications. In addition to items that must currently be included in these certifications, this revision would require that details also be provided on the differences between the simulator and the facility for which the applicant seeks a license and on the actions taken to ensure that these differences will not result in the applicant's misinterpreting plant response or taking incorrect action.

Regulatory Guide 1.134, "Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator Licenses," (35) addresses the area of physical condition and general health of operator license applicants. This guide endorses the requirements of ANSI N546-1976. In addition, it indicates that this standard addresses, in some detail, physical conditions that may be cause for denial of a license application, but is more general in identifying the mental conditions that may be cause for denial. As a result, this regulatory guide requires that potentially disqualifying mental conditions, identified during the medical examination, be evaluated by a licensed psychologist, psychiatrist or physician professionally trained to identify the condition.

2.5.3.2 Utility Certification Practices

Utility practices for satisfying NRC certification requirements were fairly consistent at all facilities visited. These practices included the same three basic parts identified in the proposed revision to ANSI/ANS-3.1-1978; namely:

- o Simulator certification examination,
- o Prelicense examination(s) and
- o Final certification by corporate management.

Simulator certification examinations are conducted to satisfy the requirements of Appendix F of NUREG-0094. This appendix (discussed in Section 2.4.1.1) specifies requirements for eligibility for a license examination at an operating power reactor with no reactor startup demonstration. A portion of this program described in NUREG-0094 is the certification from a simulator training center attesting to the applicant's ability to:

- o Manipulate the controls and keep the reactor under control during a reactor startup,
- o Predict instrument response and use the instrumentation during a reactor startup,
- o Follow the facility startup procedures and
- o Explain alarms and annunciators that may occur during this operation.

The proper performance of a reactor startup is the only evolution required to be demonstrated. The certification letters provided to utilities from these training centers state that the applicant has demonstrated these four abilities.

Although completion of this certification was principally the result of successful performance of a reactor startup on the simulator, some training centers included an oral examination as part of this certification process. Instructors conducting the startup certification usually made use of an examination standard or checklist to aid in evaluating candidate performance.

The second portion of certification included comprehensive written and oral examinations. The written examinations were similar in scope and format to the NRC written licensing examinations. Oral examinations were usually of a plant "walk-through" nature. Some utilities administered their own written and oral certification examinations. Other utilities followed a practice of having an independent organization, usually a reactor plant vendor or training services contractor organization, conduct these examinations. For cold license training programs, all training centers conducted comprehensive written and oral examinations in addition to the simulator examination.

The final portion of certification involves the decision-making process used to determine which candidates will be certified to the NRC as ready for licensing examinations. At most facilities visited, three individuals on the utility staff were primarily involved in this process: the Training Supervisor, Operations Superintendent and Plant Superintendent. The Training Supervisor was responsible for initial review of each individual's performance during the training programs, with emphasis applied to performance on certification examinations.

After concurrence by the Operations Superintendent, recommendations from the Training Supervisor are approved by the Plant Superintendent. All Training Supervisors interviewed indicated that plant management was usually very supportive of training department recommendations. In fact, every Training Supervisor interviewed could recall instances where marginal candidates, who had progressed through the license training program, were not allowed to take the NRC examination based on training department recommendations.

During interviews at some facilities visited, a few cases were mentioned in which the training department and operations department were not in agreement as to whether or not a candidate should be certified. These types of disagreements were usually resolved at the next level of corporate management with authority over both training and operation functions (for example, Plant Superintendent).

Although recently implemented requirements (13) now specify that the highest level of corporate management responsible for plant operation (for example, the Vice President for Operations) must sign certifications in license applications, this level of corporate management does not take an active role in the certification process. Operations Superintendents and Training Supervisors indicated that this new requirement was purely administrative and would not result in a higher level of participation by these individuals.

2.5.3.3 NRC Practices

The OLB reviews the certification received from the facility with the application for license. Review of this certification includes a review of the description of the training received as required by 10 CFR Part 55 (see Section 2.5.3.1).

In addition to this review of training received, a report of a current medical examination from a licensed medical practitioner is reviewed. A medical examination completed within 6 months of the date of application is considered current (12). Although the NRC considers it the licensed medical practitioner's responsibility to identify and evaluate potentially disqualifying physical conditions, the final determination of the applicant's medical qualification is made by the NRC (35).

2.5.3.4 U.S. Navy Certification Practices

During the U.S. Navy initial training program for nuclear propulsion plant operators, final certification occurs during prototype training. Satisfactory completion of this certification means that the candidate is fully qualified to stand watch. Certification includes the following four criteria:

1. Final watchstanding grade. This grade is the average of all graded watches stood under instruction.

2. Final evaluated watch (officer students). A three-member board evaluates performance during this watch.

3. Final comprehensive written examination. This examination is 4 hours for enlisted personnel and 8 hours for officers and covers mechanical, electrical, reactor and integrated plant areas, as well as chemistry and radiological controls.

4. Final oral board. Members of the board are alerted to the student's weak areas by a review of training records. All board members must assign passing grades in all areas for successful completion of this examination.

2.5.3.5 Evaluation of RO Candidate Certification Practices

Techniques used by utilities to certify technical competence focus on a candidate's ability to pass an NRC examination. Written and oral examinations are very similar to NRC examinations in subjects covered, depth of information required and physical makeup. There is an obvious advantage to utilities to conduct certification examinations in this manner because there is a reasonable expectation that successful completion of these examinations at the reactor site or training center will improve an operator's chances of passing a similar NRC examination. The disadvantage with this approach is that deficiencies that exist in the content of the NRC examinations (in particular, the written examination; see Section 2.6) carry over into the certification process. It is reasonable to expect, therefore, that improvements in the NRC examinations would lead to improvements in this part of the certification process.

Section 2.4, "Reactor Operator and Senior Operator License Training," discussed the problems associated with control room simulator courses that are centered around certifying that an RO candidate can conduct a reactor startup. Because this reactor startup is only one of numerous RO operational requirements that can only be trained and evaluated on a simulator, a certification that includes only the reactor startup will not adequately evaluate these areas. As indicated in Section 2.4, to verify adequately that an applicant can operate the reactor plant in a competent and safe manner, this certification should include performance in other areas such as:

- General plant operations in addition to reactor startup,
- Emergency operating procedures,
- Procedures for abnormal, offnormal or alarm conditions,
- Emergency actions not completely addressed by procedures, including multiple casualties and
- Unannounced casualties for the purpose of evaluating diagnostic skills.

Although expanding the certification requirements during the simulator training phase would help the certification process be more performance oriented, the overall certification process does concentrate on technical knowledge and competence of individuals. The appropriate levels of plant management (that is, Operations Superintendent and Training Supervisors) are making certification decisions on technical competence. There were no indications that candidates who are not considered technically competent are being sent routinely to NRC examinations by utilities. In fact, most Training Supervisors receive strong support from plant management in decisions related to certification for NRC examinations. There were exceptions to this general rule, however.

Although corporate management (above the Plant Superintendent level) interest and involvement in training vary widely between facilities, active participation in the certification process was generally nonexistent at this level. Although this may not be the appropriate level for certification of technical knowledge, there are several nontechnical areas relating to a reactor operator's overall makeup that could be certified by higher corporate management. The proposed revision to ANSI/ANS-3.1-1978 (discussed in Section 2.5.3.1) lists some of these areas.

The OLB review of license training received in replacement programs presently constitutes a de facto approval of the utility training program, since this training is not evaluated against any previously approved training program (Section 2.4.4.3). It is important that the NRC evaluate the adequacy of training received as part of the licensing process. The optimal way to do this is to evaluate training received against the requirements stipulated in a previously approved training program. Section 2.4 provides recommendations for requirements for submittals of program descriptions for approval with the FSAR. This section also recommends that changes to these programs other than those necessary to keep the program current with plant design should be approved by the NRC. A practice of comparing training received with a currently approved training program would remove the current subjectivity involved in the present OLB application review process.

Section 2.5.1 discusses the importance of identifying signs of unsuitable personality dysfunction during initial selection of operator candidates. The conclusions and recommendations presented in Section 2.5.1.7 are equally important for the medical certification process. Although current requirements of ANSI N546-1976 and Regulatory Guide 1.134 appear adequate in areas relating to physical qualification requirements, a more comprehensive program (such as that described in Recommendation 2 of Section 2.5.1.7) should be applied to verify the absence of undesirable personality traits before licensing.

2.5.3.6 Conclusions and Recommendations for Certification of RO Candidates

Conclusions

1. There are varying degrees of utility corporate management involvement and interest above the Plant Superintendent level in license training. At utilities where a higher degree of interest exists, the training organization and its training programs have apparently benefited. Plant management at most facilities was very

supportive of training organization functions and recommendations. It is noted that there were exceptions, however.

2. Although the NRR letter of March 28, 1980, implemented a requirement for certifications pursuant to the requirements of 10 CFR Part 55 to be signed by the highest level of corporate management responsible for plant operation, the actual certification process still occurs at the Training Supervisor and Operations Superintendent level. Several utilities follow a commendable practice of using an independent, outside organization to conduct written, oral and reactor startup (on a simulator) examinations as part of this certification. These examination practices are centered around measuring a candidate's ability to pass the NRC licensing examination. This process could be made more performance oriented by extending certification requirements for simulator operation to include areas such as:

   - Emergencies (including multiple casualties),
   - Abnormal, offnormal and alarm conditions and
   - General plant operations (other than startup).

3. There is an appropriate function in the certification process for the highest level of corporate management for plant operations (for example, Vice President for Operations). Although this individual is now required to sign certifications pursuant to the requirements of 10 CFR Part 55, the vast majority of supervisory operations and training personnel interviewed felt that this requirement would not generate an actual higher level of certification. This study concludes that in practice this is not the proper level for evaluating technical knowledge or proficiency in reactor operations control. It is the proper level of management, however, for looking beyond the issue of technical competence to consider the overall makeup of the individual in light of the responsibilities to be assumed after licensing. Of particular interest should be the candidate's appreciation of reactor safety responsibilities and the candidate's obligations to the utility and the general public, assessed through a personal interview. The December 1979 proposed revision to ANSI/ANS-3.1-1978 provides appropriate guidance for conducting this certification. A number of short courses in nuclear power plant fundamentals and reactor

plant operations are offered by training centers and would provide appropriate training for these management personnel to conduct this type of certification.

4. Current requirements of ANSI N546-1976 and Regulatory Guide 1.134 are considered adequate for determining the medical qualifications of operators except that more comprehensive programs for identifying unsuitable personality dysfunction should be required for all nuclear power plants (see Conclusion 2, Section 2.5.1.7).

Recommendations

1. Utility corporate management personnel currently required to sign certifications of license candidates' competence pursuant to 10 CFR Part 55 should actively participate in the certification process. This certification should consider more personal character issues beyond those of technical competence and training received. Interviews should be conducted to assess the candidates' appreciation of reactor safety responsibilities and their obligations to the utility and the general public.

   To help foster more corporate management involvement in operator training, the NRC should establish a practice of interfacing with utilities at the Vice President for Operations level on major issues affecting operator training and licensing.

2. The following recommendations presented in previous sections of this report are applicable to the certification process:

SECTION	RECOMMENDATION NUMBER	SUBJECT
2.4.5.2	5	NRC expand simulator certification requirements.
2.4.5.2	11,12	Utilities and training centers submit detailed training program descriptions for approval and NRC approve changes to these programs.

SECTION	RECOMMEN-DATION NUMBER	SUBJECT
2.5.1.7	2	Utilities employ programs to identify unsuitable personality dysfunction.
2.5.2.6	2	Facilities submit summary of candidate training performance with application for license.

2.5.4 Selection of SRO Candidates

2.5.4.1 Selection Requirements

Industry Standards. ANSI/ANS-3.1-1978 provides the following criteria for selection of personnel to be advanced to SRO licensed positions:

> Education. High school diploma or equivalent.
>
> Experience. Four years of power plant experience of which 2 years are nuclear power plant experience. Six months of the nuclear experience shall be at the plant for which the operator seeks a license or on a similar unit.

The December 1979 proposed revision to this standard differentiates between the Shift Supervisor and senior operator levels. Under this proposed revision, education requirements for Shift Supervisors would be increased to include 60 semester-hours of college-level instruction in mathematics, reactor physics, chemistry, materials, reactor thermodynamics, fluid mechanics, heat transfer, electrical theory and reactor control theory. If a Shift Supervisor does not meet these education requirements, a Shift Technical Advisor would be required to be present during the shift. In addition, the revised experience requirements would include participation in some specific reactor operator activities while satisfying the requirement for 2 years of nuclear power plant experience. These activities include operations at power, startup, shutdown, and startup preparations following a refueling outage.

Under this proposed revision, senior operators would be required to have 30 semester-hours of college-level instruction in the same subjects as required for Shift Supervisors. A total of 3 years of power plant experience would be required with 2 years being nuclear power plant experience. An additional requirement of 6 months' experience as an RO would be required before an operator is upgraded to the SRO position.

Federal Regulations and NRC Guidance. Current regulatory requirements for selection of SRO candidates are provided in Regulatory Guide 1.8 and the NRR letter of March 28, 1980, to power reactor applicants and licensees. Regulatory Guide 1.8 endorses the criteria that were contained in ANSI N18.1-1971, which was revised in 1978 by ANSI/ANS-3.1-1978. The NRR letter of March 28, 1980, implemented an additional requirement to the ANSI/ANS-3.1-1978 criteria. This requirement is that an applicant for an SRO license shall have held an operator's license for 1 year.

NRC requirements for selection of SRO license candidates are still undergoing review. A May 1980 proposed revision to 10 CFR Part 55 provides education and experience requirements for senior operator license applicants. This revision includes:

- o Those requirements stated in ANSI/ANS-3.1-1978 and the NRR letter of March 28, 1980,
- o Acceptance of a General Education Development (GED) Program Certificate as the equivalent of a high school diploma and
- o The requirement for 30 semester-hours of college-level instruction that was stated in the December 1979 proposed revision to ANSI/ANS-3.1-1978.

In addition, a January 1980 report prepared for the NRC, NUREG/CR-1280, "Power Plant Staffing," (25) provided recommendations for eligibility requirements for licensed operators (see Appendix D for a review of this report). From this discussion of industry standards, federal regulations and NRC guidance, it is obvious that the establishment of education and experience criteria for the selection of SRO candidates has been reviewed to a considerable extent by the industry and the NRC during the last year. Table 2.21 summarizes existing and proposed requirements in this area.

TABLE 2.21
EDUCATION AND EXPERIENCE REQUIREMENTS FOR SRO LICENSE CANDIDATES

EDUCATION OR EXPERIENCE CATEGORY	CURRENT REQUIREMENTS		PROPOSED REQUIREMENTS		
	ANSI/ANS-3.1 (1978)	NRR LETTER (MARCH 1980)	NUREG/CR-1280 (JANUARY 1980)	REVISION TO ANSI/ANS-3.1-1978 (DECEMBER 1979)	REVISION TO 10 CFR PART 55 (MAY 1980)
High School Diploma or Equivalent	X				
High School Diploma or General Education Development Program Certificate			X	X	X
College-Level Instruction in Technical Subjects				SS - 60 semester-hours[1] SCO - 30 semester-hours[1]	30 semester-hours
Total Power Plant Experience	4 years	4 years		SS - 4 years SCO - 3 years	3 years
Total Nuclear Power Plant Experience	2 years	2 years		2 years (SS or SCO)	2 years
Total Experience at Plant for which a License is Sought	1/2 year	1/2 year			
Experience as an RO		1 year	3 years[2]	1/2 year	1 year[3]

[1]SS - Shift Supervisor
SCO - Supervising Control Room Operator
[2]Bachelor's degree in engineering or physical science would be substituted for this requirement.
[3]Experience must be at the facility for which the applicant seeks an SRO license.

2.5.4.2 Utility Selection Practices

All utilities visited selected candidates for SRO licenses in accordance with the requirements of ANSI/ANS-3.1-1978 and Regulatory Guide 1.8. No utilities required their SRO candidates to have more education than a high school diploma or its equivalent. Until the requirement for 1 year of RO experience implemented by the NRR letter of March 28, 1980, there were no established NRC requirements for experience as an RO before advancement to SRO. As a result, some utilities had followed a practice of qualifying an "instant SRO" - an individual with no RO license experience who had completed the initial training program at the SRO level and had received an SRO license. Operations superintendents interviewed, who had followed this practice, indicated that having a high percentage of SROs on the operating staff provided greater flexibility in manning required shift positions. Due to typical advancement schedules at the facilities visited, however, an SRO with less than 1 year of experience as an RO was the exception rather than the norm. Of the 117 SRO licensed operators on whom information was collected for the performance predictive indices study (Section 2.3), only 27 (23 percent) had less than 1 year of experience as licensed ROs.

Two principal criteria were applied when considering candidates for advancement to SRO positions: performance as an RO and seniority. As discussed under utility selection practices for RO candidates (Section 2.5.1.2), some utilities used seniority as the sole criterion for RO and SRO candidate selection, based on requirements of labor-management agreements. At some of these facilities with labor unions, the SRO positions were classified as management positions. As a result, some of the utilities that used seniority as the sole criterion for selection of RO candidates were able to apply performance evaluation as an additional criterion for SRO selection.

2.5.4.3 NRC Practices

NRC practices relating to selection of SRO personnel are the same as those for RO selection, discussed in Section 2.5.1.3. These practices consist of initial review of personnel qualification requirements in SARs and periodic reviews of utility QA program requirements.

2.5.4.4 Evaluation of Practices for Selection of SRO Candidates

Selection 2.5.1.7 indicated that, based on the training program content developed from the generic RO and SRO job task analysis (Sections 2.2 and 2.4), a high school diploma or GED certificate provides adequate background education for acquiring RO-level skills and knowledges. Operators with SRO licenses, however, are in positions with increased responsibilities and involvement in decision-making, problem-solving and other analysis processes. These individuals need greater depth of knowledge in fundamental technical areas, such as those listed in proposed revisions to ANSI/ANS-3.1-1978 and 10 CFR Part 55, to carry out these functions. Current training programs do not provide instruction at the equivalent college level necessary to accomplish this goal.

Although requirements of 30 and 60 semester-hours have been recommended as sufficient for this purpose, no systematic determination has been conducted to derive a suitable requirement. Plant-specific job task analyses, such as those recommended in Section 2.4, could be used to identify specific content areas needed. From these results, a determination of appropriate requirements for length of instruction can be made. This training, designed to support the job requirements for SRO licensed individuals, is preferable to requiring college degrees for supervisory operator positions, since instruction in several disciplines not related to reactor operation is required to acquire a college degree. In addition, due to the specific educational needs for reactor operators, few degrees in engineering or related fields (with the exception of nuclear engineering) would provide instruction in all of the areas needed.

As indicated in Section 2.5.4.1, development of experience requirements for SRO candidates has been another area of industry-wide review during the last year. Almost all operations department and training department supervisory personnel interviewed felt that SROs needed a period of experience as an RO before advancing to SRO positions. This period not only provides the RO with needed reactor operations experience, but also permits the RO to exercise some supervisory functions (for example, directing non-licensed operator actions and supervising performance of surveillance operations by technicians). In addition, such a period permits evaluation of the RO by supervisory personnel. Opinions on the proper length of this period varied from 6 months to as much as 2 years.

The study of performance predictive indices (Section 2.3) also provided some empirical evidence to support these opinions. This study showed that the number of years as a reactor operator was statistically related to performance as an RO and that a high percentage (60 percent) of ROs with 1 year or less of licensed experience were rated as below-average performers. Since the RO and SRO job task analysis (Appendix A) indicated that RO skills and knowledges are a subset of those required of SROs, satisfactory performance as an RO is necessary to provide assurance of satisfactory performance at the SRO level.

Section 2.5.1.6, "Evaluation of Practices for Selection of RO Candidates," discusses the problems associated with the heavy reliance on seniority as a criterion for selection of RO candidates. These problems also exist when this practice is relied upon for selection of SRO candidates. Utilities without labor unions and utilities that included SRO positions as management placed considerably more emphasis on prior performance as an RO and indications of supervisory capability when selecting ROs for advancement. These practices are more consistent with the importance and responsibility of SRO positions than reliance on seniority as a criterion.

2.5.4.5 Conclusions and Recommendations Regarding Selection of SRO Candidates

Conclusions

1. Due to their increased responsibilities and involvement in decision-making, problem-solving and analysis processes, SROs require college-level instruction in technical subjects such as mathematics, reactor physics, chemistry, materials, reactor thermodynamics, fluid mechanics, heat transfer, electrical theory and reactor control theory. Proposed revisions to ANSI/ANS-3.1-1978 and 10 CFR Part 55 would require increased college-level education in these subject areas consisting of 30 to 60 semester-hours. A plant-specific task analysis would identify the specific content areas needed to be covered in this instruction and the expected number of hours of instruction needed. The use of 30 semester-hours of college-level instruction on these subjects is considered appropriate as an interim measure until plant-specific job task analyses can be conducted. (Thirty semester-hours equate to approximately a 3 semester-hour course for each of

these subject areas.) The results of these task analyses could be used to revise this 30 semester-hour requirement, if necessary.

A further conclusion from this study is that a college degree in engineering or other related fields is not a necessary requirement for the Shift Supervisor position. More important is the necessity to receive college-level instruction in the areas important to the job functions of reactor operators. Many subject areas required for a degree in any discipline are not necessary for an operator. In addition, many science and engineering degrees would still not provide all the required college-level instruction in the subject areas mentioned above.

2. Based on the results of a generic RO and SRO job task analysis, a study of RO and SRO performance predictive indices, and interviews conducted with operations department and training department personnel at utilities visited, it is concluded that certain minimum operational experience requirements should be required before receiving SRO licenses. The current requirement for 1 year of experience as a licensed operator before receiving an SRO license is considered adequate.

3. Conclusion 4 of Section 2.5.1.7 concerning the importance of including performance evaluations as part of the selection criteria for RO candidates is also applicable to the selection process for SRO candidates.

Recommendations

1. As an interim measure, the NRC should adopt the education requirements for RO and SRO license applicants proposed in the May 14, 1980 draft revision to 10 CFR Part 55, "Operators' Licenses." This proposed revision would require 30 semester-hours of college-level instruction for SRO candidates in related technical subjects. In the long term, the NRC should use the results of plant-specific job task analyses conducted at facilities to identify more specifically the content areas needed to be covered in this instruction and the expected number of hours of instruction needed.

Although these subjects should be taught at the college level for SROs, this requirement should not necessarily imply that this instruction needs to be conducted at a college. Several alternatives appear feasible:

a. Utilities could upgrade their instructor staff to provide college-level instruction in these areas,

b. Training contractor organizations could provide this instruction,

c. Vendor training centers could upgrade their instructor staffs to provide this instruction or

d. College or technical schools that provide appropriate curricula could be used.

These programs would need to be formally accredited for providing this level of instruction. This accreditation could be satisfied by normal education institution practices in the case of alternative d. INPO, the NRC, or a special "Operator Training Accreditation Board" concept, such as that currently undergoing review by the NRC, could accredit programs provided in alternatives a, b and c. Utilities should be permitted to provide this college-level instruction at any appropriate time before SRO licensing. This instruction could be received during part of the RO license training program, while performing duties as an RO or during the SRO license training program.

2. Recommendation 5 of Section 2.5.1.7 regarding the use of a combination of criteria (rather than relying solely on seniority) when selecting RO candidates is also applicable to the SRO selection process.

2.5.5 Screening and Certification of SRO Candidates

Active screening of candidates during SRO license training is generally not conducted due to the brevity of these programs. Certification requirements for SRO candidates are the same as those for RO candidates discussed in Section 2.5.3.1 with the exception of the simulator certification examination. Utilities use a comprehensive written examination (similar in scope and format to the NRC SRO written examination) and oral examinations to verify technical competence at the SRO level. The final utility decision process for certifying SRO candidates for the NRC examination is the same as that for RO candidates.

Due to the similarities between certification practices for RO and SRO candidates, the conclusions and recommendations of Section 2.5.3.6 are applicable to the certification of SRO candidates. The importance of the involvement of corporate management in the certification process is especially true for SRO candidates, considering their supervisory responsibilities.

2.6 LICENSING OF REACTOR OPERATORS AND SENIOR REACTOR OPERATORS

2.6.1 Introduction and Background

Licensing of ROs and SROs is a formal process set forth in 10 CFR Part 55 (11). The initial step in the licensing process involves a written application for license by an authorized representative of the facility. This application includes the following:

- o Education and experience of the applicant,
- o Previous licenses held (if any),
- o Certification that the applicant has learned to operate the controls in a competent and safe manner (that is, successful completion of an NRC-approved training program) and
- o Report of current medical condition of the applicant.

These aspects of the licensing process have been addressed in Section 2.4 (Reactor Operator and Senior Reactor Operator License Training) and Section 2.5 (Selection, Screening and Certification of Reactor Operator and Senior Reactor Operator Candidates) and therefore are not included here. This section discusses the examination of RO and SRO license candidates by the NRC OLB. The operator and senior operator examinations are divided in two parts: a written examination and an operating test. Present requirements for passing the written examination are a score of 80 percent overall with no less than a score of 70 percent in each functional area. The oral and operating test is scored on a pass/fail basis. Waivers of any or all of the examination requirements may be approved by the NRC on a case basis, although waiver requests are relatively infrequent. RO and SRO licenses expire after 2 years. Licenses have been routinely renewed by the NRC if the licensee has satisfactorily completed a facility requalification program, continues to be in good physical condition and is certified by the facility to be discharging his duties safely and competently. Renewal of operator licenses and requalification training is addressed in Section 2.7. Section 2.6.2 describes RO and SRO licensing requirements and practices. NRC operator licensing requirements and practices are evaluated in Section 2.6.3. Section 2.6.4 provides conclusions and recommendations.

2.6.2 Operator Licensing Requirements and Practices

2.6.2.1 NRC Licensing Examination Requirements and Practices

The basic fede regulation concerning requirements for RO and SRO licensing is 10 CFR Part 55. Those aspects of the regulations and requirements that deal with selection, screening and certification of license applicants were described in Section 2.5. 10 CFR Part 55 specifies the scope of both written examinations and operating tests. Section 55.21 of Part 55 sets forth 12 topics to be included in the written examination. For examination purposes, these topics have been grouped into the seven categories listed below:

- o Principles of reactor operation,
- o Feature of facility design,
- o General operating characteristics,
- o Instruments and controls,
- o Safety and emergency systems,
- o Standard and emergency operating procedures and
- o Radiation control and safety.

For the senior operator written examination, Section 55.22 of Part 55 sets forth nine additional topics. For examination purposes, these topics have been grouped into the five categories listed below:

- o Reactor theory,
- o Radioactive material handling, disposal and hazards,
- o Specific operating characteristics,
- o Fuel handling and core parameters and
- o Administrative procedures, conditions and limitations.

The May 1980 proposed revision to 10 CFR Part 55 would change Sections 55.21 and 55.22 to include the categories just listed rather than the present topics. One other category (reactor plant operations) would be added to the operator and senior operator examinations that would address hydraulics, fluid flow, heat transfer and thermodynamics.

Section 55.23 of 10 CFR Part 55 sets forth the scope of RO and SRO operating tests, including operator demonstration of an understanding of procedures, manipulations, alarms and annunciators, instrumentation, systems, radiation hazards, and the Emergency Plan. The proposed revision to Section 55.23 would require that items of the RO and SRO operating test that lend themselves to use of a simulator shall be administered using a suitable simulator.

Waiver requirements are established in Section 55.24 of 10 CFR Part 55. They provide primarily for recognition of operating experience at a comparable facility in considering the need for a written or operating examination.

The primary additional guidance concerning the conduct of written examinations and operating tests has been NUREG-0094, "NRC Operator Licensing Guide," (12) which, in addition to elaborating on the requirements of 10 CFR Part 55, also includes:

- o Typical questions for RO and SRO written examinations,
- o Eligibility for examination with no reactor startup demonstration and
- o A checklist for the operating test.

The NRR letter of March 28, 1980, to all power reactor applicants and licensees (13) implemented the following changes to licensing examinations:

1. Established a new category on RO and SRO written examinations dealing with thermodynamics and related subjects (this change is consistent with the proposed revisions to Sections 55.21 and 55.22 of 10 CFR Part 55 described earlier),

2. Set time limits on the written examinations of 9 hours for ROs and 7 hours for SROs,

3. Required passing grades for written examinations of 80 percent overall and 70 percent in each category (previous standards were 70 percent overall and 60 percent in each category) and

4. Required operating tests as well as written examinations for all SRO license applicants (operating tests had been routinely waived for SRO license applicants who were currently licensed as ROs).

In practice, the examination process has been routinely implemented in the following manner. Written examinations are generally prepared by the examiners who administer them. General questions (not specific to a particular plant) are routinely taken from a book of about 400 questions. Plant-specific questions are developed from the plant's FSAR, Emergency Plan, operating procedures and Licensee Event Reports (LERs). Examinations prepared by OLB members are not formally reviewed. About 20 percent of the written examinations and operating tests are developed and administered by part-time consultant examiners; about half work full-time for national laboratories and about half are college professors. Few of these consultant examiners have had experience operating commercial reactors.

Written examinations prepared by consultant examiners are required to be reviewed by OLB group leaders.

An NRC OLB examiner comes to the applicant(s) facility to administer both the written examination and operating test. At the same time the written examination is administered, the examiner may review the examination with facility management to ensure that the questions and the answer key are current with plant design and procedures. The operating test may be given either immediately following the written examination (that is, the next day) or, if there are many applicants, (for example, cold license examinations) a few weeks after the written examination. Before simulators were generally available, the operating test included a reactor startup at the facility; however, in the last several years, this requirement has been completed through a certification by the simulator facility attesting to the applicants' ability to:

- Manipulate the controls and keep the reactor under control during a reactor startup,
- Predict instrument response and use the instrumentation during a reactor startup,

- o Follow the facility startup procedures and
- o Explain alarms and annunciators that may occur during this operation.

Therefore, the operating test does not include any manipulations of controls that would affect plant operations.

The NRC licensing requirements are more stringent for cold examinations (prior to initial criticality) than hot examinations (replacement operators). For the cold examination, the applicant must have extensive operating experience at a comparable reactor. As indicated in NUREG-0094, the examinations (written and operating) cover the same areas as the hot examinations, but the applicants' responses are evaluated more vigorously. The Chief of the OLB is the individual responsible for granting all RO and SRO licenses. The Chief's decisions are reviewed only in regard to denials of licenses, which must be approved by the Chief's superior, the Director of the Division of Human Factors Safety. There are no formal selection requirements for OLB examiners; however, the chief of the OLB attempts to select college graduates with engineering degrees and experience in plant operations. On-the-job training, including observation of actual examinations, is provided under the tutelage of one of the more experienced examiners.

The OLB "Examiner's Manual" (36) assigns OLB Group Leaders the responsibility to arrange and coordinate training programs for all headquarters and consultant examiners assigned to their groups. These programs include:

- o An annual workshop in conjunction with an examiners' conference,
- o Distribution of appropriate technical material and
- o Periodic observation of reactor operations not normally conducted but discussed orally as part of an operating test.

10 CFR 55.7 and 55.24 are the regulatory requirements with respect to criteria for waiver of examinations. These criteria include:

- o Operating experience at a comparable facility within the past 2 years,
- o Discharge of responsibilities competently and capability of continuing to do so (as certified by facility licensee) and
- o Knowledge of operating procedures and certification by facility licensee as qualified to operate competently and safely.

The Chief of the OLB is the individual charged with passing judgment on all operator license waivers.

The OLB allows multi-unit licensing, that is, licensing an RO or SRO on more than one identical or similar unit at the same facility. Most facility licensees at multi-unit facilities attempt to have ROs and SROs licensed on all identical or similar units to provide for greater flexibility in assigning operations personnel.

If an applicant fails a licensing examination, 10 CFR Part 55.12 provides procedures for re-examination. After the first failure, a new application for a license may be filed within 2 months after the date of denial. This application must detail additional training provided to the applicant. If a second failure occurs, a third application may be filed 6 months after the date of denial. Third and subsequent failures of licensing examinations require a 2-year period before filing subsequent license applications. There is no limit on the number of times an applicant may apply for an operator's license.

In practice, utilities infrequently apply for a license for a particular applicant more than twice, with some utilities allowing an applicant only one opportunity at passing the licensing examination. In the past, the OLB has used passing rates as a qualitative assessment of utility training programs and has taken a more in-depth look at programs that were associated with high failure rates. This practice has caused most utilities to be sensitive about sending for examination only those applicants whom they expect will pass. As indicated in Section 2.5.3.2, audit examinations are administered to prospective applicants before the NRC licensing examinations. In most cases, the utility will withdraw the application of an individual who does poorly on these audit examinations.

2.6.2.2 Federal Aviation Administration Certification Practices (26, 27, 28)

The FAA issues commercial pilot certificates upon successful completion of an examination process which includes a written examination, an oral examination and a flight test.

The written examination may be administered following completion of required ground instruction. This examination consists of approximately 80 multiple-choice questions and is developed and graded at the FAA Examination Standards Branch in Oklahoma City, Oklahoma. This examination covers fundamental knowledge in areas such as federal regulations, basic aerodynamics and airplane operations.

Upon successful completion of the written examination and flight training, a candidate can be administered an oral examination and flight test by an FAA examiner. The oral examination is given at the time of the flight test, but may not be given during flight maneuvers. This examination covers more plane-specific items than the written examination covers. During the oral examination, the candidate must demonstrate satisfactory knowledge in areas such as systems, components, performance factors and normal, abnormal and emergency procedures. The FAA examiner uses a standard checklist to assist in the administration of this oral examination and the flight test. This checklist lists the areas in which satisfactory knowledge is required. During the oral examination, the examiner uses the results of the written examination to probe indicated weak areas to ensure that a satisfactory level of knowledge has been achieved.

The flight test includes evaluation of pilot performance during inspections, normal procedures, prescribed maneuvers and casualties. Satisfactory performance during specific evolutions is required of all candidates examined. The use of a simulator to conduct some of these required maneuvers and procedures is authorized provided the simulator has been approved by the FAA for the specific maneuver or procedure. Federal regulations indicate that successful demonstration of an ability to perform the required pilot operations is based on the following:

1. Executing procedures and maneuvers within the aircraft's performance capabilities and limitations, including use of the aircraft's systems.
2. Executing emergency procedures and maneuvers appropriate to the aircraft.
3. Piloting the aircraft with smoothness and accuracy.
4. Exercising judgment.
5. Applying aeronautical knowledge.
6. Showing that the applicant is the master of the aircraft, with the successful outcome of a procedure or maneuver never seriously in doubt.

If the applicant fails any of the required pilot operations, the applicant fails the flight test. A 30-day waiting period is required following the flight test. The written examination does not have to be retaken until 24 months have expired without successful completion of the oral and flight test. In case of failure on the flight test, the applicant is given credit for those operations successfully performed.

2.6.3 Evaluation of RO and SRO Licensing Requirements and Practices

2.6.3.1 Evaluation of RO and SRO Written Examinations

Two fundamental areas are related to the RO and SRO written examinations: depth of knowledge required and content areas addressed. With respect to depth of knowledge, written questions can be segregated into five categories (in ascending order of depth of knowledge examined):

1. Knowledge and Recall. For example, "Define natural circulation."

2. Comprehension and Interpretation. For example, "Give two examples of natural circulation; include sketches."

3. Application of Rules and Principles. For example, "Describe the natural circulation flowpath for your reactor. List the primary indications you would monitor and give representative readings within two hours after shutdown assuming the reactor had been at 100 percent power for 30 days. List any assumptions."

4. Analysis and Deduction. For example, "List primary indications and representative readings for natural circulation within two hours after shutdown (from 100 percent power for 30 days). How would these readings change (direction and magnitude) two weeks later?"

5. Synthesis and Evaluation. For example, "List primary indications and representative readings for natural circulation within two hours after shutdown (from 100 percent power for 30 days). How would these readings change if:

a. The difference between the hot and cold leg temperatures doubled?

b. The difference in height between the reactor core and the heat sink was halved?"

These five knowledge areas are cumulative; that is, a question that involves application of rules and principles will, of necessity, also test the respondent's knowledge, recall and comprehension. For reactor operators, analysis and deduction are expected to be the most in-depth knowledge required for plant operations. For example, the reactor operator might be required to analyze plant conditions and determine what emergency operating procedure should be implemented. For senior reactor operators, the synthesis and evaluation level of knowledge would also be required. The primary example of operator actions and responsibilities falling in this area would be emergencies that are not completely addressed by individual procedures. These situations would require supervisory personnel to draw upon their knowledge of the plant and to synthesize an approach to deal with the situation based upon this knowledge; for example, develop an approach to mitigate core damage.

To evaluate the depth of knowledge on RO and SRO examinations, 10 RO written examinations and 7 SRO written examinations that provided a representative distribution of examiners and plants were selected from the OLB examination files. These examinations were then scored by the percentage of points on the examination which fell into each of the five knowledge areas identified above. Table 2.22 shows the distribution of these scores. None of the 17 examinations had any questions which required knowledge at the synthesis and evaluation level, while overall less than 4 percent of RO examination points and 7 percent of SRO examination points (that is, the mean values in Table 2.22) required knowledge at the analysis and deduction level. Overall, greater than 85 percent of RO examination points were either knowledge and recall or comprehension and interpretation level questions while greater than 75 percent of SRO examination points were in these two categories. It is more difficult and time consuming to construct and grade questions at the analysis and deduction level than at the knowledge and recall level. As indicated in interviews with the Chief, OLB, and several of his examiners, OLB examiners as a whole are overworked and, therefore do not have the time to prepare or score more in-depth examinations. In addition, these examiners do not necessarily have the depth of knowledge of individual plants to be capable of developing and evaluating

TABLE 2.22
PERCENTAGE DISTRIBUTION OF RO AND SRO WRITTEN EXAMINATION POINTS
BY DEPTH OF KNOWLEDGE ADDRESSED

EXAMINATION	RO EXAMINATIONS (percent of examination points)				
	KNOWLEDGE AND RECALL	COMPREHENSION AND INTERPRETATION	APPLICATION OF RULES AND PRINCIPLES	ANALYSIS AND DEDUCTION	SYNTHESIS AND EVALUATION
1	28.5	43.8	27.7	0	0
2	35.0	56.0	9.0	0	0
3	34.3	54.7	11.0	0	0
4	51.0	32.1	8.7	8.2	0
5	38.5	53.0	7.0	1.5	0
6	34.0	49.9	11.3	4.7	0
7	44.1	39.6	8.8	7.5	0
8	32.7	51.1	6.9	9.3	0
9	35.5	51.5	10.1	2.9	0
10	25.0	66.5	6.5	2.0	0
Mean	35.86	49.82	10.7	3.61	0
Standard Deviation	7.02	7.4	5.88	3.41	0

EXAMINATION	SRO EXAMINATIONS (percent of examination points)				
	KNOWLEDGE AND RECALL	COMPREHENSION AND INTERPRETATION	APPLICATION OF RULES AND PRINCIPLES	ANALYSIS AND DEDUCTION	SYNTHESIS AND EVALUATION
1	9.1	55.7	32.4	2.8	0
2	4.7	67.9	20.7	6.7	0
3	37.1	36.0	19.2	7.2	0
4	23.7	29.2	25.6	21.3	0
5	58.0	27.5	10.5	4.0	0
6	23.5	56.0	16.9	3.6	0
7	36.2	47.3	12.7	2.5	0
Mean	27.47	45.66	19.71	6.87	0
Standard Deviation	16.85	13.67	7.04	6.13	0

more in-depth, plant-specific questions. Once again, this is due to a lack of time in the examiners' schedules for gaining this knowledge.

To evaluate the content areas of RO and SRO examinations, the skills and knowledges required for adequate performances as ROs and SROs that were developed from the job task analysis in Section 2.3 were used. An evaluation was conducted to determine which of these skills and knowledges were suitable for written examination. This evaluation indicated 34 subject areas suitable for written examination (shown in Table 2.23). Representative written RO and SRO examinations were then evaluated, and each question was categorized into 1 of these 34 subject areas. For the SRO examination evaluated, 11 of the 34 subject areas judged suitable for written examination were addressed; while for the RO examination, 12 of 25 subject areas were addressed (9 skills and knowledges were required for SROs only).

As shown in Table 2.23, RO examination questions were largely (76 percent) categorized by three skills and knowledges:

SKILL OR KNOWLEDGE	PERCENT OF EXAMINATION POINTS
o Purpose, functions, design basis and limits, and interrelationships of plant systems	49.0
o Principles and theories of nuclear physics and reactor theory	20.0
o Performance of required actions of the Emergency Plan and emergency operating procedures.	7.0

The bulk of the SRO examination (84.5 percent) addressed six of the SRO skills and knowledges:

SKILL OR KNOWLEDGE	PERCENT OF EXAMINATION POINTS
o Identification of technical specification limits and basis	36.0
o Principles and theory of nuclear physics and reactor theory	15.0

TABLE 2.23
DISTRIBUTION OF RO AND SRO WRITTEN EXAMINATION POINTS
BY SKILL AND KNOWLEDGE AREAS

SKILLS AND KNOWLEDGES	RO OR SRO	SRO ONLY	PERCENT OF EXAMINATION POINTS ADDRESSED BY	
			SRO EXAM	RO EXAM
1. Principles or theories of health physics	X		4.0	4.0
2. Principles or theories of mathematics	X		0	0
3. Principles or theories of chemistry	X		1.0	0
4. Principles or theories of nuclear physics and reactor theory	X		15.0	20.0
5. Principles or theories of I&C	X		0	1.0
6. Principles or theories of nuclear instruments	X		0	3.5
7. Principles or theories of electricity and electronics	X		0	0
8. Principles or theories of heat transfer and fluid flow	X		6.5	0
9. Principles or theories of generic nuclear power plant systems and components	X		0	1.0
10. Know general plant safety precautions	X		0	0
11. Identify technical specification limits	X		36.0	4.0
12. Know whether procedures or changes to procedures can be authorized on shift		X	0	-
13. Review completed written procedures		X	0	-
14. Know purpose, functions, design basis and limits, and interrelationships for all plant systems and equipment		X	9.5	49.0
15. Calculate radiation levels, doses, etc.	X		1.0	1.0
16. Identify results of area radiation surveys and air samples	X		0	0

TABLE 2.23 (continued)
DISTRIBUTION OF RO AND SRO WRITTEN EXAMINATION POINTS
BY SKILL AND KNOWLEDGE AREAS

SKILLS AND KNOWLEDGES	RO OR SRO	SRO ONLY	PERCENT OF EXAMINATION POINTS ADDRESSED BY	
			SRO EXAM	RO EXAM
17. Plan radwaste releases for appropriate conditions		X	0	-
18. Identify actions associated with shift activities		X	0	-
19. Calculate plant parameters	X		0	0
20. Choose components to isolate that will provide necessary safety	X		0	0
21. Choose operators to support activities in consideration of allowable radiation exposures		X	0	-
22. Read applicable procedures, directives, electrical prints, flow diagrams, etc.	X		0	0
23. Determine conditions that preclude shift activities (turnover, training, etc.)			0	0
24. Identify events and actions requiring written reporting		X	3.0	-
25. Determine additional equipment or support required to combat emergencies		X	0	-
26. Comply with applicable station directives and ensure that others comply		X	11.0	0
27. Carry out actions of the Emergency Plan and emergency operating procedures (partial*)	X		6.0	7.0
28. Determine steps or procedures for emergency conditions, given any applicable cue(s) (partial*)	X		0	0

*"Partial" indicates that these skills and knowledges can only be partially evaluated by written examination. Complete evaluation of these skills and knowledges would require an oral or operating examination.

TABLE 2.23 (continued)
DISTRIBUTION OF RO AND SRO WRITTEN EXAMINATION POINTS
BY SKILL AND KNOWLEDGE AREAS

SKILLS AND KNOWLEDGES	RO OR SRO	SRO ONLY	PERCENT OF EXAMINATION POINTS ADDRESSED BY	
			SRO EXAM	RO EXAM
29. Determine required abnormal, offnormal or alarm procedures given any applicable cue(s) (partial*)	X		0	3.5
30. Determine that cue(s) is(are) not completely addressed by a single procedure (partial*)	X		0	0
31. Determine whether multiple casualties have occurred (partial*)	X		0	0
32. Identify cue(s) as indicative of an emergency condition (partial*)	X		7.0	1.0
33. Identify cue(s) as indicative of abnormal, offnormal or alarm conditions (partial*)	X		0	0
34. Carry out all evolutions addressed by normal operating procedures in proper sequence through reference to procedures (partial*)	X		0	5.0

*"Partial" indicates that these skills and knowledges can only be partially evaluated by written examination. Complete evaluation of these skills and knowledges would require an oral or operating examination.

SKILL OR KNOWLEDGE	PERCENT OF EXAMINATION POINTS
o Compliance with applicable station directives	11.0
o Purpose, functions, design basis and limits, and interrelationships of plant systems	9.5
o Identification of cues as indicative of an emergency condition	7.0
o Performance of required actions procedure of the Emergency Plan and emergency operating procedures,	6.0

While the six skills and knowledges just mentioned are important to ensuring a safe and competent SRO, other skills and knowledges of Table 2.23 are also important, and it would be desirable to sample applicants' knowledge in these areas as well.

It is felt that the distribution of RO and SRO examination points by skills and knowledges is not more uniformly distributed than it is for two reasons:

1. Guidance concerning the content of RO and SRO examinations (NUREG-0094 and 10 CFR Part 55) is organized around the facility features, system characteristics and theory rather than around what the operator is required to do in performing his job.

2. Questions were written primarily at the recall and comprehension levels, which fact, combined with item 1 above, lead to an examination of memorized facts and figures. An examination written at the analysis and evaluation levels would be oriented more toward operator actions and, thus, would tend to sample more operator skills and knowledges.

Based upon the limitations of current written licensing examinations with respect to the depth of questions and the concentration of examinations on only a few of the RO and SRO skills and knowledges suitable for evaluation through a written examination, it is judged that these examinations do not have sufficient content validity (that is, a passing score on the written examination does not ensure that an applicant has sufficient knowledge to function as an RO or SRO).

Current written examinations are almost exclusively essay and short-answer examinations, with few, if any, objective (multiple-choice) questions. Present OLB training requirements are informally identified and do not specify examiner training on methods to reduce inter- and intra-scorer differences, which is necessary to provide reliable essay tests. Standard answer keys have been developed for generic questions. This practice is valuable in maintaining the reliability of these questions; however, plant-specific questions and their associated answer keys are routinely prepared by individual examiners without any routine review for consistency.

Essay and short-answer questions are necessary to address synthesis and evaluation level of knowledge questions, although they have limitations with respect to inter- and intra-scorer reliability. However, for knowledge/recall and comprehension/interpretation level questions, objective (multiple-choice) questions could be used and would have the following advantages:

- o Less time is required for the applicant to respond to each question; therefore a greater sampling of knowledge can be obtained in the same time with objective questions than with essay questions.

- o Objective question responses can be scored more rapidly than essay questions, reducing administration time.

- o Statistical methods can be used to identify the uncertainty in the observed test score, thus providing an objective measure of an individual's knowledge and skills.

- o The effects of writing ability, time limitations and other biases on test scores can be determined.

- o Quantitative corrections for guessing on questions can be used, which is not possible with essay tests.

In spite of the limitations associated with using a written examination to evaluate the skills and knowledges of ROs and SROs, written examinations are an appropriate part of the licensing process because they provide the most efficient way of sampling the knowledge of multiple candidates. With the present shortage of OLB examiners, this advantage is particularly important.

2.6.3.2 Evaluation of RO and SRO Oral and Operating Examinations

It has become standard practice for the reactor startup portion of the RO and SRO oral and operating tests to be conducted at a control room simulator. Most of these startups are administered by vendor training center personnel, except where the utility operates the simulator. In these cases, OLB examiners generally conduct the startup test. Therefore, the license applicant routinely does not perform any plar . manipulations during the oral and operating test administered by the OLB examiner that would interfere with power operations. The oral operating test has thus become primarily a walk-through of the applicant's plant. Thus, there are a number of areas of the oral and operating examination summary report [Appendix G of NUREG-0094 (12)] that cannot be properly examined during the plant walk-through. These inc' .ue the following:

- o Manipulations,
- o Understanding of console operations,
- o Conduct of normal, abnormal and emergency operating procedures,
- o Effects of malfunctions,
- o Ability to predict responses,
- o Ability to follow procedures,
- o Dexterity and feel for console operations,
- o Knowledge of reactivity effects,
- o System behavior and response,
- o Ability to manipulate manual controls,
- o Knowledge of automatic controls,
- o Component response and
- o Reactivity effects including coefficient effects and transient analysis.

This is a serious deficiency in the current licensing process because these are skills and knowledges that are important to safe operation of the plant. The skills and knowledges identified above can be evaluated either in the applicant's control room or at a control room simulator; however, for both safety and practical reasons, the plant is not suitable. It is not acceptable to initiate emergency or abnormal events on the plant. In addition, the cost is great due to lost revenues while the plant is not producing electricity. Therefore, control room simulators provide the only mechanism for evaluating some RO and SRO skills and knowledges and should be used during the licensing process. Simulators used for this purpose should meet the same criteria concerning similarity to the applicant's facility as identified in Section 2.4 for operator license training.

Appendix F of NUREG-0094, "Eligibility for Examination with No Reactor Startup Demonstration," indicates that, for those applicants who are examined without a reactor startup demonstration, the simulator training center shall certify to the applicant's ability to:

- o Manipulate the controls and keep the reactor under control during a reactor startup,
- o Predict instrument response and use the instrumentation during a reactor startup;
- o Follow the facility startup procedures and
- o Explain alarms and annunciators that may occur during this operation.

In comparing the RO and SRO skills and knowledges considered suitable for evaluation through an oral and operating test with those capable of being comprehensively evaluated through a plant walk-through and reactor startup, the following RO and SRO skills and knowledges were determined <u>not</u> to be capable of evaluation through current OLB licensing practices:

1.* Coordinate actions of two or more procedures (SRO only).
2. Carry out actions of abnormal, offnormal and alarm procedures in proper sequence through reference to procedures.
3.* Recall plant personnel (SRO only).
4.* Use decision rules (SRO only).
5.* Maintain good judgment and problem-solving performance under stressful or physically hazardous environment.
6.* Identify cues as indicative of an emergency condition.
7.* Determine that cues are not completely addressed by a single procedure.
8.* Determine whether multiple casualties have occurred.
9. Identify cues as indicative of an abnormal, offnormal or alarm condition.
10.* Receive advice from Shift Technical Advisor and other technical personnel (SRO only).
11.* Coordinate actions of all shift personnel (SRO only).

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*Skill or knowledge is a critical requirement as defined in Section 2.4.1.

It is important to note that 9 of these 11 skills and knowledges not evaluated by current OLB licensing methods are critical requirements (as defined in Section 2.4.1) for performance as an RO or SRO. A control room simulator would be required to conduct a comprehensive evaluation of an applicant's proficiency in these skills and knowledges.

In a review of the operating and oral examination summary report (Appendix G of NUREG-0094, NRC Form 157), the following limitations of such an examination method were noted:

- No provision is made for a quantitative measure of applicant performance and knowledge; only a pass/fail criteria can be assigned.

- No provision is made on the form for the OLB examiner to prepare questions before the test or to ask followup questions.

- With evaluations of "satisfactory", "marginal" or "unsatisfactory" in each subject area, there is no objective or consistent method to ensure that each examiner has similar criteria for acceptance or even that the same examiner is consistent in acceptance criteria from one examination to the next.

- The examination form and method do not lend themselves to consistent examinations from one examiner to the next (there is no record of questions asked or method to review the examination material before or after it is administered).

OLB examiners also indicated dissatisfaction with the operating and oral examination summary report and the associated examination method. Utility training coordinators indicated that the most important item of interest about forthcoming RO or SRO examinations (particularly the oral tests) was the identity of the NRC examiner because each examiner emphasized different areas. These comments further indicate that present oral examination methods are not resulting in consistent examinations and examination methods between different examiners.

In the operator licensing process, a place exists for both an oral examination and an operating examination; however, these tests should be clearly separated and the skills and knowledges appropriate for each method determined.

The oral examination should be conducted as a walk-through of the applicant's facility, with emphasis on equipment and actions to be performed outside the control room, because these areas cannot be addressed at a control room simulator.

The operating test should be conducted on a control room simulator and should evaluate applicant performance in representative emergency, abnormal and normal conditions.

Other regulatory agencies use three distinct examinations (written, oral and operating) for licensing and certifying operators. As indicated in Section 2.6.2.2, the FAA certifies commercial pilots through a multiple-choice written test, followed by an oral test addressing airplane-specific systems, performance and procedures, and, finally, an operating test in either the airplane, on a simulator or a combination of the two. As indicated in Section 2.5.3.4, the U.S. Navy certifies their enlisted and officer operators through a written examination, an operating test on a prototype reactor plant (in the form of graded watches) and an oral examination administered by a board of qualified personnel.

2.6.3.3 Evaluation of OLB Waiver and Re-examination Requirements and Practices

To evaluate OLB waiver practices and compare them to 10 CFR Part 55 requirements, 10 utility waiver requests and OLB responses were evaluated. In addition, interviews were conducted with the Chief of the OLB, who acts on all waiver requests, and with the training coordinators at each of the nine license facilities visited. On the basis of this information, it appears that the granting of waivers, as it has been implemented to date by OLB, has not had any detrimental effect on the health and safety of the public because waivers have been granted in a conservative manner. The OLB has apparently taken particular care to ensure that, for any waivers granted, there are clear indications (including previous examination scores, operating experience and formal training) that the applicant has acquired the skills and knowledges addressed by the waived examination.

The primary limitation with the waiver process as it presently exists is that, other than 10 CFR Part 55.24 (which provides broad requirements), licensees are not given formal guidance on acceptable criteria for waivers. The OLB "Examiner's Manual" does provide some criteria for waiver of examinations; however, it primarily addresses waivers based upon previous examinations at "identical," "similar" or "different" units and is not available to licensees. The lack of specific formal criteria for waivers leads to the following potential problems:

- o No formal avenues for audit or review of waivers,
- o The application of criteria that may not be consistently applied to all licensees because of the subjective nature of current procedures and
- o No mechanism to provide consistency in the granting of waivers in the absence or departure of the incumbent Chief of the OLB.

The Chief of the OLB is judged to be the appropriate approval authority for waiver requests.

While the waiver process for licensing individuals on multiple units seems appropriate, one aspect related to the implementation of multi-unit licensing is of concern - the maintenance of operator proficiency on multiple units. Some utilities have dealt with this question by routinely rotating personnel from one unit to another; however, other utilities have not implemented a method to maintain operators proficient at all units for which they hold a license.

As indicated in Section 2.6.2.1, 10 CFR Part 55 allows for an individual who fails a licensing examination to be re-examined after 2 months, 6 months and 2 years after the first failure, second failure and subsequent failures, respectively. For the reasons indicated in Section 2.6.2.1, this system is not apparently being abused. Also, the waiver process is being conservatively applied to re-examinations in terms of determining whether all or part of the examination must be retaken.

2.6.3.4 Evaluation of Pass/Fail Criteria as a Measure of NRC and Utility Qualification Programs and Operator Performance

The percentage of RO and SRO applicants that pass the NRC's licensing examinations can potentially be an effective measure of the quality of utility training and qualification programs, if the examinations are verified to accurately evaluate if an applicant possesses the skills and knowledges required for licensing.

In Section 2.3.5.2, an attempt was made to validate the RO and SRO written examinations as predictors of RO and SRO job performance. This analysis indicated no statistically significant correlation between RO or SRO written examination scores and the performance of these same operators. Evaluation of the RO and SRO written and oral or operating examinations in Sections 2.6.3.1 and 2.6.3.2, respectively, indicated that:

- o The RO and SRO written examinations measured primarily recall and comprehension rather than operator skills and knowledges in analysis, evaluation and synthesis.

- o The RO and SRO oral and operating examinations were subjectively evaluated with no assurance of consistency between examiners.

On the basis of the results above, it is not expected that actual pass/fail ratios for present RO or SRO licensing examinations would necessarily be valid or reliable measures of the quality of a utility's training and qualification program; however, it would be important to have such a measure of utility training and qualification programs, and the NRC operator licensing examination is potentially the best method for providing this performance measure. Therefore, this need is another reason for the NRC to work toward modifications and improvements to current examination methods.

There is precedence for using expected versus actual pass/fail ratios for evaluation of training and qualification programs. The FAA uses an 80-percent passing rate as a point below which an automatic audit of the subject training and qualification program results. Since the OLB has a very limited staff, this methodology could serve as the vehicle for allocation of auditing resources to identify and upgrade weaker training programs.

The accepted quantitative methods for developing criteria for minimum acceptable scores for criterion-referenced examinations involve first determining the relationship between scores on the examination of interest and the performance of these same individuals in their jobs (37). Then, by defining an acceptable level of job performance, the associated examination score is determined that segregates acceptable from unacceptable performers. For this method to be used, the examination must be performance related (that is, a relationship between examination scores and job performance must exist).

As noted earlier in this section, for the data base evaluated, no statistically significant relationship was found between RO or SRO written licensing examination scores and job performance. In addition, the examination questions were generally judged not to be performance based. These two results strongly suggest that the present operator licensing written examinations are not performance related. RO and SRO oral and operating tests cannot be performance related because they are pass/fail tests. Therefore, no objective method is presently available to determine a minimum passing score criterion for RO or SRO examinations, and there is not apt to be one until:

- The written examination is performance based and
- The oral and operating test is graded with consistent numerical scores.

Some qualitative assessment of NRC operator licensing examination minimum passing scores and pass/fail ratios can be obtained through a comparison of operator written examination data with data from other high-technology industries with common goals of providing safe and competent operators. The operators considered include:

- Airline transport pilots,
- Airport control tower operators,
- U.S. Navy Officers (EOOW),
- U.S. Navy reactor operators (enlisted),
- U.S. Merchant Marine Chief Engineers and
- U.S. Merchant Marine Assistant Engineers.

Table 2.24 shows the required passing grades and percentage passing licensing (certification) examinations for each of these professions. About 90 percent passed these examinations in almost all occupations including ROs and SROs. A minimum score of 70 percent was used for those occupations requiring a minimum passing grade. This criterion is consistent with NRC passing criteria used until May 1980 (13), when the minimum passing criterion was raised to 80 percent. As indicated in SECY-79-330E, "Qualifications of Reactor Operators" (38), this change was made to "prevent individuals from obtaining licenses who have a lack of knowledge in specific areas." While this 80-percent criterion seems acceptable as an interim measure, it would be preferable in the long term to have performance-based licensing examinations with criterion-referenced validity where a quantitative basis for a minimum passing score could be developed.

TABLE 2.24
COMPARISON OF PASSING GRADES AND PERCENT OF PERSONNEL PASSING EXAMINATIONS

OCCUPATION	NUMBER EXAMINED	MINIMUM PASSING GRADE	PERCENT PASSING	DATE OF EXAMINATIONS
Airline Transport Pilot	3144	70	90	3/78, 1/79, 1/80
Airport Control Tower Operator	4344	70	88	3/78, 1/79, 1/80
U.S. Navy Officer (EOOW)				
Nuclear Power School	Unknown	*	89	1975 - 1979
Prototype Reactor Training	Unknown	*	98	1975 - 1979
U.S. Navy Reactor Operators (enlisted)				
Nuclear Power School	Unknown	*	73	1975 - 1979
Prototype Reactor Training	Unknown	*	85	1975 - 1979
U.S. Merchant Marine				
Chief Engineer	Unknown	70	≈ 80	Unknown
Assistant Engineer	Unknown	70	≈ 99	Unknown
Utility Reactor Operator				
Written examination	852	70**	90.6	1975 - 1978
Oral and operating test	852	Pass/fail	[illegible].5	1975 - 1978
Overall	852	-	88.5	1975 - 1978
Utility Senior Reactor Operator				
Written examination	937	70**	92.8	1975 - 1978
Oral and operating test	937	Pass/fail	93.7	1975 - 1978
Overall	937	-	89.4	1975 - 1978

*No single examination is associated with certification of these occupations, therefore no minimum passing grade is appropriate.

**These minimum passing scores were raised to 80 percent in May 1980.

2.6.4 Operator Licensing Conclusions and Recommendations

The OLB is a dedicated group of individuals who are genuinely interested in permitting only fully qualified personnel to serve as licensed operators of nuclear power plants. OLB requirements and practices have provided a much needed standard for evaluating the qualifications of these individuals and, hence, have resulted in a significant contribution to the safety of nuclear power plants. The following conclusions and recommendations address areas where improvement is needed to provide increased assurance of operational safety.

2.6.4.1 Conclusions

1. To conduct the best comprehensive evaluation of whether RO and SRO applicants will be safe and competent operators with the limited personnel resources of the OLB, a combination written, oral and operating examination is required. Each of these three examination methods has some unique advantages and limitations with respect to evaluating applicants:

    Written Examinations. Written examinations are the most efficient way to evaluate the knowledge of multiple candidates, but they do not lend themselves to evaluation of operator manipulative or procedural skills.

    Oral Examinations. Oral examinations provide the flexibility to probe knowledge to a greater depth, as required. They offer an opportunity for demonstration of some skills. Oral examinations require fewer resources than operating examinations.

    Operating Examinations. Operating examinations are the only valid method of evaluating manipulative and procedural skills, but they require more resources than other examinations.

2. RO and SRO written examinations, as currently used, have the following limitations:

a. RO and SRO written examination questions primarily measure knowledge and recall, and comprehension and interpretation. To perform adequately, particularly for emergency conditions, an RO must have a greater depth of knowledge (at the analysis and deduction level) and an SRO an even greater depth of knowledge (synthesis and evaluation level). Thus, most RO and SRO examination questions do not probe the applicant's knowledge to a sufficient depth.

b. The contents of RO and SRO written examinations do not include all the skills and knowledges determined to be suitable for written examination. The content of RO written examinations is heavily weighted in the areas of:

- o Plant systems (purposes, functions, design basis and limits, interrelationships, and instrumentation and controls),
- o Principles and theories of nuclear physics and reactor theory and
- o Response to emergency conditions.

The content of SRO written examinations is heavily weighted in the areas of:

- o Technical specification limits,
- o Plant systems (purposes, functions, design basis and limits, interrelationships, and instrumentation and controls),
- o Principles and theories of nuclear physics and reactor theory,
- o Principles and theories of heat transfer and fluid flow,
- o Station directives and
- o Identification of and response to emergencies.

While these skills and knowledges a. important in ensuring that an applicant will be a safe and competent operator, there are 13 other RO skills and knowledges and 23 other SRO skills and knowledges that are also suitable for the written examination. Skills and knowledges that are infrequently evaluated on either RO or SRO written examinations include:

- Principles and theories of chemistry,
- Principles and theories of electricity and electronics,
- General plant safety procedures and precautions,
- Review and authorization of maintenance activities,
- Isolation of plant components for maintenance and surveillance and
- Reading of electrical prints, flow diagrams, control and logic diagrams, etc.

c. The combination of limitations b and c leads to the conclusion that RO and SRO written examinations do not have sufficient content validity; that is, based upon these limitations, a passing score on the written examination does not ensure that an applicant has sufficient knowledge to function as an RO or SRO.

d. Through the analysis conducted in an attempt to validate written licensing examinations, no statistically significant relationship between RO or SRO examination scores and operator performance was found. This means that RO and SRO written examinations have no criterion-referenced validity (no relationship to job performance).

e. Since RO and SRO written examinations were determined to have insufficient content validity and no criterion-referenced validity, satisfactory completion of these written examinations does not provide:

  - The necessary assurance that applicants will be safe and competent operators,
  - A valid measure of the effectiveness of licensee training and qualification programs or
  - A quantitative means for determining an appropriate minimum passing score.

f. For a test to be valid, it must be reliable (that is, consistent). Because of the current format of using solely essay-type questions, it is difficult to:

- o Provide an objective measure of an individual's ability (determine a confidence interval around an observed test score) or
- o Discern the effects of writing ability, time limitations and other biases on test scores.

The use of essay tests necessitates some assurance that inter- and intra-scorer differences are minimal. In practice, it is extremely difficult to provide this assurance, which leads to a decrease in consistency and dependability. Various means can be used to help ensure reliable tests. Among them are:

- o Workshops in test development and scoring,
- o Detailed guidelines for constructing tests including the use of standardized answer keys and parallel (equivalent) questions and
- o Any other mechanism that will help standardize test construction and scoring practices.

Although standard answer keys for generic questions are used and informal examiner meetings, which include discussion of these issues, are held, no current program integrates these practices with a central objective of providing reliable tests.

Another means to increase the reliability of a test is to use a balanced combination of essay, short-answer and objective (multiple-choice) items. The use of well-constructed, multiple-choice items has the following advantages:

- o Allows a much greater sampling of content areas,
- o Reduces administration time,
- o Provides for objective measurement of ability,
- o Allows the assessment of various biases on test scores,
- o Allows for the empirical determination of item effectiveness,
- o Can be used to measure all levels of knowledge, with the exception of synthesis and evaluation and
- o Can be corrected for guessing.

The FAA and the Merchant Marine written examinations are composed entirely of multiple-choice items. Although this approach is not advocated, the advantages of using a well-balanced examination of both essay and multiple-choice questions are evident from the discussions above.

3. RO and SRO oral tests, as currently used, have the following limitations:

   a. A number of areas that are currently a part of the oral test cannot be properly examined through this method. These include:

      - Manipulations,
      - Understanding of console operations,
      - Ability to carry out normal, abnormal and emergency operating procedures,
      - Effects of malfunctions,
      - Ability to predict instrument and system responses,
      - Dexterity and feel for console operations and
      - Reactivity effects, including coefficient effects and transient analysis.

   b. The present criteria for determining whether an applicant has passed the oral test is subjective and there is no mechanism available for ensuring consistent scoring or examination methods between examiners. Upon completion of the operating test, which generally lasts several hours, the examiner must make a "pass/fail" evaluation based upon marks of "S" (satisfactory), "M" (marginal) or "U" (unsatisfactory) in each of the areas of the operating and oral examination summary report form, plus any comments the examiner may have written during the oral test. There are no written criteria for a failing score resulting from a given number of "U" or "M" marks, or a consistent basis for assignment of an "S", "M" or "U" to a response.

      No record of questions administered during the oral test is required. This procedure provides no routine means for supervisors to ensure that examiners are administering consistent examinations or for counseling examiners on their techniques. OLB procedures provide for the Chief, OLB, or his designated representative to accompany each examiner annually during the administration of at least one written and one oral and operating test, to provide an opportunity for counseling and exchange of views on examination administration. However, due to personnel constraints during the past several years, this policy has not been effectively implemented.

4. The present RO and SRO operating tests, which require only a reactor startup demonstration, do not adequately ensure an RO applicant's ability to recognize or respond to emergency or abnormal conditions or an SRO applicant's ability to direct plant operations, particularly during emergency or abnormal conditions. Operating tests are potentially the most valid measure of whether an applicant will be a safe and competent operator, since the examiner can essentially evaluate the applicant's performance on the job. Operating tests that include representative emergency and abnormal events provide a unique opportunity to evaluate the applicant's ability to perform under the stress of these conditions. Control room simulators provide the only feasible method for conducting comprehensive operating tests.

5. OLB licensing practices and requirements have placed too much emphasis on the written examination and not enough emphasis on operating tests. Many utility training and qualification programs are structured more toward ensuring that applicants pass OLB licensing examinations than they are based upon comprehensive task-related criteria. Therefore, not only does the OLB licensing process not provide a comprehensive evaluation of RO or SRO performance, but, for this reason, many utility training programs do not provide comprehensive training in the same areas in which the examinations are deficient.

6. No serious deficiencies were noted in OLB examination waiver methods. Waivers have apparently been granted only where there is clear evidence that previous experience or knowledge is equal to or greater than that required to pass the subject examination.

Prior to changes to OLB practices resulting from the NRR letter of March 1980, waivers of the oral and operating test for SRO applicants who were licensed and performing as ROs were routinely granted. Automatic waivers of any licensing requirements are not appropriate. If a requirement is unnecessary, the regulations, regulatory guides and standards should be revised to delete it.

7. The practice of licensing operators on multiple units is considered appropriate as long as provisions are made by the operating organization to maintain operator familiarity with all units for which a license is held.

8. Current OLB re-examination requirements and practices were determined to be appropriate.

2.6.4.2 Recommendations

1. RO and SRO licensing examinations should be composed of three distinct parts:

   - o A written examination,
   - o An oral test administered at the applicant's facility and
   - o An operating test administered at an appropriate control room simulator.

   Applicant· should be required to pass all three parts of the examination to be licensed.

2. RO and SRO written examinations should be revised to improve their content validity and reliability. These changes should include:

   - o Organization of examinations around required RO and SRO skills and knowledges rather than around facility features, system characteristics and theory.

   - o Development of more operation-oriented questions that evaluate RO and SRO knowledge to greater depth. RO questions should be at the analysis and deduction level with some SRO questions at the synthesis and evaluation level.

- o Implementation of an integrated program to improve reliability to include workshops in test development and scoring and formal guidelines for constructing tests.

The OLB should also begin integrating objective (multiple-choice) questions into written examinations to allow a greater sampling of knowledge, reduce administration time, and improve examination reliability; however, the entire examination should not be objective questions since higher level knowledge questions (synthesis and evaluation) are not suitable to this format.

3. The scope of the oral test should be limited to those skills and knowledges that have been determined to be suitable for examination by a "walk-through" of the applicant's facility.

The procedure for administration of the oral test should be revised to provide for more reliable (consistent) and auditable results. These revisions would include:

- o Organization of examination by skills and knowledge areas,
- o Assignment of point values to each of these skills and knowledge areas,
- o Use of a numerical scale rather than the present "satisfactory," "marginal" or "unsatisfactory" scale,
- o Preparation of particular questions for each of the skills and knowledge areas prior to administration of the test and a pre-test review of these questions by OLB supervisors,
- o Periodic OLB examiner workshops and training sessions to provide examiners with an opportunity to compare their scoring standards to those of other examiners.

Through scoring each question at the time it is administered on a numerical scale and by having a weighting assigned to each question, at the completion of the oral test the examiner can determine a quantitative score for the total test.

By advance preparation of particular questions, an opportunity is provided for pre-test review of individual test questions as well as for the comparison of examiner questions over time.

By conducting periodic workshops with structured sessions that provide a controlled environment, examiners (and OLB management) can evaluate the consistency of their question selection, administration methods and scoring standards.

Through a combination of the changes described above, the oral test would be a more reliable, valid and auditable measure of whether an applicant will be a safe and competent operator.

4. The scope of the operating test should be expanded to include evaluation of applicant performance in:

   - Recognizing emergency conditions and carrying out the appropriate actions of emergency operating procedures and Emergency Plan,
   - Recognizing abnormal, offnormal and alarm conditions and carrying out the actions of appropriate procedures and
   - Carrying out normal plant operations in accordance with appropriate procedures (not limited to a reactor startup).

   The operating test should be conducted on a control room simulator. In the long term, these operating tests should be administered by OLB examiners. As an interim measure, the OLB should develop and provide criteria to vendor training centers to expand the certifications that they now perform (reactor startup) to include the areas above. For utility-owned simulators, OLB examiners should either witness or administer operating tests.

5. The aggregate of these recommended revisions requires a substantial implementation effort. It is recommended that the OLB take a systematic approach to revising operator licensing methods. The revision of examinations should <u>not</u> be assigned to present examiners as a collateral duty, but rather to a separate functional group whose purpose is development and implementation of a program to revise examination methods. In this manner a smooth transition in licensing methods can be realized without further overloading present OLB personnel.

2.7 ASSURING CONTINUED OPERATOR COMPETENCY

2.7.1 Licensed Operator Requalification Programs

2.7.1.1 Requalification Requirements

Industry Standards. ANSI/ANS-3.1-1978, "Selection and Training of Nuclear Power Plant Personnel," requires a requalification training program (often called "retraining") covering a 2-year period which includes preplanned lectures, on-the-job training and operator evaluations on a regular and continuing basis. These three basic parts of requalification programs include the following components:

a. Preplanned Lectures. No less than six per year, spaced throughout the year. Attendance may be required of all licensed individuals or attendance requirements may be based on the results of an annual comprehensive examination (minimum grade required for lecture exemption is 80 percent).

b. On-the-Job Training

   1. Control Manipulations. Ten reactivity control manipulations are required during the 2-year period. SRO licensed personnel can receive credit by directing or evaluating these manipulations. Acceptable manipulations are listed. No requirements are specified to ensure a variety of manipulations are performed.

   2. Knowledge of plant systems. The program should include a review of operational requirements. Demonstration of this training can be satisfied by manipulations of the system, walk-through of procedure steps and use of a simulator.

   3. Knowledge of facility design changes, procedure changes and facility license changes. This training may be accomplished by lectures, meetings or written communications to licensed individuals.

4. Review of abnormal, emergency and security procedures. This training can be accomplished by actual performance on the plant, performance on a simulator, walk-through on the plant, on-shift lectures or self-study combined with these techniques.

c. Evaluation

1. Annual examinations. This written examination is required to be comparable in scope and difficulty to the NRC licensing examination. A grade of less than 70 percent overall results in mandatory participation in an accelerated requalification program and removal from license duties until upgrading is completed. A grade of greater than 70 percent is required on any examination used to indicate successful completion of accelerated requalification.

2. Periodic examinations. Written examinations are required during the lecture series. A grade of less than 80 percent requires additional training in the subject area.

As stated in this standard, facility staff members who hold RO and SRO licenses for the purpose of providing backup capability to the operating staff are required to participate in the program except to the extent that their normal duties preclude the need for requalification in certain areas.

The December 1979 proposed revision to ANSI/ANS-3.1-1978, if adopted, would make the following changes to these requirements:

- More detailed requirements for control manipulations would exist. This revision lists 6 manipulations which would be required on an annual basis and 21 other manipulations which, if applicable, would be required on a biennial basis.

- For the annual written examination, accelerated requalification in a particular subject area would be required if a grade of less than 70 percent was received in a section, and an overall grade of less than 75 percent would result in accelerated requalification.

- o An annual oral examination (in addition to the written examination) would be required.

Federal Regulations and NRC Guidance. Appendix A to 10 CFR Part 55 is the basic document that establishes federal requirements for licensed operator requalification programs. The purpose of the program as indicated in this appendix is to demonstrate competence for license renewal in place of another NRC licensing examination every 2 years. Utility requalification programs are required to be approved by the OLB. The requirements of this appendix are the same as those of ANSI/ANS-3.1-1978, with the following exceptions:

- o The use of simulators is encouraged for satisfying requirements for reactivity control manipulations, demonstrating understanding of systems operations and simulating emergency and abnormal conditions for retraining. If a simulator is used, it must accurately reproduce the operating characteristics of the facility, and the arrangement of the instrumentation and controls of the simulator must closely parallel that of the facility (this requirement has not been interpreted to mean a plant-specific simulator).

- o Specific subject areas are listed for the preplanned lectures if annual examinations indicate that emphasis is needed in these areas. These subjects include:

  - Theory and principles of operation,
  - General and specific plant operating characeristics,
  - Plant instrumentation and control systems,
  - Plant protection systems,
  - Engineered safety systems,
  - Normal, abnormal and emergency operating procedures,
  - Radiation control and safety,
  - Technical specifications and
  - Applicable portions of Title 10, Chapter I, Code of Federal Regulations.

The March 1980 NRR letter to power reactor applicants and licensees implemented three additional requirements for requalification programs. These include:

- o Modifying the content of requalification programs to include instruction in heat transfer, fluid flow, thermodynamics and mitigation of accidents involving a degraded core,

- o Modifying the criteria for requiring participation in accelerated requalification to be consistent with the new NRC written examination passing grades of 80 percent overall and 70 percent on each category and

- o Modifying the control manipulations requirements to include the list of 27 manipulations that are specified in the December 1979 proposed revision to ANSI/ANS-3.1-1978. Six specific manipulations are required to be performed or simulated annually by in-plant walk-through or drills in a control room simulator. The remaining manipulations are required biennially. The six required annual manipulations are the following:

    - Plant or reactor startups to include a range that reactivity feedback from nuclear heat addition is noticeable and heatup rate is established,
    - Manual control of steam generators and feedwater during startup and shutdown,
    - Any significant (greater than 10 percent) power changes in manual rod control or recirculation flow,
    - Loss of coolant including:
        - Significant PWR steam generator leaks,
        - Inside and outside primary containment,
        - Large and small losses, including leak-rate determination and
        - Saturated reactor coolant response (PWR),
    - Loss of core coolant flow and natural circulation and
    - Loss of all feedwater (normal and emergency).

The May 1980 proposed revision to 10 CFR Part 55, currently undergoing review, would make several regulation changes to place more emphasis in requalification programs. These changes would include the following:

- o Require enrollment in the requalification program as a condition of an operator's license,
- o Reinforce the importance of completing annual examinations by indicating that a license may be revoked or suspended for failure to satisfactorily complete these examinations,
- o Require the use of a simulator for abnormal, infrequent and emergency training for ROs and SROs as part of the requalification program,
- o Change the purpose of the annual examination from the determination of areas in which retraining is needed to verification that an operator can operate the controls or supervise operation of the controls (SRO) in a safe and competent manner,
- o Include an oral examination and simulator test as well as a written examination in the annual examination,
- o Require that the NRC administer annual examinations (however, as stated in the proposed revision, the NRC may permit these examinations to be given by the facility).

2.7.1.2 Utility and Training Center Requalification Practices

In contrast to the wide spectrum of practices found in utility initial license training programs (Section 2.4), requalification programs were fairly consistent at the nine reactor sites visited. Most differences involved methods used for implementation, rather than content. All utility requalification programs had the same components as those required by ANSI/ANS-3.1-1978 and 10 CFR Part 55. In describing utility and training center practices, this section discusses each of these parts.

Preplanned Lectures

Two basic approaches were used for scheduling these lectures. The most common technique was to rotate a shift of operators into the training department for 3 to 5 days during each fifth or sixth week. Although this system would appear to provide approximately 40 days of requalification time a year, there are many other demands on this time (for example, annual physical examination, fire brigade training, general employee training, etc.). As a result, approximately 20 days a year was more representative of the actual time used for requalification training. The second technique involved concentrating the lecture series during a shorter period (for example, 12 weeks) and rotating operators into training more frequently during that period. The number of hours devoted to these lectures varied between facilities and from year to year at some facilities. Some utilities had specific requirements for number of lecture hours and others did not. Most of the facilities followed a practice in which a portion of the lectures were required for all licensed operators and others were required only for individuals who received a grade of less than 80 percent on that section of the last annual examination. Lecture requirements ranged from 40 to 96 hours a year.

Most preplanned lecture subjects were tailored to the subject areas listed in 10 CFR Part 55 (see Section 2.7.1.1). Several utilities had shifted from an approach (as described in 10 CFR Part 55) of using the annual examination as an indicator of individuals and subject areas needing upgrading to using the lecture series to prepare operators for the next annual examination. Most facilities conducted this training with their own training staff personnel, although training services contractors had been used occasionally to augment the facility training staff.

Control Manipulations

All utilities required that 10 reactivity control manipulations be conducted biennially. Most used the list provided in ANSI/ANS-3.1-1978 as the list of acceptable manipulations (the March 1980 NRR letter requirements had not yet been implemented at the sites). All facilities used an administrative system to document manipulations actually performed on shift. All of these facilities used short training programs at control room simulators to ensure completion of the reactivity manipulation requirements. Most of these utilities had no requirements to ensure variation of manipulations; however, two facilities did require that each operator conduct manipulations in at least three categories on the list.

Most control room simulator programs used by these facilities varied from 3 days to 5 days and were conducted annually. One utility provided a 10-day program each year. The facility that made the least use of simlulators provided a 5-day course for their operators at a reactor plant vendor training center every 2 years. Simulator training programs conducted at training centers were tailored to the facility's training needs and, hence, varied considerably between utilities in areas such as:

- o Distribution of demonstration, practice or evaluation sessions,
- o Emphasis on major plant casualties,
- o Emphasis on abnormal conditions and
- o Emphasis on general plant operating procedures (startup, shutdown and reactivity control manipulations).

All programs followed the basic 4-hour classroom/4-hour control room combination for training time usage described in Section 2.4, "Reactor Operator and Senior Operator License Training."

Although considerable variation was found between simulator requalification programs, most programs could be characterized as concentrating on the more advanced aspects of plant operations, such as:

- o Operator knowledge of major equipment and instrumentation failures commonly known throughout the industry and their effects on plant operation,
- o Major accident diagnosis and corrective action,
- o Recognition of multiple failures and their effects and
- o Training in infrequently used procedures.

As an example of the variability of this training, one facility, in contrast to most requalification programs, provided a 3-day course for 37 of its operators in which the control room portion consisted of a session of reactor startups, a session of plant heatups from cold to hot shutdowns and a session of plant startups (hot shutdown to full power). Few malfunctions were performed and no major accidents or multiple failures were simulated. Operators interviewed at this facility were particularly outspoken in a negative manner as to the usefulness of this type of requalification program.

Plant Systems

The facilities visited used three techniques to maintain familiarity with plant systems: job performance on shift, simulator training and lectures. On-the-job performance was assumed to maintain a certain level of familiarity with plant systems due to the day-to-day operation of the plant. Simulator training provided additional reinforcement in this area, and most facilities included some systems training in their preplanned lecture series or classroom sessions at the simulator training center.

Facility Design, Procedures and License Changes

The most commonly used technique to ensure that operators remained current on these types of changes was a routing system which distributed this information to licensed operators and required signatures to indicate reading of this information. Some facilities routed a copy of this information to each licensed operator. Others used a centrally located notebook (usually in the control room), which operators read while on shift. In addition to this system, some utilities included this information in their preplanned lecture series. Operations Supervisors or Training Supervisors or both were responsible for deciding the information that should be communicated to operators. The number of complaints registered by Training Supervisors and operators interviewed indicated that, at some facilities, the administrative systems for making the Training Supervisor aware of these changes so they could be factored into the requalification program were inadequate.

Abnormal, Emergency and Security Procedures

Most facilities used self-study as the primary method to ensure familiarity with these systems. All these systems were required to be reviewed biennally. Some utilities required annual review of all emergency procedures. A common administrative approach to document this review was for the Training Supervisor to route a monthly list of procedures to be reviewed. Following review of these procedures, the operator would sign the list and return it to the training department. Some of these procedures were usually included in the preplanned lecture series or during classroom sessions during simulator training.

Annual Written Examination

All facilities administered annual written examinations similar in scope and complexity to the NRC licensing written examination and covering the topic areas listed in Appendix A to 10 CFR Part 55. In addition to covering all these subject areas, three utilities included a section on facility design characteristics and one utility included questions relating to recent plant modifications and problems that have occurred at similar plants. Most facilities administered the entire examination at one point during the year; however, three facilities followed a practice of "segmented requalification" where the examination was divided into approximately four segments given at different times of the year. In both cases, requirements existed for minimum acceptable performance on each category of the examination and overall average grade for the entire examination.

Unsatisfactory performance on a category of the examination (usually a grade of 80 percent was required) resulted in mandatory attendance at one or more lectures on that topic area, followed by a retest in that area. Unsatisfactory overall performance (usually a grade of 70 percent was required) resulted in removal from shift duties and mandatory attendance in an accelerated requalification program designed by the Training Supervisor or by a board of supervisory personnel from the plant management staff. Re-examination following the accelerated requalification program included, as a minimum, another written examination on weak areas and, at some facilities, included an oral examination administered by training or operations staff personnel or both.

A review of the most recent annual examinations given indicated that all except one facility developed their own tests. That utility used an examination developed by a training services contractor that had assisted in administration of the requalification program. Most utilities developed completely different examinations each year, although one facility used an entirely different approach. This utility changed only 30 percent of the written examination questions each year, so that 70 percent of the examination each year included questions from the previous year's examination. It was also noted that requalification examination average scores at this facility were noticeably higher than those of other facilities visited.

Periodic Examinations

All facilities administered quizzes following preplanned lectures to satisfy this requirement. Some facilities also gave quizzes as part of the self-study program for maintaining familiarity with operating procedures. The satisfactory grade was usually 80 percent and additional training was provided if a grade of less than 80 percent was received on any of these quizzes.

Observation and Evaluation of Operators

Combinations of the following methods were used to satisfy requirements for periodic observation and evaluation of operators:

- o Evaluation by shift supervisory personnel during actual plant evolutions and abnormal and emergency conditions,
- o Evaluation during simulator training,
- o Evaluation during walk-through drills conducted in plant and
- o Annual evaluation by operations department personnel.

Observation and evaluation of operators during plant evolutions and during simulator training were the most common methods used to satisfy this requirement. Most utilities used a documentation system that paralleled the one used to document performance of reactivity control manipulations. For each manipulation or group of manipulations, whether performed in plant or on a simulator, each operator's performance (or knowledge if only a walk-through was conducted) was graded as satisfactory or unsatisfactory by a designated supervisor.

One facility visited used annual drills conducted in plant to evaluate operator knowledge. These drills were of a walk-through nature and were conducted by two or three members of the training department staff. Procedures for abnormal and emergency conditions were walked through, simulating actions and alarms and locating all switches and controls. Each team of operators was evaluated as "excellent," "satisfactory" or "unsatisfactory" in the following areas:

- o Knowledge of immediate actions,
- o Understanding of subsequent operator action,
- o Knowledge of sources of alarms,
- o Knowledge of applicable technical specifications limits,
- o Knowledge of indications to check,
- o Use of applicable followup procedures and
- o Completion of plant incident report.

A technique of formal annual evaluations by operations department supervisory personnel was used at three facilities. This annual review included an oral examination and evaluation of general performance on shift. Two of these facilities used a standard checklist that provided a list of areas on which the oral examination should be conducted. Annual evaluations usually graded operators on various aspects of level of knowledge, job performance and personal attributes (for example, attitude and dependability).

2.7.1.3 NRC Practices

Responsibilities for requalification programs are shared between OLB and IE. OLB is responsible for approval of requalification program descriptions submitted by facilities. IE is responsible for verifying that these programs have been implemented and are being conducted in accordance with the approved program descriptions. In addition, IE is responsible for determining whether sufficient documentation is being maintained by the facility to permit the OLB to verify the technical adequacy of examinations administered by the facility. OLB is also responsible for reviewing the contents of the written examinations taken by licensed operators and the evaluation conducted by the facility of operators' performance on these examinations.

Each licensed power reactor facility is required to submit to the OLB for approval a description of its requalification program. Since the criteria for approval of these programs is conformance to the requirements of Appendix A of 10 CFR Part 55, these descriptions are basic outlines of the programs with detail similar to that contained in 10 CFR Part 55. Changes to these programs after initial approval must also be approved by OLB. OLB has approved the program descriptions of existing operating facilities. Acceptance of requalification programs for new facilities is conducted as part of the FSAR approval process.

In carrying out IE responsibilities for requalification training, each regional office conducts an audit of each facility's program on an annual basis and resident inspectors at each site are required to attend two requalification lectures every 6 months. However, interviews with site training personnel and resident IE inspectors indicated that attendance at lectures is often not accomplished at the required interval. The annual audits consist of reviews of program documents and operator training records and interviews with licensed operators and training department supervisory personnel.

A review of requalification training documentation is conducted to check that:

- o A schedule has been prepared for the preplanned lectures,
- o Lesson plans provide an adequate description of the scope and depth of lectures (usually three lesson plans are reviewed) and
- o Deficient areas to be covered in the lecture series have been determined by the facility based on the results of the last annual examination.

A review of operator training records is conducted to ensure that adequate documentation exists to verify that requalification training has been carried out in accordance with the requirements of 10 CFR Part 55. Specific items verified to be present in training records include the following:

- o A copy of the last annual examination and responses,
- o Documentation of attendance at all required lectures,
- o Documentation of the required control manipulations,
- o Results of performance evaluations,
- o Documentation of additional training received for individuals who failed all or part of the annual examination,

- o Documentation that any required procedure reviews and self-study have been completed and
- o Approval from NRR to resume licensed duties for those individuals who did not perform licensed duties for a period of 4 months or longer.

In this review, a sample of records (usually those of two ROs, two SROs and two licensed individuals not actively engaged in operating the facility) is inspected. To verify the accuracy of these records, interviews are conducted with licensed operators to determine that the documented training was actually received.

IE provides feedback of observed weaknesses to OLB. OLB receives a copy of inspection reports involving requalification training and, if the case warrants, IE identifies specific operators in a separate letter to OLB. On the basis of input from IE involving specific operators, OLB determines if immediate action regarding an operator's license is required or if additional verification of operator competency will be required at the next license renewal.

As indicated previously, each resident inspector is required to attend two requalification lectures for licensed personnel semiannually. The inspector is required to verify that lesson plan objectives were met and that the training was in accordance with the requalification program schedule and objectives.

Every 2 years, OLB conducts an audit of the adequacy of the technical contents of written examinations administered by each facility and the facility's evaluation of the results of these examinations. This audit is usually conducted during a visit to the facility to administer licensing examinations.

These audits consist of a detailed review of annual requalification examinations and a check of quizzes given as part of the preplanned lecture series. For the annual examinations, at least three RO and three SRO examinations are reviewed. At least one of the SRO examinations is that of a licensed staff member who is not engaged in operating the facility. These audits verify the following:

- o Applicability of questions for the type of examination (RO or SRO) and the category of the examination,

- o Assignment of proper point values to questions,
- o Adequacy of the examination for covering the total plant and its operation and
- o Grading of the examination.

The grading of the examinations conducted by the facility is emphasized during these audits. The OLB examiner grades a category from each selected examination to verify agreement with OLB standards (agreement within ± 5 percent is required). The grading of the examinations is also audited for:

- o Depth of answers expected (the facility answer key is compared to answers expected by OLB),
- o Consistency among examinations to ensure that individuals are being graded in the same manner and
- o Total grade in a category.

When conducting the review of quizzes administered as part of the preplanned lecture series, the examiner evaluates the adequacy of questions as they relate to the topics covered in the lecture and the required level of understanding demonstrated in the answer. Auditing of the grading of these quizzes is not required.

At the completion of the OLB audit, the examiner files a report on the evaluation of the examinations and provides recommendations. If only minor deficiencies are noted, these findings will be discussed with facility management. If serious deficiencies are found, a copy of the examination and answer key will be brought to OLB headquarters for in-depth review. Following this review, utility management is informed of the results and corrective action required by the OLB.

2.7.1.4 Foreign Utility Requalification Programs

Great Britain (18,19)

In Great Britain, the requalification program for nuclear reactor operators at utilities is conducted on a 2-year cycle. The requalification program contains the following elements:

- o Formal courses at the training center in nuclear safety, fault studies, etc.,
- o Simulator training with emphasis on offnormal and emergency conditions and review of startup and shutdown operations (3 to 5 days),
- o Review of procedures and
- o In-plant drills on emergency and offnormal events.

West Germany (20, 21)

West German utilities are required to provide at least 100 hours of nuclear reactor operator retraining per year. This training includes the following:

- o Review of changes in systems or operating procedures,
- o Evaluation of operational experience and
- o Simulator training on emergency and abnormal events (1-week program).

Canada (22, 23)

The Atomic Energy Control Board of Canada has no requalification requirements for nuclear reactor operators; however, Ontario Hydro does retest all ROs each year to ensure that they maintain acceptable levels of competence to cope with emergencies. The Ontario Hydro retraining program also includes a review of all significant event reports and new or modified procedures.

All licensed personnel receive further simulator training in the form of annual refresher courses. This refresher training includes two 1-week sessions each year during which startups, shutdowns and responses to major malfunctions are practiced. Operators are required to demonstrate proficiency in dealing with these malfunctions.

2.7.1.5 U.S. Navy Requalification Practices (24, 25)

The U.S. Navy requires that its watchstanders in nuclear propulsion plants requalify biennially. Requalification involves satisfactory completion of comprehensive oral and written examinations similar in scope and depth to those administered during the initial qualification process. During the 2-year periods between requalification, watchstanders are required to maintain their proficiency on watchstations and participate in a continuing training program.

Watchstanders are considered to have maintained their proficiency on watchstations if they stand watch at a minimum prescribed frequency. The required frequency varies between watchstations but is usually 1 or 2 watches each month. Failure to satisfy these requirements results in the watchstander's being removed from the list of qualified watchstanders for that station. Upgrading and certification are required before the operator can stand the watch again. This process includes standing a required number of training watches and satisfactory completion of an oral examination administered by an officer.

The continuing training program consists of a series of lectures and seminars and practical training. The lecture and seminar program is conducted at the department and division levels, is approved by the Commanding Officer and is patterned after a list of required topics provided by Naval Reactors. These lectures and seminars cover, on a recurring basis, subjects in all areas relating to the nuclear propulsion plant, including reactor plant fundamentals, operating procedures, primary and secondary plant systems, operating characteristics, reactor plant incidents and plant modifications. Lesson plans are required for these lectures. Each lecture is monitored by a senior individual attending the lecture or seminar and a report on the quality of the lecture is retained. Quizzes concerning the lecture subjects are administered periodically.

Practical training consists of the performance of plant evolutions and operating drills. These evolutions and drills are selected from a Naval Reactors' list of required evolutions and drills that must be performed or walked through periodically. Monitors, who have received instruction on their responsibilities, are required for conducting the evolutions and drills. Drills follow a formal drill plan that has been previously approved by the Commanding Officer. Whenever possible, the reactor plant is actually manipulated to provide realistic training.

The Nuclear Propulsion Examining Board conducts an annual evaluation of each ship's ability to operate its reactor plant(s) in a safe and competent manner. As a part of this examination, watchstander knowledge is sampled through interviews and written examinations conducted by board members. Watchstander proficiency is evaluated by requiring individuals or watch sections to perform plant evolutions and conducting a session of comprehensive drills for each watch section.

2.7.1.6 Federal Aviation Administration Recertification Practices (26)

The FAA administers a program to maintain the certifications of airline pilots. This program consists of three basic components: quarterly requirements, line checks and proficiency checks.

To ensure recent experiences in takeoffs and landings, pilots must have performed at least 3 takeoffs and landings within the last 90 days. These evolutions may be performed in a simulator approved by the FAA for takeoffs and landings. If this requirement has not been met, the pilots must perform three takeoffs and landings, which include certain operational requirements, to the satisfaction of a check airman (airline pilots certified by the FAA to conduct recertification checks). The check airman must certify that the person observed is proficient and qualified to perform flight duty. Additional maneuvers may be required, if necessary, to make this certification.

Line checks are required at 12-month intervals. These are conducted by FAA inspectors or check airmen (check airmen conduct the majority of these inspections). This check consists of at least one flight over a typical route. Pilots are evaluated for satisfactorily performing the duties and responsibilities of their positions.

Proficiency checks are required at 6-month intervals. During a 12-month period, one of the 2 checks required may be satisfied by use of a simulator course. Proficiency checks performed in aircraft are conducted by FAA inspectors or check airmen (check airmen conduct the majority of these) and must include specific items required by federal regulations. These requirements include oral or written examinations, demonstrations, simulated casualties, abnormal operations and normal maneuvers and procedures. If a simulator is used, the course must include at least 4 hours in the simulator performing the same maneuvers and procedures that are required for an actual flying proficiency check.

An option to this type of simulator program includes "line-oriented" training using a complete flight crew. This program conducts a simulated flight that includes normal, abnormal and emergency maneuvers and procedures that may be expected in actual line operations.

2.7.1.7 Evaluation of Utility Requalification Practices

A number of differences were observed between the implementation of utility initial license training programs and their requalification training programs. Requalification programs were more consistent among utilities than were license training programs due to the greater detail of requalification requirements existing in 10 CFR Part 55. There is generally less reliance on outside organizations to provide portions of this training (with the exception of the simulator portion). Self-study is used as an instructional method to a greater extent. In several ways, requalification training poses a greater challenge for instructors because they are dealing with experienced licensed operators.

To help evaluate these programs, an approach was used that was similar to the one employed in Section 2.4 to evaluate license training programs. This approach is illustrated in Figure 2.11. Initially, all required RO and SRO skills and knowledges that were identified in Section 2.4 (see list in Appendix C) from the generic job task analysis were reviewed with consideration of the related job task areas associated with each. Thirty-three of these skills and knowledges were determined to receive complete reinforcement during routine nuclear power plant operations. Since a primary objective of requalification training is to maintain operators' proficiency in the skills and knowledges required to perform their jobs, the remaining 46 required RO and SRO skills and knowledges were concluded to need periodic retraining to maintain this proficiency. It should be noted that staff personnel, who are licensed to provide backup operator capability but do not periodically function in these positions, would not receive reinforcement of the 33 skills and knowledges routinely used during normal plant operations.

Using the criteria discussed in Section 2.4, instructional settings (that is, classroom, in plant, generic simulator, plant-specific simulator) suitable for providing complete retraining of each skill and knowledge were then determined. These requalification program content areas (skills and knowledges that require retraining) and their appropriate instructional settings constitute the requalification training program criteria against

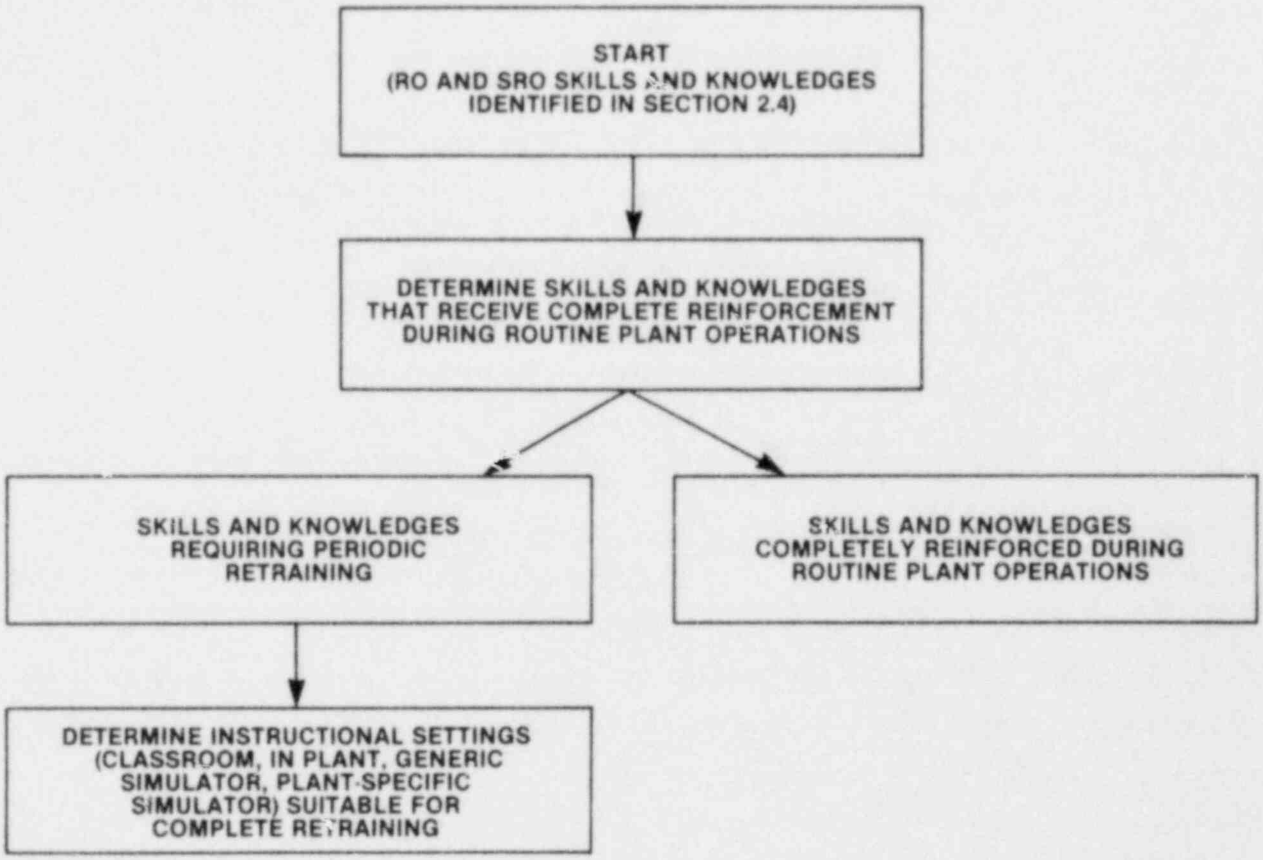


Figure 2.11 Methodology for Identification of Requalification Training Content and Instructional Settings

which current programs were evaluated. These requalification program content areas and instructional settings are, in reality, a subset of the content areas and instructional settings required for initial license training programs.

Of the 46 skills and knowledges concluded to require retraining in order to maintain operator proficiency, 27 require a simulator to provide complete training, 4 require in-plant training to ensure required familiarity and 15 are suitable for classroom instruction (classroom instruction includes self-study).

The skills and knowledges identified to require retraining in a control room simulator involved the following general training objective categories discussed in Section 2.4:

- o Application of concepts and principles,
- o Reasoning and problem-solving abilities,
- o Procedural compliance,
- o Execution of team skills and
- o Operation and functioning of equipment and systems.

In addition, the training objectives worksheets of Appendix C and the applicable tables of Appendix A were used to identify the RO and SRO job task areas relating to these skills and knowledges. This approach identified the following task areas as needing simulator retraining (see Table 2.9 or Appendix A for a complete list of RO and SRO job task areas):

- o Carry out emergency actions not completely addressed by procedures,
- o Carry out emergency operating procedures,
- o Carry out procedures for abnormal, offnormal or alarm conditions and
- o Carry out general plant operating procedures.

Although the simulator retraining programs used by utilities were generally oriented much more around the practice and use of the skills and knowledges relating to these RO and SRO job task areas than were license training simulator programs, these retraining programs were too short to provide adequate reinforcement of these skills and knowledges. The insufficient length and infrequent use (3 to 5 days annually were most common) of this simulator training was a common weakness identified in operator and training personnel interviews at the sites visited.

Table 2.17 of Section 2.4 lists the skills and knowledges that require plant-specific simulators for complete training. These skills and knowledges were also found to require periodic retraining. The alternative instructional settings identified in this table also apply to utility requalification programs. As indicated in this analysis discussed in Section 2.4, the use of plant walk-through drills would be necessary in some cases to augment the training provided by a generic simulator if a plant-specific simulator is not available. In these cases where in-plant drills would be necessary, there is no apparent benefit in conducting them on an unannounced basis if simulator training is conducted frequently enough to permit rapid operator response to immediate actions of emergency procedures. On the basis of the analysis conducted in Section 2.4, it was concluded that a plant-specific simulator is necessary to provide complete training in some of the required RO and SRO skills and knowledges. This conclusion is also true in the case of retraining. However, an even greater argument can be made for the need for plant-specific simulators considering the negative effects on operator attitude when retraining is attempted with experienced operators on a simulator different from that of their actual plant. Many operators interviewed during site visits identified this problem as a deterrent to effective training. The following conclusion supporting this argument was also reached in an independent study of nuclear power plant simulators (39):

> "It should be noted that personnel engaged in requalification training are already licensed and have actual plant operating experience. Thus, even minor differences between simulator and plant can have a significant impact on the effectiveness of simulator training in such programs. In some cases, depending upon the attitudes of licensees toward accepting training on a simulator that does not correctly reproduce responses they have observed in their actual plant, the value of the simulator could be rendered totally ineffective. Requirements for plant-specific simulation, therefore, appear to be more important for effective requalification programs than for initial training."

Although performance as a control room team of operators is characteristic of the "real-life" situation, simulator requalification is generally focused on the individual operator. Some training centers are beginning to emphasize the team aspects of control room operations, such as division of responsibilities during emergencies. Some utilities have demonstrated an interest in strengthening the execution of team skills and make efforts to send representative shift complements to simulator training. Other facilities are principally interested in satisfying minimum requirements for reactivity control manipulations for individuals and hence make no such efforts.

In addition to any in-plant drills that might be necessary if a facility does not use a plant-specific simulator, four skills and knowledges requiring in-plant training were identified. These skills and knowledges involved two functional areas for ROs and SROs: performing manual and manipulative operations outside the control room and carrying out procedures of the Emergency Plan. Current programs do not provide adequate training in these areas, although drills involving the Emergency Plan are periodically (for example, annually) performed at all reactor sites. No procedures are implemented to ensure that all operators have an opportunity at some periodic interval to participate in a drill involving implementation of the Emergency Plan to maintain proficiency in the practical application of these procedures. In fact, due to the relatively infrequent performance of these drills, operators might never have an occasion to participate in such a drill. Walk-through or other practical training in other operations that ROs and SROs are required to be able to perform outside the control room (except refueling) are not usually included in requalification programs.

A review of the skills and knowledges that require retraining and that are suitable for classroom instruction (including self-study) indicated that the following general subject areas should be included in this type of periodic retraining:

- Technical specifications,
- Plant design bases,
- Emergency, abnormal and general plant operating procedures,
- Facility design changes and procedures changes,
- Operating experience evaluations (for example, LERs, plant incident reports, abnormal occurrence reports),
- Advanced integrated plant topics,
- Primary, secondary, instrumentation and electrical systems and
- Reactor plant principles and theories.

Self-study is considered a suitable method for review of technical specifications, plant design bases and operating procedures. Classroom lecture or seminar methods would be more suitable for the remaining subject areas because they typically lend themselves to more open discussion or require more in-depth understanding of fundamentals.

Classroom training conducted as a part of the requalification program is generally designed around two objectives: satisfying requirements for improving knowledge deficiencies indicated by grading of annual written examinations and preparing licensed operators for forthcoming annual written examinations. The need to address the many areas covered by an annual examination, which is very similar to the NRC written licensing examination, and the limited amount of time available for requalification training result in the fact that none of the subject areas listed above are reviewed in any depth. Considering this fact, it is not surprising that many of the licensed operators interviewed during reactor site visits considered requalification lecures to be nothing more than a "rehash" of old material that is very boring and has little training value. Several of these operators also felt that, with this type of requalification program, their knowledge level in most of the areas covered during initial license training decreased over a period of years to an unsatisfactory level. They expressed the opinion that a need exists to conduct a comprehensive review of license training subjects at some periodic interval (for example, every 5 years).

An important subject area applicable to this portion of requalification training is review of operating experiences (LERs, plant incident reports and abnormal occurrence reports). All utilities had an administrative system for routing these reports to licensed operators for reading. Some facilities also incorporated this information into their lecture or seminar series to permit further discussion. The one facility that annually conducted walk-through drills in plant indicated that recent events at their facility and similar plants were considered when selecting drills to be conducted. No facilities indicated that these events were factored into their simulator training programs on a routine basis. All of these methods - self-study, lecture, in-plant drills and simulator training are appropriate techniques for conveying this information and reinforcing this knowledge with practical training. A thorough requalification program should include both communication and reinforcement of this information.

Although all Training Supervisors interviewed realized a need to keep operators informed on these operating occurrences, some of the current methods used to communicate this information to reactor facilities do not provide sufficient information to adequately accomplish this goal. The LER system was a principal offender in that LER information content is generally not sufficient to permit effective training. In their final report, the TMI-2 Lessons Learned Task Force (40) addressed the problem of keeping operators informed of lessons learned from operating experience and recommended that each facility use standard distribution lists or lectures or both to accomplish this goal. Although it is agreed that utilities should use these methods, they should also factor this information into their practical retraining; however, the end product of this training can only be as good as the quality of information provided to utilities.

Another problem identified through several interviews lies in the quality of instruction provided during this portion of requalification training. Many shift operators felt that requalification instructors have a credibility problem due to spending long periods of time away from duties involving the actual operation of the plant. This problem is discussed in more detail in Section 2.10, "License Training Instructors."

Appendix A of 10 CFR Part 55 states that the purpose of the annual written examination is "to determine areas in which retraining is needed to upgrade licensed operator and senior operator knowledge." However, utilities generally tend to rely upon the results of this examination as the key indicator of an operator's competence. Only a few of the utilities visited conducted a comprehensive, periodic evaluation of all aspects of operator performance and used that evaluation as a basis for judging continued competency. Most facilities visited used only a "satisfactory" or "unsatisfactory" judgment of performance when accomplishing required reactivity control manipulations on a simulator or in plant as the only evaluative tool in addition to the written examination.

The annual written examinations used at facilities quite adequately accomplish the goal of being similar in scope and depth as the NRC written examination. In fact, some facilities even use a bank of "typical NRC questions" to construct this test. As a result, these examinations suffer from the same limitations as the NRC written licensing examination discussed in Section 2.6, "Licensing of Reactor Operators and Senior Reactor Operators." These limitations include the following:

- Examination questions do not probe the operator's knowledge to a sufficient depth,
- All skills and knowledges suitable for written examination are not included and
- Examinations lack content validity.

Considering these limitations and the fact that a written examination is not an adequate tool for measuring all performance-related skills and knowledges (see Section 2.6), a problem exists with the current utility dependence upon these examination results.

2.7.1.8 Evaluation of NRC Licensed Operator Requalification Practices

The NRC generally takes a stronger management approach when regulating requalification practices than it does for initial license training. This appears to be due, at least in part, to the greater detail of requirements provided for requalification programs (Appendix A of 10 CFR Part 55 and the March 1980 NRR letter) than currently exist for initial license training programs.

Although IE regional inspectors conduct very thorough and detailed reviews of training documentation, the quality and depth of the training provided by these programs is not assessed. Since these audits are requirements-oriented and not quality-oriented, utilities tend to conduct the same type of review. Since the organization conducting these audits (IE) is different from the one that approves these requalification programs (OLB), no effective check is made to verify that actual implementation is the same as was anticipated when the program was approved.

The OLB has an effective method for ensuring that annual written examinations conducted by utilities are consistent in content and grading as the licensing examinations. Procedures for conducting these reviews, however, do not address the necessity for variability in questions asked on a year-to-year basis. The practice that was followed at one facility of changing only 30 percent of the examination questions each year casts doubt on the effectiveness of this tool for sampling operator knowledge in that situation.

10 CFR Part 55 requires that, if a licensee has not been "actively involved" in performing licensed duties for a period of 4 months or longer, the individual is not qualified to operate the facility until approved by OLB. In IE procedures, "actively involved" is defined for on-site personnel as actively functioning in their normal position in addition to participating in the requalification program. Under these guidelines, individuals who are licensed to provide backup operator capability and do not normally operate the facility can assume RO or SRO responsibilities with no additional requirements other than

having participated in the requalification program. The analysis of RO and SRO skills and knowledges described in Section 2.7.1.7, however, indicated that at least 33 of these skills and knowledges are adequately reinforced during normal plant operations and do not need retraining for operating personnel. Because requalification programs are appropriately designed for shift operating personnel requirements, the assumption that a "backup operator" who participates in the requalification program is adequately prepared to immediately assume operating duties is not necessarily valid. Although this problem is commonly discussed throughout the industry and most Training Supervisors felt that identical requalification requirements for on-shift operators and backup operators could not be justified, only a few of the utilities visited imposed additional requirements on backup operators to maintain a continuing familiarity with normal plant operations. These requirements typically included a required amount of plant observation or on-shift operating time as RO or SRO on a periodic basis (for example, 8 hours of RO or SRO watch every 4 months).

Current NRC requirements and practices do not provide a comprehensive basis for evaluating licensed operator competency. There is an over-reliance on the annual written examination for providing assurance of this competency. As discussed in Section 2.6, a comprehensive written examination alone is not adequate for conducting a comprehensive evaluation of whether ROs and SROs are safe and competent operators. Methods used to evaluate operator competency must permit a performance-related assessment. As discussed in Section 2.6, operating examinations and oral examinations are the methods available to evaluate performance-related skills. Written examinations are also needed, because they provide the most efficient means for evaluating the knowledge of multiple candidates. Use of all these methods in a manner appropriate for assuring continued operator competency, would provide significant improvement in this area.

These types of examinations would obviously require examiners with detailed knowledge and understanding of plant operations and a level of plant technical knowledge consistent with that necessary to examine operating personnel in those technical areas. Considering this fact, it is doubtful that the use of technically expert NRC personnel with limited operating knowledge (for example, some Nuclear Reactor Regulation and Nuclear Regulatory Research individuals) would provide any improvement in the examination process.

An additional problem related to the requirement for an annual written examination similar in scope and depth to the NRC licensing examination, is the negative impact it has on requalification training program content and licensed operator motivation. This requirement results in a major emphasis in requalification training being applied to preparing operators to take, in effect, the NRC written licensing examination every year. Operators generally consider the resulting repetitious nature of requalification training and the necessity for taking this examination as key demotivators. Substitution of this requirement with a program which uses more performance-related techniques for evaluating competency would be welcomed by operators as a more appropriate means for evaluating their competency. In addition, the time available for requalification training might be used more effectively.

An alternative approach to current operator requalification programs that has potential for correcting these deficiencies is presented in Recommendation 7 of Section 2.7.1.9.

2.7.1.9 Conclusions and Recommendations for Licensed Operator Requalification Programs

<u>Conclusions</u>

1. Requalification programs are used by utilities as a means for assuring continued licensed operator competence through a system of retraining and evaluation. These programs are generally consistent in content among utilities but vary to some degree in implementation practices. The greater consistency of these programs when compared to license training programs can be attributed to the greater detail of requirements in federal regulations for requalification programs. Although the components of the programs (for example, preplanned lectures, on-the-job training and evaluations) are collectively suitable for accomplishing requalification goals, deficiences in the employment of these techniques reduce the effectiveness of these programs.

2. A control room simulator is needed to provide complete retraining in a number of RO and SRO skills and knowledges that are not reinforced during normal plant operations. RO and SRO job task areas related to these skills and knowledges include the following:

- o Carrying out emergency actions not completely addressed by procedures,
- o Carrying out emergency operating procedures,
- o Carrying out procedures for abnormal, offnormal or alarm conditions and
- o Carrying out general plant operating procedures not normally performed during routine plant operations.

Most control room simulator retraining programs used by utilities are too short and are not provided often enough to ensure adequate retraining of the skills and knowledges required in these task areas. In many cases, this training is centered around accomplishing reactivity control manipulations for individual operators with little emphasis on team training concepts.

3. A plant-specific simulator is needed to ensure complete retraining on some skills and knowledges. For other skills and knowledges, which could be completely taught on plant-specific simulators, alternative instructional settings which include generic simulators (with certain requirements for similarity to the actual plant) and plant walk-through drills are suitable. The use of a generic simulator which does not correctly reproduce responses that are observed in their actual plant can have a negative effect on experienced operator attitude and significantly reduce the effectiveness of training received.

4. Some in-plant training is necessary to ensure adequate retraining of all RO and SRO skills and knowledges. In particular, this training is needed to ensure competency in carrying out the Emergency Plan and performing operations outside the control room. The specific skills and knowledges requiring in-plant training for reinforcement can be determined from a plant-specific job task analysis.

5. Classroom training conducted as a part of the requalification program is generally designed around two objectives: satisfying requirements for improving knowledge deficiencies indicated from the last annual written examination and preparing licensed operators to take upcoming annual examinations. As an attempt to accomplish the second objective, many preplanned lectures tend to be repetitive from year to year and have marginal use in maintaining a satisfactory level of knowledge over a period of years. More productive use of the limited time available for this portion of requalification training would significantly improve requalification training and be more challenging to operators.

6. Utilities use appropriate techniques (required reading and lectures) to factor available information on lessons learned from operating experiences into the requalification programs. They do not, however, routinely reinforce this instruction with practical training (simulator and in plant). Some of the current methods used to provide this information to facilities (for example, LERs) lack sufficient detail to permit effective training on these problems.

7. Audit practices employed by IE and OLB effectively evaluate utility requalification programs for satisfying federal requirements. These audits, however, do not assess to any significant degree the adequacy of training provided by these programs or the competence of individuals who conduct this training.

8. Requalification requirements for utility staff personnel who are licensed to provide backup operator capability are not adequate to ensure periodic retraining of all required RO and SRO skills and knowledges. These individuals receive similar requalification training as shift operators but fail to receive routine operational experience. Such experience is needed to reinforce some required RO and SRO skills and knowledges not normally covered in retraining programs.

9. Utilities and the NRC inappropriately rely on the results of the annual written examination as the basis for judging operator competency. Most of the utilities visited do not have an effective system for periodic comprehensive evaluation of operator competency and neither does the NRC. Use of an annual written examination of comparable scope and depth as the NRC licensing examination fosters development of requalification programs designed around passing these examinations, has a negative effect on operator motivation and is, by itself, an ineffective tool for evaluating many aspects of operator competency.

Recommendations

1. Utilities should be required to conduct a formal assessment of their requalification training programs to ensure that adequate retraining is provided for all RO and SRO required skills and knowledges not reinforced during normal plant operations. A plant-specific job task analysis would be the basis for identifying these skills and knowledges. As part of the requalification program approval process, the facility

should be required to identify the methods that will be used to provide the required retraining for each skill and knowledge. It is anticipated that this analysis would identify specific needs for in-plant training (possibly including drills), simulator training, lectures and self-study.

2. The NRC should require control room simulator training as part of each facility's requalification program. As discussed in the recommendations for initial license training, emphasis should be placed in training to a predetermined level of proficiency in the simulator. The NRC should establish minimum time requirements for these simulator programs and maximum allowable intervals between this training.

   The approach used by the FAA is considered suitable for adaptation by the NRC. Training objectives for simulator requalification programs would be deduced from a generic job task analysis. Based on these objectives and consideration of experience levels of these operators, estimated minimum lengths of simulator sessions would be determined. Considerations for the relative importance of the skills and knowledges identified by this approach in assuring the safe and competent operation of the plant would lead to determination of maximum allowable intervals between training. Based on the results of the generic job task analysis conducted in this study and interviews with operations and training personnel at reactor sites, 1 week of simulator training conducted at 6-month intervals is an appropriate requirement at least on an interim basis.

3. Recommendation 6 in Section 2.4.5.2, specifies that a long-range goal should be adopted to require that all plants conduct training on a simulator specific to the plant. Adoption of such a goal is equally applicable to requalification training. In the interim, facilities with no plant-specific simulator currently available should submit to the NRC for approval a plan for providing retraining in the RO and SRO skills and knowledges that require requalification training, but cannot be acquired by the use of a generic simulator. It is expected that this plan would require more in-plant training, including drills.

4. The NRC should require that, as a part of their requalification program, utilities commit to conducting training on lessons learned from operating experience. This training should include practical training, where appropriate, conducted on a simulator or in plant.

   The NRC should improve its present systems for providing this information with the objective of ensuring that sufficient detail is provided for effective training use.

5. Recommendation 9 for initial license training (Section 2.4.5.2) which addresses the need to expand the current emphasis of NRC audits to include adequacy of facility internal requirements and actual conduct of training applies to requalification programs. To provide greater consistency, all requalification audit responsibilities should be assigned to the organization within the NRC that has program approval responsibility, the OLB.

6. Requalification program requirements for individuals who are licensed to provide backup operator capability should be increased to account for the fact that these individuals do not routinely perform operating functions. As a minimum, the NRC should establish requirements that these individuals obtain in-plant operating experience at intervals sufficiently frequent to ensure that skills and knowledges necessary for routine plant operations are reinforced. For example, a requirement such as 8 hours of shift operations as an RO or SRO every 3 months should be considered for these individuals.

   An alternative to this approach might require that utilities identify personnel in this category and commit to an approved program of upgrade training prior to permitting these individuals to operate the facility. A key part of this upgrade training would include measures to ensure proficiency in RO and SRO skills and knowledges not reinforced by participation in the requalification program.

7. Evaluation of licensed operator competence should consist of a comprehensive program that uses the most effective combination of evaluative tools integrated into a requalification program that is more performance-related, less repetitious and more challenging to operators than current programs. Table 2.25 presents a recommended

TABLE 2.25
PROPOSED REQUALIFICATION PROGRAM

<table>
<tr><td rowspan="3"></td><td colspan="3">REQUALIFICATION PROGRAM COMPONENTS</td></tr>
<tr><td colspan="2">UTILITY FUNCTIONS</td><td rowspan="2">NRC FUNCTIONS</td></tr>
<tr><td>TRAINING</td><td>EVALUATION</td></tr>
<tr><td rowspan="6">ANNUAL RETRAINING PORTION</td><td>1. Self-Study
o Technical specifications
o Design bases
o Operating procedures
o Emergency Plan</td><td>Written quizzes</td><td>Annual audit of quizzes</td></tr>
<tr><td>2. Required lectures and seminars
o Facility design and procedure changes
o Operating experience evaluations
o Advanced integrated plant topics</td><td>Written quizzes</td><td>Annual audit of quizzes</td></tr>
<tr><td>3. Systems and principles refresher training
o As indicated to be necessary by diagnostic test</td><td>Diagnostic test
o Given on 25 percent of systems and fundamentals taught during initial training
o Used to identify necessary refresher training</td><td>Annual audit of most recent test</td></tr>
<tr><td>4. Simulator retraining</td><td>As deemed appropriate by utility/training center</td><td>Annual operating test using a simulator
o Individual evaluation and team evaluation
o Supplemented by oral examination if weaknesses noted</td></tr>
<tr><td>5. In-plant retraining</td><td>Appropriate for training received</td><td></td></tr>
<tr><td>6. --</td><td>Comprehensive annual performance assessment</td><td></td></tr>
<tr><td>UPGRADE TRAINING (every 5 years)</td><td>1. Review of fundamentals and systems (3 to 6 months)</td><td>As deemed appropriate by facility.</td><td>Comprehensive written and oral examination similar to that for initial licensing</td></tr>
</table>

program for adoption by the NRC which would provide these improvements. The key components of this program are described below.

Proposed Requalification Program: This program would group retraining requirements into two groups -- Annual Retraining and Upgrade Training. Annual Retraining would include the following components:

- o Self-study,
- o Required lectures and seminars,
- o Systems and principles diagnostic test,
- o Simulator retraining and
- o In-plant retraining.

Self-Study: This portion of the program is designed to refresh operators in areas in which the amount of retraining needed varies among operators, but the subject areas are suitable for individual study. It is recommended that the following areas be reviewed on an annual basis:

- o Technical specifications and design bases,
- o Emergency operating procedures and
- o Emergency Plan.

The following additional areas should be reviewed at least biennially:

- o Procedures for abnormal, offnormal or alarm conditions and
- o General plant operating procedures.

Review of these subjects and procedures would be reinforced by participation in the control room simulator and in-plant retraining portions of the programs. Satisfactory completion of the self-study portion of requalification would require passing quizzes administered to all licensed personnel in these areas.

Required Lectures and Seminars: All licensed personnel would be required to attend lectures or seminars on the following subjects:

- Facility design and procedure changes,
- Operating experience evaluations (LERs, plant incident reports, abnormal occurrences) and
- Advanced integrated plant topics.

These subjects require explanation not available in self-study, lend themselves to more open discussion and require more in-depth understanding of fundamentals. The changing nature of these topics should preclude these lectures and seminars from being repetitious and permit training of a more challenging nature in areas requiring a broad understanding of plant operations. Satisfactory completion of this portion of requalification would require passing quizzes administered to all licensed personnel in the subjects covered.

Systems and Principles Refresher Training: This portion of the requalification program would work in conjunction with Upgrade Training to ensure that operators are maintaining a required familiarity with plant systems and fundamental principles and theories. The facility requalification program, approved by the NRC, would define the primary, secondary, instrumentation and electrical systems and the reactor plant principles and theories taught during initial license training that require retraining. Each year, operator knowledge in 25 percent of these subjects (one segment) would be sampled through a diagnostic test administered by the facility. Necessary refresher training would be provided as indicated from the results of this test. It should be emphasized that this test is not intended to be of a punitive nature. Reducing the subject areas covered by this test from the broad spectrum of topics covered in the present annual written examination would permit a more adequate sampling of knowledge level in these areas. Over a period of 4 years, all segments would be checked by this method. During the fifth year, the operator would be due for Upgrade Training. During the year following Upgrade Training, the operator would re-enter the cycle previously described. Figure 2.12 shows how these diagnostic tests would be scheduled for several operators so that a facility would need to administer only one diagnostic test each year.

Simulator Retraining: A control room simulator retraining program implemented in a manner addressed in Recommendations 2 and 3 would provide necessary practical

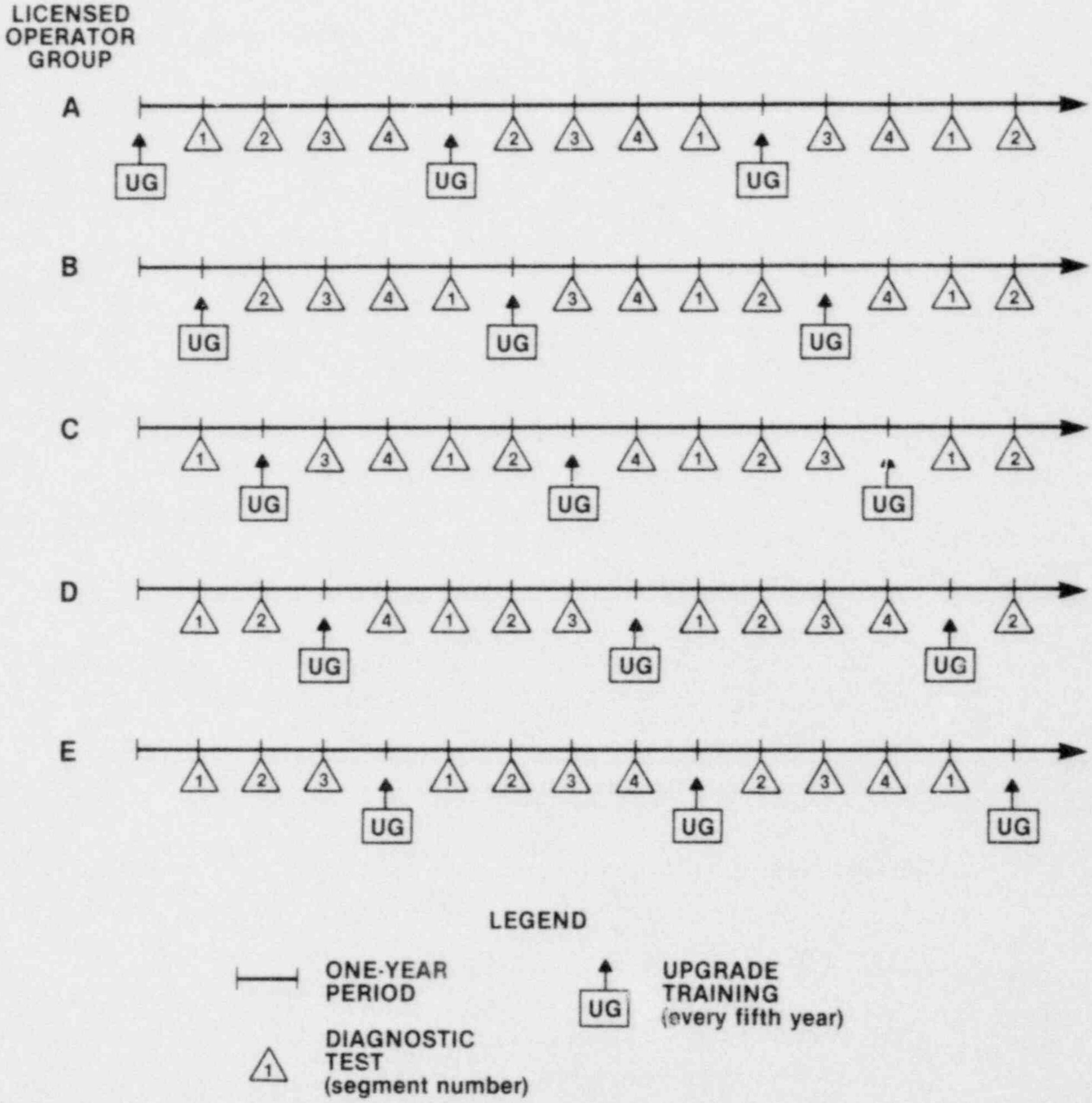


Figure 2.12 Scheduling of Systems and Principles Diagnostic Tests and Upgrade Training

training in areas not suitable for in-plant training. In addition to accomplishing required retraining for individuals, team training concepts should be emphasized.

In-Plant Retraining: This training would include drills and other exercises necessary to complete practical retraining on required skills and knowledges.

Upgrade Training would be conducted for each licensed operator every 5 years. This training would include a detailed review of subjects covered in the nuclear power plant fundamentals and plant systems phases of initial training. It is anticipated that this training would require 3 to 6 months of classroom instruction. Applicable portions of this training could be provided at the college level to help satisfy SRO qualification requirements. At the conclusion of Upgrade Training, the NRC would administer a written and oral examination comparable to that used during the initial licensing process.

Evaluation of operator competence conducted as a part of the requalification program would include the following components:

- On-shift supervisor evaluation. These evaluations would be conducted at periodic intervals and should be formally documented. Their purpose is to evaluate operator performance in using the skills and knowledges that are reinforced during normal plant operation.

- Written quizzes conducted as part of the self-study and required lectures and seminars portion of requalification training. The NRC would audit these quizzes as part of their annual audit of the requalification program.

- Operating examination on a control room simulator. This examination would be conducted by the NRC on an annual basis and include normal, abnormal and emergency conditions. Criteria would be developed by the NRC to permit evaluation of individual operator performance and performance of a team of operators. Oral examinations would be used to probe knowledge deficiencies noted during the operating test. Individual operators and teams of operators would be required to pass this examination in order to continue operating the facility.

- o Comprehensive facility performance assessment. Each facility would be required to conduct an annual comprehensive assessment in all areas of operator performance, including technical knowledge, operating experience and personal attributes.

- o NRC written and oral examination conducted in conjunction with Upgrade Training. This examination would be similar to that conducted for initial licensing.

Implementation of a requalification program such as this has the following advantages over current programs:

- o Evaluative criteria are more performance-related and more suitable for identifying unsatisfactory operators.

- o Familiarity in procedural areas is maintained and reinforced with practical training in a simulator and in-plant.

- o Lecture programs are not repetitious but, instead, address areas of continuing change.

- o Knowledge areas, which may not receive significant reinforcement on the job and are prone to degrading over a period of years, are upgraded in a comprehensive program designed for that purpose.

- o Skills and knowledges reinforced during normal plant operations are evaluated in that environment.

- o Skills and knowledges requiring retraining are evaluated by the most appropriate and efficient methods.

For most of the facilities visited, this program should not increase time currently used for requalification training. Instead, it would result in more appropriate use of this time for effective retraining. Under this proposed program, some of the time currently used in self-study and lecture training to prepare individuals to take annual written examinations would be applied to more performance-related training such as increased simulator training and in-plant training. It is expected that Upgrade Training would present the biggest problem for some facilities. Although a requirement for 3 months of Upgrade Training over a 5-year period represents a relatively small percentage (5 percent) of an operator's time, some scheduling difficulties are inevitable if all of this training is conducted during a single calendar quarter. Conducting this training at intervals during the fifth year (for example, several 2- to 3-week training periods) should be an option available to facilities.

2.7.2 Operator Error Reporting

2.7.2.1 Present Requirements and Practices

The NRC guidance that applies to the reporting of operator errors as well as other "reportable occurrences" is contained in Regulatory Guide 1.16, "Reporting of Operating Information - Appendix A Technical Specification" (41). These guidelines provide general requirements for communications, notification, maintenance of records and information to be reported. Specific reporting requirements are defined in the technical specifications of each facility licensee.

A computer-based system has been established to collect, collate, store, retrieve and evaluate information concerning licensee events. The data forms used to report this information are called Licensee Event Reports (LERs). Dissemination of LERs is made by the NRC to the nuclear industry. A standard data entry sheet (LER form) is used to report operator errors as well as all other reportable occurrences. NUREG-0161, "Instructions for Preparation of Data Entry Sheets for Licensee Event Reports (LER) File" (42), provides detailed instructions for completing LER forms. In addition to the LER forms, written reports must be prepared within time frames specified in the licensees' technical specifications.

The distribution of LERs and confirmatory reports are delineated in Regulatory Guide 1.16 (41). As indicated in a July 1979 report to the NRC Commissioners from the Officer of Nuclear Reactor Regulation (SECY-79-330E) (38), LERs are reviewed at IE regional offices for completeness, safety significance, appropriateness of licensee actions and adequacy of the report. The IE inspector reviewing the LER has responsibility for informing OLB of an event that indicates poor performance by a licensed operator. As guidance to the IE inspector, OLB has made available at all IE Regional Offices, OLB procedure, "Consideration of Performance of Licensed Operators and Senior Operators." NRC's Office of Management Information and Program Analysis (MIPA) is on distribution for all licensee LERs and has responsibility for maintaining and providing to utilities and other interested parties computerized printouts and searches of LERs.

All utilities surveyed had a method for reviewing LERs. Most utilities had an individual in the training or operations department responsible for identifying LERs that were related to operator errors. If an LER was determined to be applicable to the facility, the information was made available to affected personnel through a routing system or by incorporation of the information into training sessions. The following complaints and opinions concerning the LER system were commonly expressed in interviews:

- LERs do not provide enough information to describe the event to be useful for training. Several individuals interviewed indicated that they were accustomed to telephoning the applicable facility for the necessary information.

- Some organizations are reluctant to classify events as "personnel errors." Therefore, events classified as "defective procedures" or "design or installation causes" are sometimes, in reality, due to personnel error.

The present LER system does not identify the individuals responsible for personnel errors, although the NRC can obtain this information if desired. Disciplinary action against individuals by the NRC has been infrequent. One licensed operator's license has been suspended and six other operators re-examined as a result of their actions (38). The more common NRC enforcement actions in the event of reportable occurrences (including personnel errors) that are determined to have potential significant safety consequences are fines of the facility licensees (utilities).

The Nuclear Plant Reliability Data System (NPRDS) is a voluntary reporting system involving participation by industry, the government and the public. The NPRDS is described in ANSI standard N524-1967 (N18-20) "Nuclear Plant Reliability Data Collection and Reporting System" (43). A proposed rulemaking action in the Federal Register of January 30, 1980, would make the NPRDS a mandatory requirement for all facility licensees. Consideration is also being given under this rulemaking action to include man-machine interface data and to perform reliability analysis which consider human factors.

Some utilities have internal systems for collecting data on individual personnel errors and for using the data for decisions on advancement and disciplinary action. One utility surveyed has an internal committee that reviews all personnel-related events in the plant. For exemplary actions, individuals receive company-wide recognition and monetary rewards. For negative events, the committee draws conclusions and provides recommendations including changes to procedures and design. The results of these investigations (without names of personnel involved), including the consequences in terms of cost and lost power generation, are widely distributed.

At one facility visited, the Operations Supervisor maintains confidential operator error information for all operators including AOs. All errors are considered; not just those resulting in safety questions. Errors are considered for advancement and disciplinary decisions. While no licensed operators have been relieved of their responsibilities due to personnel errors, at least one AO was so disciplined. Operator errors are grouped into three categories, with minor errors resulting in verbal discussions or reprimands; the more serious errors resulted in relief from duties for a varying number of days without pay. This organization has also tasked operators who were responsible for personnel errors to prepare operator training sessions that emphasize ways for others to avoid making similar errors.

The NRC is establishing an Office of Operational Data Analysis and Evaluation to provide NRC-wide coordination of all operational analysis activities (including personnel errors) performed within NRC.

The nuclear industry has established two organizations with responsibilities related to analysis and dissemination of operating information. Nuclear Safety Analysis Center

(NSAC) has established a program to systematically review event reports and operating data. Emphasis is on identifying possible precursor events, trends, and problem areas. INPO will review and analyze operating experience and provide feedback to licensees, incorporate lessons learned into training programs, and coordinate reporting and analysis with other organizations.

In addition to these programs, principal architect-engineer firms and nuclear steam supply systems (NSSS) vendors have established or are establishing programs for review of operating experience and are providing this information to applicable plants to improve operational safety and plant availability.

2.7.2.2 Evaluation of Operator Error Reporting Practices

Before the accident at TMI-2, another Babcox & Wilcox reactor (Davis Besse) had experienced the same stuck-open power-operated relief valve (PORV) and misleading indications similar to those which contributed to the TMI-2 accident; however, the operators at TMI-2 were not provided this information. Had they been aware of the Davis Besse incident, they might have correctly diagnosed the problem and taken appropriate corrective action before core damage had occurred. This situation and others convinced both the NRC and the industry that significant improvements in operating experience evaluations (including operator error reporting) were required. It is premature to judge the revised programs being implemented by the NRC, NSAC, INPO or individual utilities; therefore this evaluation applies primarily to operator error reporting as it has been in the past.

A computer printout of LERs identified as personnel errors from January 1, 1978, to June 26, 1980, was provided by the NRC's Office of Management and Program Analysis. This listing included about 900 reportable occurrences. A review of these data yielded the following observations:

1. The root causes of personnel errors were infrequently identified. The following are representative examples of LERs submitted and questions left unanswered by each:

a. An LER reported that temperature limits in the containment had been exceeded. The cause indicated was an incorrect valve lineup of the containment cooling system. But what was the reason for the incorrect lineup? Lack of appropriate procedures? Unqualified personnel performing evolutions? A training program that did not include this area? The LER further indicated that this was a repetitive event, but no corrective action was indicated.

b. An LER reported that the temperature rise across the main condensers exceeded the maximum allowable. The cause identified was the operator's failure to decrease power enough to compensate for the rapid increase in main condenser delta-T caused by debris in the intake. Corrective action was to decrease power until the delta-T decreased within specifications and clean the condenser water boxes. Is this a routine problem? What actions were taken to prevent a recurrence of this event?

c. An LER reported that a tag-out and isolation of a system had been conducted incorrectly in that one valve that was normally locked open had not been closed. The cause was identified as personnel failure to recognize proper system configuration before maintenance. The corrective action was to discuss the occurrence directly with the personnel involved and generally during a Shift Supervisors' meeting. The root question here seems to be <u>why</u> the valve was overlooked. Were the procedures inadequate? Was the valve shown on the source material used to prepare the tag-out? Was training in preparing tag-outs inadequate?

d. An LER indicated that a combination of switch positions during maintenance rendered the reactor core isolation cooling system inoperative, but the condition was not recognized by the licensed operators. The cause of the event was "personnel error." Corrective action was to complete maintenance and return switch lineups to normal.

2. Corrective actions for reportable events sometimes were not indicated. Other corrective actions indicated no apparent attempt to deal with root causes of reportable events. The following are examples of corrective actions reported:

- o Personnel alerted to be more aware of work activities,
- o Operators cautioned to consider their actions,
- o A memo issued to control room personnel reminding them of the importance of performing surveillance tests within allowable time frames and
- o Occurrence discussed with personnel involved.

3. It is very time consuming to sort out truly significant events since they are greatly outnumbered by minor events, such as failure to complete a routine surveillance test within a specified time period. No differentiation is made between these minor events and other more serious events.

4. Reporting information is not consistent among utilities. Some reports refer to the numbers of technical specifications without describing them, so that this information is of little value to other utilities.

Utilities have no obligation to provide architect-engineer firms or NSSS vendors with operating experience concerning their systems or equipment. Therefore, these vendors cannot make the information available to other utilities with similar plants. The relationship between vendors and utilities is dependent upon the utility, with some utilities having only minimal relationships with the architect-engineer firms and NSSS vendors once the plant is completed. Vendors have no formal responsibilities to monitor operating experience with the plants they design or construct.

Not all utilities have the personnel available on their staffs to evaluate operating experience (including operator errors) at other facilities. Therefore, the vendors, NSAC and INPO should be actively involved in evaluating operating experience.

Operator errors can be sorted into three general categories:

1. Errors due to deficiencies in operator skills or knowledges,

2. Errors due to equipment design or procedural limitations or

3. Errors due to operator negligence or serious errors in judgment.

Errors in category 1 can be attributed to either individual limitations or weaknesses in the utility's training or qualification program. Based upon a review of the corrective actions included in personnel error-related LERs, it appears that some utilities are assuming that the errors are not indicative of program weaknesses. It would seem more appropriate to assume that personnel errors are indicative of program weaknesses until there is clear evidence to the contrary. In order to determine whether an error is indicative of an individual or a program weakness, the root cause of the error must be determined. For either individual or program weaknesses, the identification of the root cause of the error and the utility corrective action would determine if it is necessary for the OLB to assess the effectiveness of that corrective action. Hence, appropriate action for the OLB for operator errors due to deficiencies in skills and knowledges would include, as a maximum, an appropriate re-examination of the operator(s) or a special audit of training programs or both.

Personnel errors due to equipment design or procedural deficiencies (category 2) are not indicative of either individual or training and qualification program weaknesses. However, there may be a need to upgrade the training of personnel to compensate for man-machine interface weaknesses of the plant design or operating procedures. NRC review of facility corrective actions in this case would help provide assurance that these types of errors will not be repeated.

Errors due to operator negligence or serious errors in judgment (category 3) are related to the individual and are the only category where disciplinary action against the individual should be considered (depending upon the degree of negligence). This disciplinary action would include suspension or revocation of an individual's operator's license.

The frequency of significant errors committed by individual operators is also important to the OLB. Two cases are worthy of consideration. The first case includes the single occurrence of an operator error of sufficient importance and falling into category 1 or 3 to warrant OLB action. The second case involves the repeated occurrence of errors which, over the long term, would give cause to doubt the competency of an individual operator.

In considering the first case (a single occurrence of a significant operator error caused by deficiencies in skills or knowledges or due to negligence), the initial problem faced by the OLB is identification of events of this nature to OLB examiners. If facilities are required to conduct a formal analysis of all events involving operator errors to sufficient depth to determine the root causes of these errors, resident IE inspectors can screen these evaluations for adequacy and applicability to the OLB. Location of OLB examiners at regional offices (as recommended in Chapter 4) would ensure prompt communication of applicable events to OLB examiners. Appropriate OLB action (program audit, re-examination or license suspension or revocation) could then be determined.

The second case is a more difficult problem to some extent. The basic issue involved concerns methods for assuring continued operator competency over time. One approach would involve creation of an elaborate administrative system for documenting all reportable errors of every licensed operator. Either the OLB could maintain these records or the facilities could be required to document these errors in operator performance records, which, in turn, would be periodically reviewed by the OLB. Such a system is neither recommended nor needed. The negative impact of this type of system on operator motivation would be significant and would counteract any purpose it might try to achieve. In addition, the increased emphasis in punitive aspects can result in less candor in reporting these errors. This, in turn, will have a negative influence on the information available to factor into training and requalification programs.

Section 2.7.1.9 recommended a requalification program which would be much more effective in assuring continued operator competency than any system of accountability for operator errors. As indicated in Recommendation 7 of Section 2.7.1.9, this program provides a combination of methods for conducting performance-related evaluations of operator competency. Considering the limitations and negative impact on operator motivation of an administrative system for accounting operator errors, the OLB can much more effectively apply its resources to implementation of an appropriate requalification program such as that recommended.

2.7.2.3 Conclusions and Recommendations Concerning Operator Error Reporting

Conclusions

1. The NRC has not taken a strong leadership position with respect to operator error reporting. As a result, the personnel error information provided through LERs has

been of limited value. Utilities have not been required to identify the root causes of personnel errors and therefore corrective actions taken have not necessarily been adequate.

2. The large volume of LERs received by the NRC, many of which are relatively insignificant violations of technical specifications, have contributed to the NRC's and industry's ineffective use of this information. No effective mechanism has existed for separating the important from the insignificant.

3. No mechanism has existed within the NRC or industry to conduct comprehensive investigations of individual or aggregate operator errors, and no effective means has existed to disseminate the lessons learned to plant operators.

4. Routing of personnel error-related LERs to plant operators as the sole means of making these personnel familiar with lessons learned at other plants is unsatisfactory (see Conclusion 6 and Recommendation 4, Section 2.7.1.9).

Recommendations

1. The NRC should revise operator error reporting criteria and procedures to place more emphasis on serious errors. The direction outlined in NUREG-0660, "NRC Action Plan Developed as a Result of the TMI-2 Accident," (16) seems appropriate:

   o Upgrade reporting to include all events having public health significance,
   o Eliminate reporting of insignificant events and failures,
   o Achieve consistency in reporting among licensees and
   o Include reporting on systems and components that may have safety implications and not just be "safety related."

   In addition, the NRC should establish more in-depth review of licensee LERs and other information submittals related to operator errors to ensure that the root causes of errors are determined and appropriate corrective actions are identified and completed. To achieve these objectives, more detail concerning causes and corrective action will be required than is currently provided by licensees.

2. The NRC should work with the industry (including INPO, NSAC, vendors and licensees) to ensure that a comprehensive system is implemented for analysis of operating experience (including serious personnel errors) and that the results of this analysis are provided to appropriate facility licensees in sufficient detail to permit effective training. Each facility licensee should have an effective means for factoring lessons learned through operator errors into both license and requalification training programs. As indicated in Section 2.7.1.9, this program should include required reading, lectures and practical training conducted in plant or on a control room simulator.

3. For each reportable occurrence that is the result of personnel error, the facility licensee should be required to conduct an evaluation to determine whether the error is indicative of a deficiency in the facility's training and qualification programs. If such a program deficiency is identified, the facility should commit to modifying or supplementing existing training programs to correct the deficiency. The resident IE inspector should review this evaluation for adequacy and applicability to the OLB. Utility evaluations of operator errors screened by resident inspectors as needing OLB review should be forwarded to designated OLB representatives.

4. Operator errors that could result in disciplinary action by the NRC (suspension or revocation of license) are those related to operator negligence or serious errors in judgment. For operator errors due to deficiencies in skills or knowledges or due to equipment design or procedural limitations, it should be considered the primary responsbility of the facility to provide effective permanent corrective action. As an evaluation of the effectiveness of facility corrective actions, the OLB should consider training program audits or operator re-examinations in these cases.

5. Rather than initiate any system for continuous accounting of specific errors to individual operators, the OLB should adopt a requalification program such as that described in Recommendation 7 of Section 2.7.1.9. Such a program will provide a combination of methods for conducting performance-related evaluations of operator competence.

2.8 UPGRADING OF LICENSED OPERATORS

2.8.1 Evaluation of Upgrading Requirements

Previous sections in this chapter have presented a number of proposed improvements for operator selection, training, licensing and requalification programs. It is expected that any effective upgrading plan for these programs will require a certain degree of requalification of presently licensed operators. Figure 2.13 presents the approach that was used to identify proposed requirements that should be backfitted to include current operators.

Initially, the aggregate list of recommendations presented in Sections 2.4 through 2.7 were reviewed for applicability to upgrading of present operators. Each of these recommendations was evaluated for its necessity for backfit based on increasing operator competency and reactor safety. From this list, recommendations of the following types were eliminated:

- o Those recommendations not applicable to upgrading of present operators (for example, screening and certification of candidates during license training) and

- o Those recommendations that do not warrant any special effort to backfit earlier than would occur by normal scheduling (for example, annual requirements of the requalification program proposed in Section 2.7.1.9).

From the resultant list of recommendations requiring special upgrading considerations, priorities were assigned on the basis of their relative prospect of assuring operator competency and reactor safety. Recommendations for implementation of these upgrading requirements were then developed.

Section 2.4, "Reactor Operator and Senior Operator License Training," provided several recommendations to improve these programs for license candidates. Since the TMI-2 accident, all of the utilities visited had re-evaluated their programs and most had made or are making significant improvements. Some facilities visited had recently lengthened their programs for license training from approximately 18 weeks to over 42 weeks. In

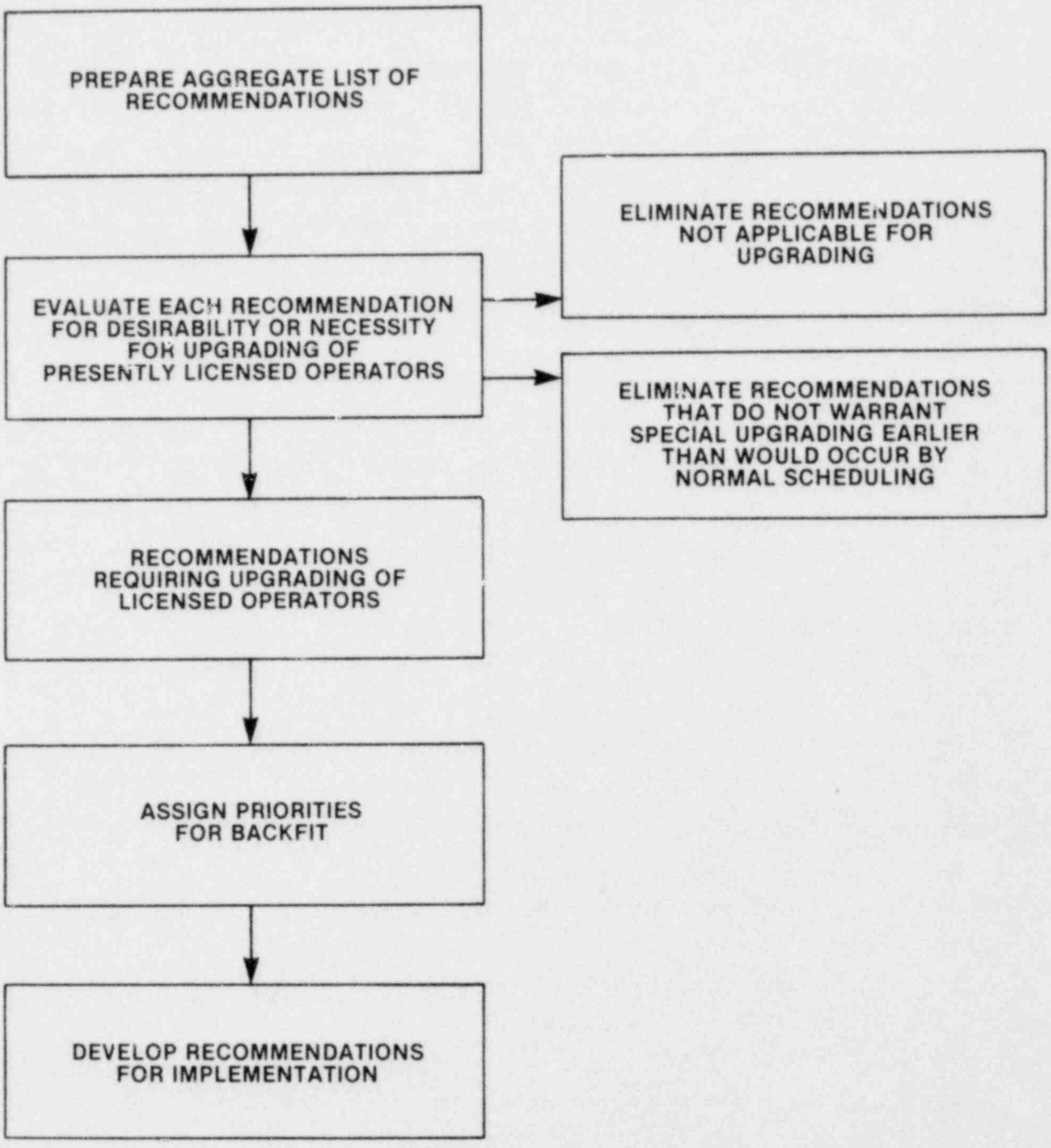


Figure 2.13 Methodology for Identification of Upgrading Requirements

general, two portions of the license training programs were principally affected by these changes: nuclear power plant fundamentals and on-the-job training.

Operators who are presently licensed and are on shift have most probably overcome any deficiencies in the on-the-job training portion of the license training programs in which they participated. This is not necessarily true, however, for the nuclear power plant fundamentals portion of license training. In fact, some subject areas presently included in license training programs were provided much less emphasis in programs prior to the TMI-2 accident. Upgrading of operators licensed through the older, shorter programs is needed in the area of nuclear power plant fundamentals.

Section 2.4 provided recommendations for improving current license training programs based on the application of a systematic approach to program development which includes plant-specific job task analyses. Admittedly, these improvements require some time to implement; however, current programs, which in several cases are more than twice as long as previous (pre-TMI-2) programs, can reasonably be expected to be significantly improved over the older versions. Through these current license training programs, a mechanism is available to provide, as an interim measure, the upgrading needed by previously licensed operators.

Section 2.7 recommended the use of a requalification program consisting of two portions: Annual Retraining and Upgrade Training. The Upgrade Training portion of this requalification program could be readily implemented as a mechanism to provide increased knowledge to previously licensed operators in the area of nuclear power plant fundamentals (operator knowledge would also be improved in other areas covered by Upgrade Training). As an interim measure, Upgrade Training curricula could be designed around current license training curricula. Long-term improvements to license training programs, resulting from the application of a systematic approach to program development (discussed in Section 2.4), could be easily backfitted into the Upgrade Training program already implemented. Once Upgrade Training is made a part of the requalification program (see Recommendation 7, Section 2.7.1.9), priority for rotation through Upgrade Training should be assigned to those operators who have been licensed longest.

Section 2.5, "Selection, Screening and Certification of Reactor Operator and Senior Operator Candidates," recommended that, as an interim measure, the NRC adopt the requirement in the May 1980 proposed revision to 10 CFR Part 55 for 30 semester-hours of college-level instruction (450 hours of instruction) in related technical subjects for SRO candidates. It was also recommended that, in the long term, the NRC use the results of plant-specific job task analyses conducted at facilities to identify more specifically the content areas needed to be covered in this instruction and the expected number of hours of instruction needed (Recommendation 1, Section 2.5.4.5). Based on the facility visits conducted, it can be expected that very few of the presently licensed SROs on shift have received the college-level instruction necessary to satisfy this 30 semester-hour requirement. Upgrading of these operators will be necessary.

Due to the number of SROs who currently would not satisfy this requirement and the relative shortage of operator workforce at some facilities, it is not reasonable to expect that all facilities could upgrade their SROs in this area within a short period of time (for example, less than 1 year). In addition, the current requirement for a Shift Technical Advisor (STA) on shift, <u>if that person meets these educational requirements</u>, wi'' help reduce the need for immediate upgrading of these SROs. The method used to .nplement this upgrading will vary from facility to facility based on the availability of SROs and the program used to provide this instruction (see Recommendation 1, Section 2.5.4.5 for a list of possible programs). Two alternatives are provided as examples of suitable implementation plans.

<u>Alternative A</u>: For a facility that is not sufficiently staffed to permit SROs to be removed from shift work for extensive periods of time (for example, 4 months or longer), this college-level instruction (30 semester-hours or 450 instruction hours) could be provided over a period of years by a combination of Upgrade Training time and shift rotation outside the control room. Part of the time provided during the Upgrade Training portion of the requalification program could be used to teach courses at the college level. Some of the time provided during the fifth or sixth week of shift work, when an operator normally rotates outside the control room, could be used to provide this instruction without compromising normal requalification program requirements. Figure 2.14 shows a program that would be complete over a 4-year period. Since some courses support others (for example, mathematics supports most of these subject areas), a prudent sequencing of these courses would be required. In this type of program, SROs on all shifts could concurrently receive college-level instruction aimed at satisfying the 30 semester-hour requirement.

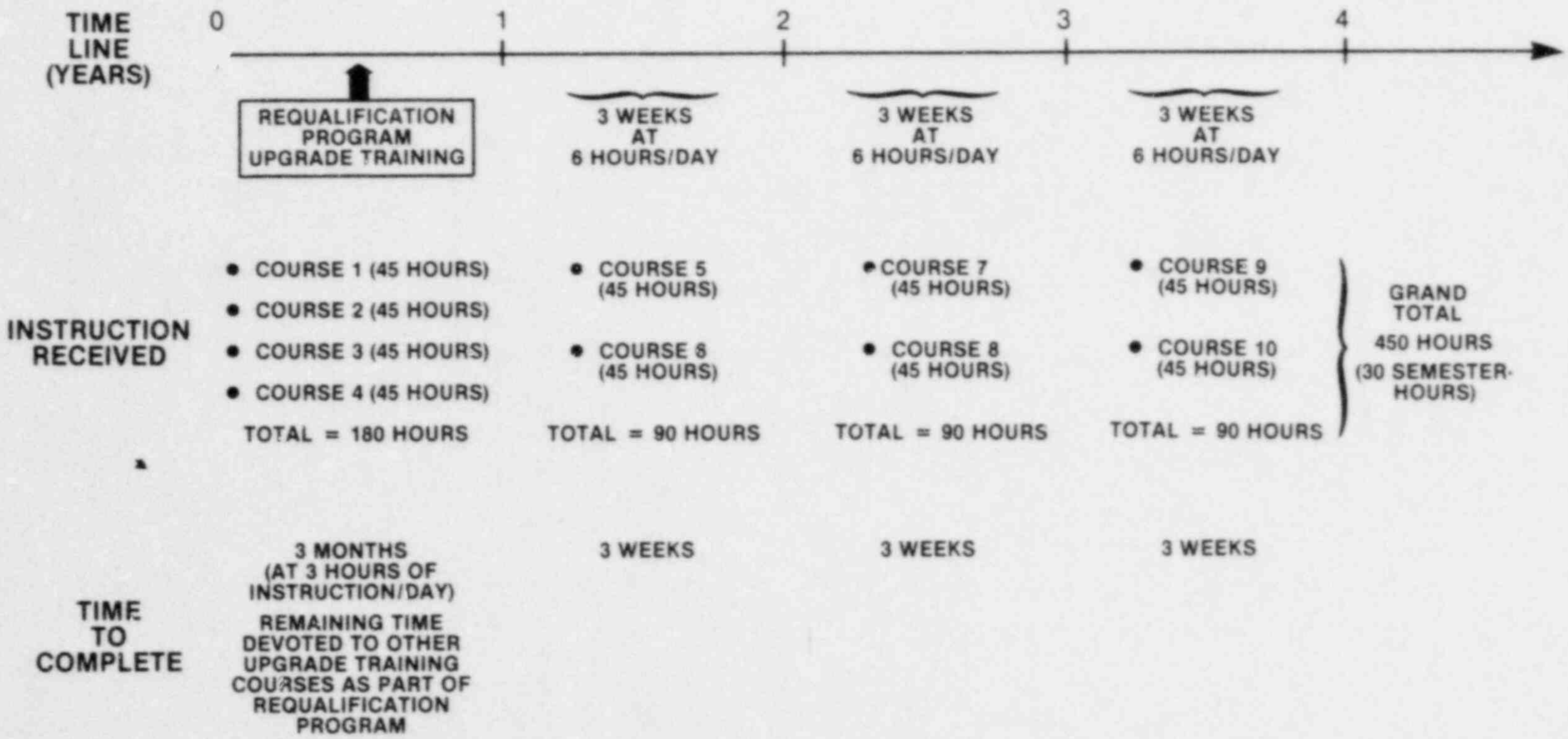


Figure 2.14 Alternative A Program for Upgrading SROs with College-Level Instruction

Alternative B: For the facility that can afford to have a small group of SROs absent from shiftwork for a number of months, this college-level instruction could be provided in one or more concentrated periods. Although this method would require a shorter period than that of Alternative A for an individual operator to complete the program, all SROs could not be receiving this instruction concurrently. It would still take a few years to rotate all SROs through the program. Figure 2.15 shows a possible program of this type that would consist of two 4-month periods spread over approximately 2 years for each SRO.

In Section 2.6, "Licensing of Reactor Operators and Senior Reactor Operators," it was recommended that the operating test be administered in an appropriate control room simulator and that the scope of this test be expanded to include evaluation of applicant performance in:

- o Recognizing emergency conditions and carrying out the appropriate actions of emergency operating procedures and emergency plan,
- o Recognizing abnormal offnormal and alarm conditions and carrying out the actions of appropriate procedures and
- o Carrying out normal plant operations in accordance with appropriate procedures (not limited to a reactor startup).

Many ROs and SROs have never been examined to NRC standards in these performance areas using a control room simulator. Some assurance that presently licensed operators can perform competently during these conditions is needed.

The proposed requalification program recommended in Section 2.7.1.9 (Recommendation 7) includes a requirement that the NRC conduct this type of examination annually using a control room simulator. The initial administration of this requalification operating test could satisfy this need to verify the competence of ROs and SROs to perform under these conditions. Due to manning limitations, it could be some time before the OLB could administer all of these examinations. To avoid this delay, as an interim measure, the NRC could develop and provide criteria to vendor training centers to conduct this operating test; however, upon implementation of this requalification program requirement, the NRC would need to administer these tests at utility-owned simulators.

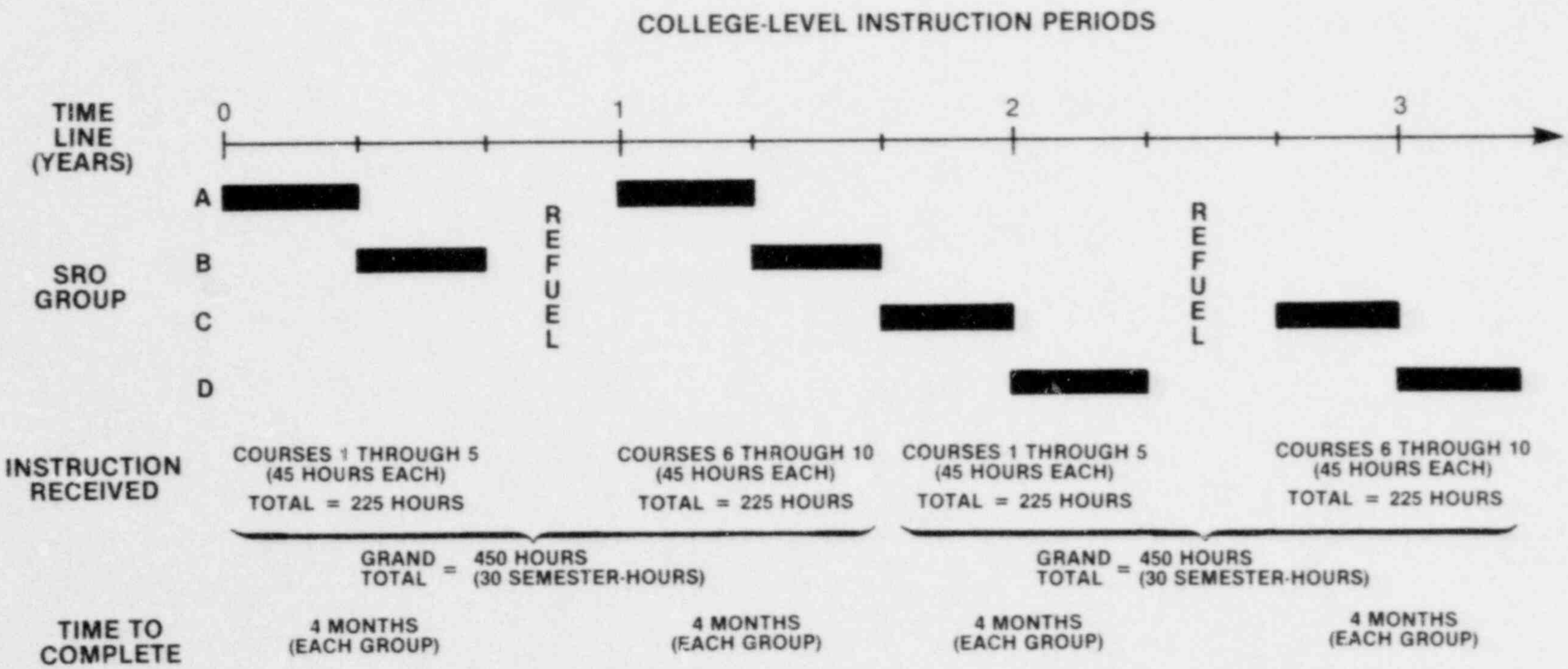


Figure 2.15 Alternative B Program for Upgrading SROs with College-Level Instruction

2.8.2 Conclusions and Recommendations for Upgrading of Licensed Operators

2.8.2.1 Conclusions

1. Operators who were licensed after completing training programs of abbreviated lengths (most notably pre-TMI-2 accident) in comparison with current programs are likely to be deficient in necessary knowledge of nuclear power plant fundamentals. These operators require training to upgrade their knowledge levels to those of operators completing current programs.

2. If the NRC adopts a proposed requirement for SRO candidates for 30 semester-hours of college-level instruction in related technical subjects, most presently licensed SROs will require upgrading in these areas. Although a number of methods may be used to implement this upgrading, it is expected that a number of years will be required to complete this backfit. The existence of an STA on shift who has educational background equivalent to this requirement, will help reduce any potential negative impact on plant safety until upgrading of SROs can be accomplished.

3. Many licensed operators have never been examined to NRC standards for their ability to properly operate a control room simulator under emergency, abnormal and normal (other than reactor startup) conditions. These operators need to be certified for their competence to operate under these conditions.

2.8.2.2 Recommendations

The following recommendations for upgrading licensed operators are presented in order of their priority for assuring operator competence:

1. Until rulemaking can be completed to require an annual operating test on a control room simulator as part of the requalification program, the NRC should require a special certification of operator competence to operate a control room simulator under normal (in addition to reactor startup), abnormal and

emergency conditions. This certification should be performed by the NRC or by conducting an operating test using criteria provided by the NRC.

The NRC could certify vendor training centers to conduct these operating tests, but the NRC should conduct them at utility-owned simulator facilites. The next occurrence of requalification training at the simulator would be adequate for timely performance of this requirement.

2. The NRC should require that all facilities provide a period of upgrade training in appropriate subjects of nuclear power plant fundamentals to licensed operators whose initial training programs were deficient in comparison with current standards and requirements.

   If the NRC elects to implement the requalification program recommended in Section 2.7.1.9, participation of these operators in the Upgrade Training portion of this program would be adequate to satisfy this requirement. In this situation, facilities should commit to rotating these previously licensed operators through Upgrade Training on a priority basis.

3. The NRC should require that facilities submit a plan for approval by the NRC to provide 30 semester-hours of college-level instruction in related technical subjects to presently licensed SROs who do not already satisfy this requirement. This plan should include a projected timetable for upgrading these individuals in this area.

2.9 COMPENSATION, STATUS AND MOTIVATION

2.9.1 Background

The objective of this section is to analyze the compensation, status and motivation of nuclear reactor operations and to make recommendations that will assist in creating and maintaining a highly motivated and dedicated nuclear work force.

The compensation of reactor operators was analyzed and evaluated by two means. The first method compared compensation levels of reactor operators with other high-technology occupations or occupations that inherently involve a high degree of responsibility. These occupations include air-traffic controllers, airline pilots, merchant marine engineers, and conventional power plant control room operators. To determine the compensation levels of these occupations, information was solicited from associated professional and governmental organizations including the U.S. Office of Personnel Management, U.S. Department of Commerce-Office of Maritime Labor and Training and the U.S. Department of Labor-Bureau of Labor Statistics.

The second means used in evaluating reactor operator compensation levels was the determination of the degree to which reactor operators are satisfied with their salaries. Personnel interviews at the sites visited and a questionnaire were used to collect this information.

To address status and motivation, information was collected through personal interviews and a job-satisfaction questionnaire (Appendix E). The questionnaire was developed and administered to all reactor operators and senior reactor operators at the nine sites visited. The questionnaire was designed to measure the level of motivation that currently exists and the factors that reactor operators perceive as important to job satisfaction. Specific areas covered by the questionnaire include:

- Fullfillment of needs (expectations),
- Job pride and public opinion,
- Prestige (status),

- o Involvement with decision-making process, } Organizational climate
- o Openness of communciations, }
- o Degree of satisfaction and perceived motivation,
- o Satisfaction with salary,
- o Degree of job boredom,
- o Degree of job commitment (dedication),
- o Advancement,
- o Recognition and sense of accomplishment and
- o Importance of various job characteristics.

Open-ended questions were included to solicit comments which were not conducive to scaled responses.

At each site visited, questionnaires were given to an individual in either the training or operations department who then distributed and collected the completed questionnaire. From the 9 sites visited, 222 questionnaires were returned.

Table 2-26 shows the distribution of responses for reactor operators and senior reactor operators along with their average (mean) salaries, range of salaries and average (mean) number of years of experience.

TABLE 2.26
DISTRIBUTION OF RESPONSES TO RO AND SRO
JOB SATISFACTION QUESTIONNAIRE

CATEGORY	REACTOR OPERATOR	SENIOR REACTOR OPERATOR
NUMBER OF RESPONSES	97	125
MEAN SALARY	$24,324	$33,800
SALARY RANGE	$19,000 to $30,000	$23,000 to $39,000
MEAN YEARS OF EXPERIENCE	2.8	6.4

2.9.2 Results

2.9.2.1 Selection of Commercial Nuclear Power

Operators were asked why they entered into the commercial nuclear power field and, if they had the chance, would they re-enter the field. The reason most often given (35 percent of responses) for entering the field was to make use of skills obtained while in the Navy. The potential for a good future was given by 24 percent and the salary and benefits the job offered were stated by 17 percent. Prior job (other than military) or educational experience was listed by 6 percent.

Of the 222 respondents, 40 percent said they would not choose a career in commercial nuclear power if they had the opportunity to start over, while 38 percent stated they would again choose the same career if given the opportunity. Operators were asked to qualify their responses which were categorized as shown in Table 2.27. As shown in this table, attributes of the job (challenging, interesting, enjoyable) were stated most frequently as reasons for again choosing nuclear power as an occupation. More than one of every four responses were concerned with excessive requirements and over-regulation as the reasons for not re-entering the field of commercial nuclear power.

2.9.2.2 Retention Factors

To determine the importance of various job characteristics in retaining operators, respondents were asked to rate 16 job characteristics on a 5-point scale. Means were computed for all respondents for each characteristic. The results of this rating, in descending order of importance, are presented in Table 2.28.

Salary was perceived by reactor operators as the most important factor for staying in their jobs. While many of the adjacent job characteristics can be interpreted as being equally important (having the same or similar mean value) in retaining operators, those characteristics at the extremes of the listing can be safely assumed to represent the ends of a continuum, with salary being the most important factor and recognition being the least important. All factors were rated as at least somewhat important (mean value greater than 3); therefore none should be disregarded.

TABLE 2.27
REASONS FOR AGAIN CHOOSING OR NOT CHOOSING THE COMMERCIAL NUCLEAR POWER FIELD

REASONS	PERCENT OF ALL RESPONSES
POSITIVE	
Challenging, interesting, enjoyable work	11
Necessity of nuclear power	7
Good benefits and opportunity	7
NEGATIVE	
Excessive requirements or over-regulation	26
Poor compensation	16
Poor working conditions (shift work)	11
Pursuit of other interests or college	8
Limited growth and advancement potential	5
Lack of government or company support	4
Anti-nuclear sentiment of the public and media	4

2.9.2.3 Ideal Job

Reactor operators were asked what factors they felt constituted the ideal job and the relative importance of each. Figures 2.16 and 2.17 show the results for ROs and SROs, respectively. Both salary and job security were the two most important factors for both ROs and SROs. The opportunity for advancement was also important for both groups. The largest difference between the two groups was having a position with responsibility, which was ranked fourth by senior reactor operators and eleventh by reactor operators. Affiliation needs (friendly associates) were of moderate importance for both groups, although slightly higher for ROs. The need to work independently (autonomy) was ranked relatively low by both groups as was the need to manage others (authority).

TABLE 2.28
RELATIVE IMPORTANCE OF SIXTEEN JOB CHARACTERISTICS FOR RETENTION (ALL RESPONDENTS)

ORDER OF IMPORTANCE TO QUESTIONNAIRE RESPONDENTS	JOB CHARACTERISTIC	MEAN VALUE
1	Salary	4.3
2	Job security	4.0
3	Management that listens	3.9
4	Good working conditions	3.9
5	Use of knowledge and skills	3.8
6	Job responsibility	3.7
7	People you work with	3.7
8	Opportunity to do challenging work	3.7
9	Opportunity to advance	3.7
10	Opportunity to learn new skills and knowledges	3.6
11	Liberal fringe benefits	3.6
12	Opportunity to work with little supervision	3.6
13	Geographical location	3.3
14	Difficulty in making same salary elsewhere	3.2
15	Work variety	3.2
16	Recognition and reward	3.2

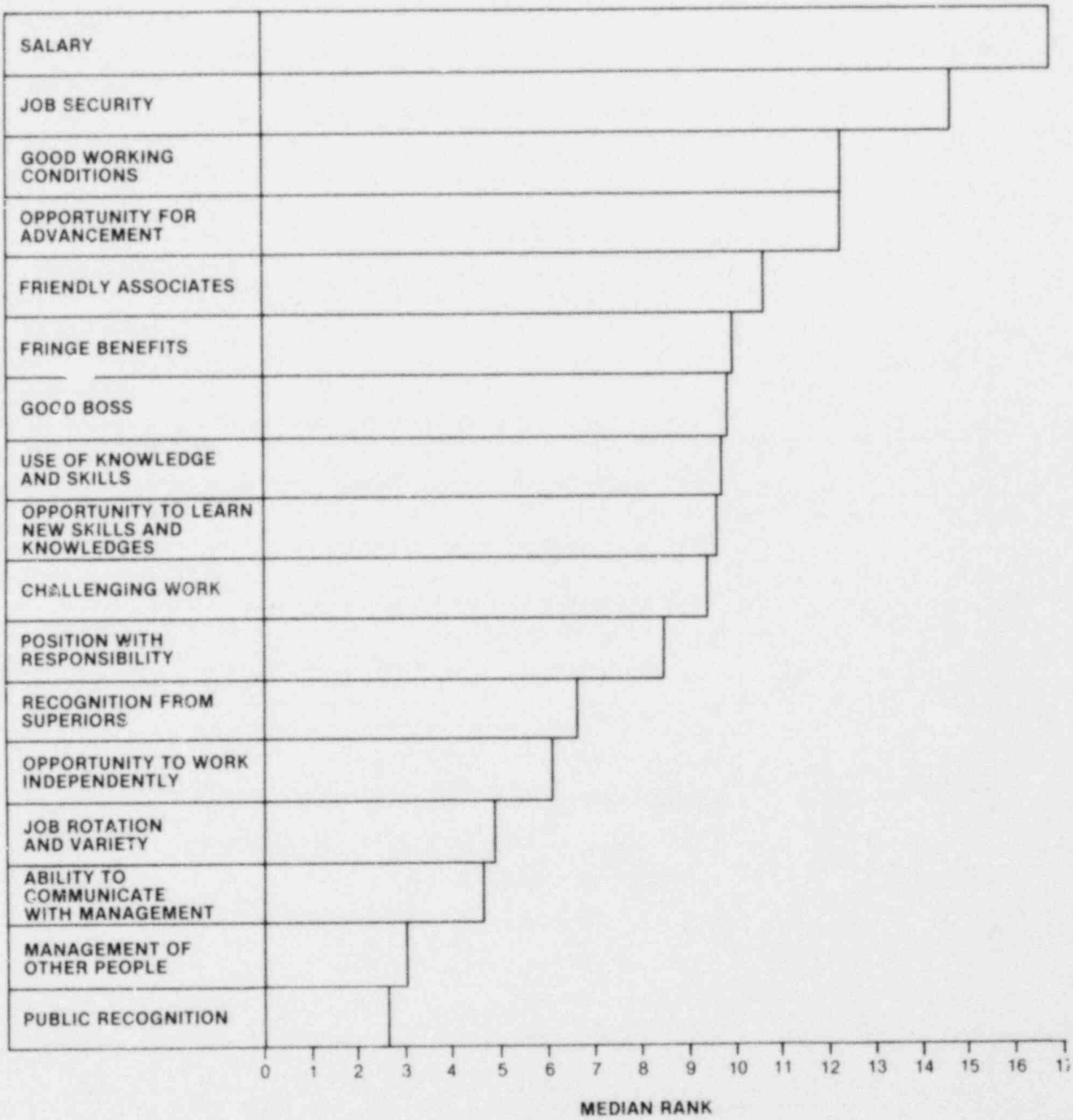


Figure 2.16 Relative Importance of Seventeen Job Characteristics for the Ideal Job (ROs)

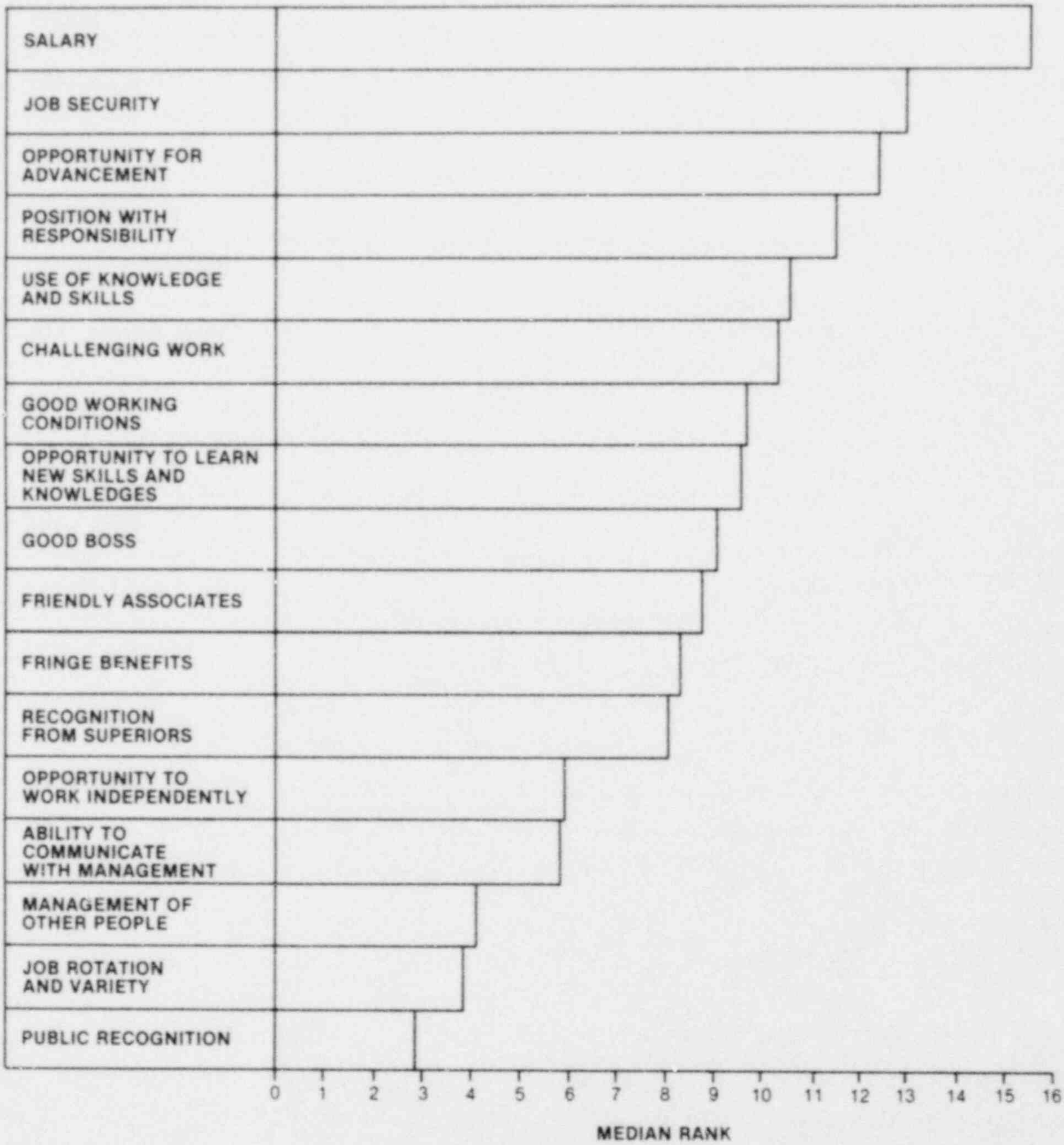


Figure 2.17 Relative Importance of Seventeen Job Characteristics for the Ideal Job (SROs)

2.9.2.4 Advancement

While the opportunity for advancement was considered important by both ROs and SROs, over half (59 percent) of the ROs felt their ability to advance to supervisory positions was limited and over three-fourths (77 percent) of all respondents felt their ability to advance to a management position was restricted.

Comments indicative of those received include the following:

> "When I first joined the company, I thought that in a few years I could reasonably become a Shift Supervisor. Now I realize that the most I'll attain without having to get a college degree is Senior Control Operator. I've spent enough time in college to know that a college degree doesn't guarantee an effective, safe plant employee, or distinguish one from a less effective employee."

2.9.2.5 Fulfillment of Needs

To determine whether the job of reactor operator met the expectations and needs of the incumbents, respondents were asked the degree to which their needs were met by the job. Only 1 percent of the operators felt their jobs completely filled their needs, while a vast majority (87 percent) felt that their jobs met their needs moderately. Twelve percent of the respondents felt that their jobs did little in meeting their needs.

2.9.2.6 Perceived Motivation and Satisfaction

To assess the existing level of motivation, operators' self-perceptions were solicited. Three-fourths of the entire sample felt they were either moderately or strongly motivated while the remaining 25 percent were slightly or not at all motivated.

Operators were also asked how satisfied they were with their jobs. Sixty percent answered "somewhat satisfied" (the mid-point of the scale), 19 percent "extremely satisfied" and 2 percent "completely satisfied." Nineteen percent of the operators said they were not satisfied with their jobs.

When asked what they liked about their jobs, 24 percent stated that the job was satisfying and challenging and provided a sense of accomplishment. Eighteen percent liked the benefits, 16 percent the responsibility and 15 percent referred to the use of knowledge, the necessity of nuclear power and the feeling associated with operating complex "technology."

2.9.2.7 Organizational Climate

Several questions were included to assess the atmosphere within which operators work.* These factors play a significant role in affecting operators' levels of satisfaction and motivation.

Forty-four percent of the ROs said they were not at all involved with making decisions affecting their jobs. Only 10 percent of the SROs were "generally consulted" and 36 percent "rarely consulted." The following comment is representative of many:

> "Company management, including station management, is not responsive to suggestions or needs of operators or first-line supervisors like myself. Station management should include SROs and ROs in briefing sessions on what the game plan is, prior to issuing orders which often appear to have no basis."

Three percent of the total sample felt that their management has complete confidence in them, while 29 percent felt that management confidence was substantial. Twenty-five percent felt that management had little or no confidence in them and, in addition, was not interested in their welfare. Of 166 respondents, 106 operators said that management interest in their welfare was "slight," "very little" or "not at all."

While operators felt they could communicate with their immediate supervisors most of the time, only 10 percent felt that communications within the organization were accurate. Over one-fourth (26 percent) of the respondents felt that intra-company communications got censored. When asked what improvements could be made, 20 percent mentioned internal communications and the need for responsive management, which

*One site requested that these organizational climate questions not be administered with the questionnaire.

included comments such as: "better communications up and down the ladder," "being shown appreciation for work done," "supervisors who are more people-oriented," "management to really understand what it is like to be in a pressure cooker," and "better communications . . . more support by supporting departments instead of continually working against each other." Seventy percent of the operators felt that they were supervised appropriately while 25 percent said they were oversupervised.

Forty-two percent of the operators felt they rarely receive credit for their work or receive recognition from utility management. Ten percent said they frequently or always receive credit for good job performance and 14 percent stated management recognizes their efforts most of the time.

2.9.2.8 Job Pride and Public Opinion

The majority of nuclear operators (83 percent) felt good when they related their occupation to other people while 17 percent "rarely" or "never" felt good when they told people what they did for a living.

Public opinion about nuclear power did not have any significant effect on how operators felt about their jobs; however, what did disturb operators was the large amount of misinformed and unanswered statements made by anti-nuclear groups, the media and the public. Comments such as "the negative (nuclear) aspect is all that seems to be made public, and industry seems content to allow this without defensive comment" and "adverse public opinion because of a lack of knowledge" were extant.

2.9.2.9 Job Rotation and Boredom

For 70 percent of the operators, boredom was not a problem, although the degree of boredom was shift-dependent. For 19 percent of the operators, about half or more of the working day is boring. Fifty-six percent of the respondents were interested in job rotation. The most prevailing idea concerning job rotation was to have ROs spend time in the plant periodically to refamiliarize themselves with plant status and operations and to be relieved from the tedium of the control room. Other ideas concerned involvement with other departments, especially where having operational knowledge and skills would benefit the overall operations of the plant. Periodic assignment to departments such as maintenance, quality assurance, health physics and engineering, which would provide operators enriched perspectives of how other departments affect and contribute to their jobs in the control room, were presented by several respondents.

2.9.2.10 Job Involvement - Extra Work

Ninety percent of all operators felt that they were moderately or fully involved with their jobs, while 10 percent were involved slightly or very little. Eight-four percent did extra work which was not required of them at least once a week or more frequently. Seven percent of the respondents did extra work less than once a month.

2.9.2.11 Feedback and Worth of Work

Almost nine out of ten operators (88 percent) felt a sense of accomplishment from their jobs, while slightly less (85 percent) felt that they saw the results of their efforts.

Operators felt that their work was worthwhile. One percent of the respondents stated that they "rarely" felt that their work was worthwhile.

Almost every operator felt that the match between his abilities and the demands of the job was at least somewhat adequate. Only one individual responded otherwise.

One-third of the entire sample thought they were prepared for their jobs extremely well, while a little more than half (57 percent) considered their job preparation satisfactory. Ten percent felt they were prepared poorly.

2.9.2.12 Prestige

To assess the status level ROs perceive of their occupation, a scale of various occupations was included. Operators were presented with ten occupations and told to rank them according to the amount of prestige (status) each carries relative to one another. Figure 2.18 shows the results. As can be seen, ROs ranked the status of their own position between that of chemist and computer programmer. The median rank assigned to ROs was 6.86.

2.9.2.13 Job Dimensions

To assess operators' feelings about the job itself, six pairs of adjectives which are polar opposites were included (see question 28 in Appendix E). In descending order,

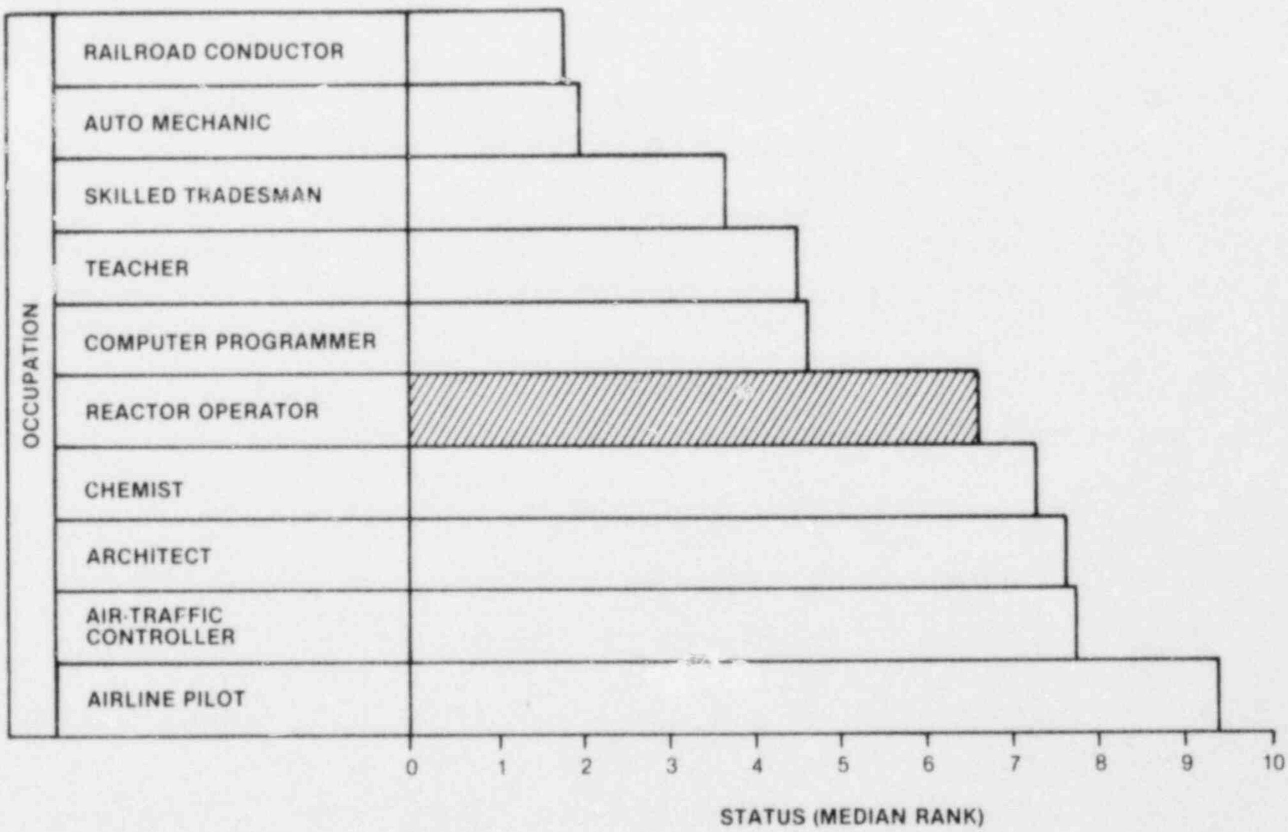


Figure 2.18 Relative Status of Ten Occupations (All Respondents)

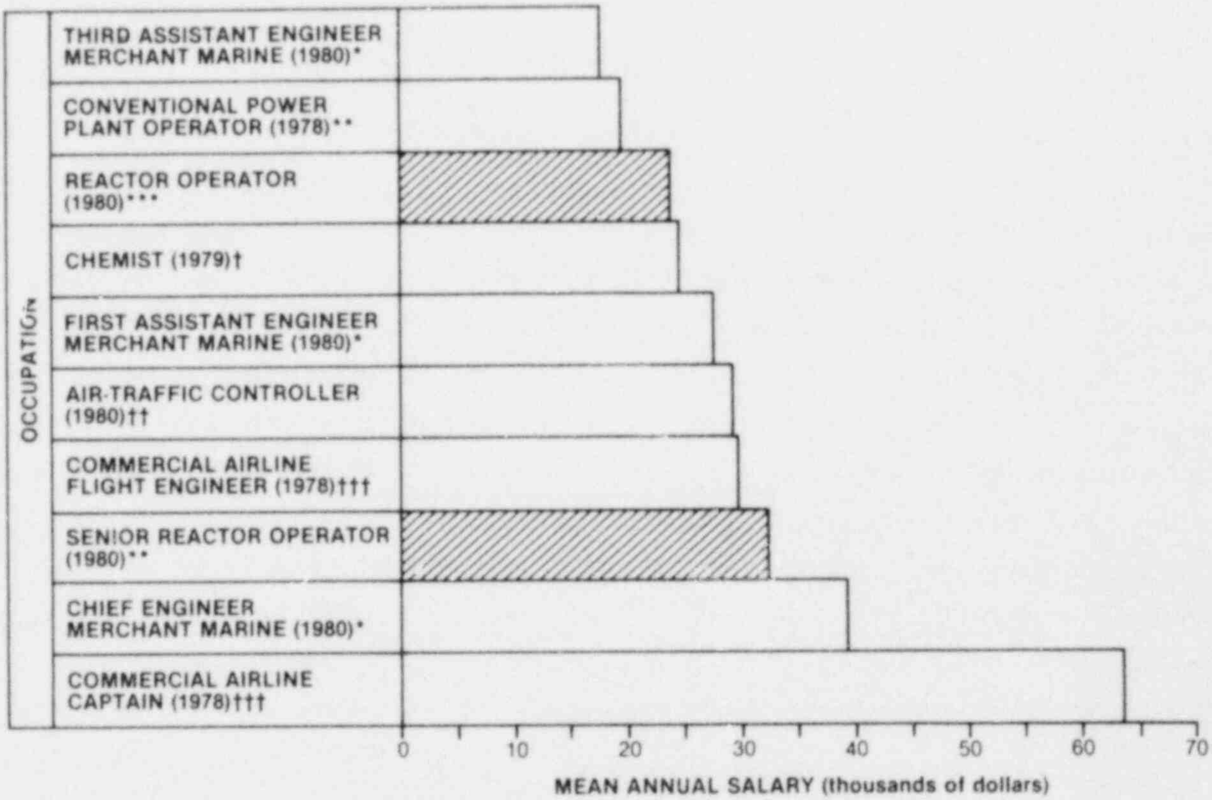
operators felt that their jobs were challenging (86 percent), interesting (71 percent), difficult (70 percent), clear (58 percent), varied (57 percent) and entailed some creativity (39 percent).

2.9.2.14 Salary

Salary is the most important job characteristic for reactor and senior reactor operators. It is also a source of dissatisfaction. Sixty-six percent of the total sample said they were dissatisfied with their salaries for the work they performed, while 81 percent stated their salaries were inadequate for the level of responsibility the job involved. Twenty percent of the comments concerning job dislikes involved salary and 25 percent of the job-improvement statements expressed a need for increased compensation. The following comment epitomizes the overall feeling: "We have to put up with training requirements imposed by the NRC on overtime; we have to put up with overtime when others go on vacation . . . the scheduled overtime is enormously burdensome . . . still we are not compensated for the degree of responsibility, risk, time on the job, loss of personal time . . . "

The average salaries of the following occupations were obtained: third, first and chief engineers in the merchant marine, conventional power plant operators, chemists, air-traffic controllers and commercial airline captains and flight engineers. Merchant marine salaries are based on monthly compensation and vary with type of ship. The salary for conventional power plant operators does not include overtime pay or any differentials, while RO and SRO salaries may. It is also important to note that the salaries for air-traffic controllers vary considerably. Commercial airline pilot salaries do not include those of industrial pilots who earn significantly less. Salary information for ROs and SROs came from the job satisfaction questionnaire. Figure 2.19 shows the salaries for these occupations and the sources of these data. Information was obtained for the latest year available, which is included for each occupation.

As can be seen from the figure, there do not appear to be any gross inconsistencies between the occupations; however, one exception exists in that conventional power plant operators earn an almost equivalent amount as their nuclear counterparts but without the stringent requirements, responsibilities, and depth and breadth of



* OFFICE OF MARITIME LABOR AND TRAINING, U. S. DEPARTMENT OF COMMERCE, WASHINGTON, D. C., TELEPHONE CONVERSATION WITH R. ZARET, ANALYSIS & TECHNOLOGY, INC., AUGUST 1980.

** INDUSTRY WAGE SURVEY, ELECTRIC AND GAS UTILITIES, U. S. DEPARTMENT OF LABOR, BUREAU OF LABOR STATISTICS, FEBRUARY 1978.

*** RO/SRO JOB SATISFACTION QUESTIONNAIRE, ANALYSIS & TECHNOLOGY, INC., 1980.

† EXECUTIVE COMPENSATION SERVICE, 6th EDITION, 1979/1980, AMERICAN MANAGEMENT ASSOCIATION, NEW YORK, NY 10020, 1980.

†† S. PERLOFT, OFFICE OF PERSONNEL MANAGEMENT, WASHINGTON, D. C., TELEPHONE CONVERSATION WITH R. ZARET, ANALYSIS & TECHNOLOGY, INC., AUGUST 1980.

††† J. MAZOR, AIRLINE PILOTS' ASSOCIATION, WASHINGTON, D. C., TELEPHONE CONVERSATION WITH R. ZARET, ANALYSIS & TECHNOLOGY, INC., AUGUST 1980.

Figure 2.19 Average Salaries by Occupation knowledge required of nuclear operators. One would surmise that nuclear operators would be reimbursed significantly more than conventional operators, especially when one considers that the utility pays both types of operators.

Because operators are more familiar with the requirements and salaries of other jobs within the utility, it is these jobs which have the most profound impact on feelings of adequacy or inadequacy of operator salaries. For example, operators know the salaries of individuals who work in Quality Assurance or Health Physics areas, and feel that these individuals do not have equivalent amounts of responsibility or shift-work requirements imposed upon them.

2.9.3 Conclusions and Recommendations Relating to RO and SRO Compensation, Status and Motivation

2.9.3.1 Conclusions

The inherent nature of the job of reactor operator requires full involvement and dedication by incumbents. Many of the personal attributes necessary to attain this requirement can only be instilled by a perceptive, involved managerial staff that fully appreciates the nature and the requirements of the job.

In any occupation, a large variance of satisfaction and motivation will exist because of the job itself and individual differences. Each individual is motivated by varying degrees of different needs. When a majority of individuals sharing the same needs voice the opinion that they are dissatisfied, a problem exists.

The results of the survey show that a majority of reactor operators are highly dedicated and motivated individuals. They have positive feelings about their jobs, feel they are supervised appropriately, and receive satisfaction from their work. The majority like their peers and enjoy many of the same interests. Most are not bored by the tedium of the control room and feel they get to see the results of their efforts. Ninety percent receive gratification and a sense of accomplishment from the job. Almost all feel their work is worthwhile and that there is a good deal of congruence between their abilities and the demands of their jobs.

In contrast to these positive feelings, a majority of operators are dissatisfied with their salaries, the lack of clear paths for advancement, the amount of overtime they must work, and their lack of participation in company communications and decision making. If given the opportunity to do so, a majority of operators would not again choose nuclear power as a field of endeavor.

While salary structures are determined by many factors, one must consider the requirements imposed on an individual, the responsibilities and the compensation levels of similar occupations. Considering the fact that nuclear power plant operators are not required to have college degrees, their salaries compare favorably with other highly technical occupations for which degrees are required; but, when one considers the job of conventional power plant operator, which entails similar working conditions (shift work), but neither the responsibility nor the requirements of a nuclear operator, the difference in salaries is almost negligible. Based on personal interviews, similar comparison can be made with Instrument and Controls (I&C) technicians, Health Physics technicians and maintenance personnel. Although salary is not a positive reinforcer of motivation, dissatisfaction with salary can definitely demotivate an individual (44).

The pervasive feeling of the absence of an advancement avenue may result in a serious problem involving two issues. One issue is the possible imposition of new educational requirements for operators and the implications for incumbents. The second issue is the absence of advancement paths themselves. Many utilities have not formulated clear advancement paths or have not communicated them to operators.

With respect to the former, many operators feel that they will not have any chance to advance to a non-shift position because of new educational requirements (13). Some utilities are pursuing a policy of upgrading their operators through accreditation of in-house training programs. Other utilities are planning to hire new individuals to satisfy the new requirements and, as a result, incumbents are justifiably concerned about their future.

The issue of advancement is not a particular problem for those utilities that are bringing new plants on-line. The addition of these new facilities makes available more responsible positions that can be filled by experienced operators.

The manpower shortage in the industry contributes to problems of advancement, excessive amounts of overtime which some operators are currently working and the lack of lateral movement afforded operations personnel within the company. These problems will only be ameliorated through a sizeable increase in the operator work force. It is important to note that at one site visited, the local population was used as a resource pool for potential operators and no shortage of operators existed.

The problems perceived by operators concerning communications, consultation, involvement and general management treatment are due, in part, to the nature of the organization. The imposition of externally originated requirements, the pressures of the job at hand, the degree of overtime and a management that is task oriented, all contribute to the lack of regard and communications espoused by operators. Task-oriented individuals typically are not very people-oriented. While it is not the intent of utility management to instill in operators negative feelings (for example, management lack of concern for operators), a conscious effort must be made by the utility to encourage people-oriented management.

2.9.3.2 Recommendations

Each of the following recommendations is important to the motivation and dedication of nuclear operators. All must be afforded the attention necessary by utility management and recognized as being in the best interests of the utilities, the operators and the public. It is possible that the cognizance of these problems by utility management will precipitate changes at the utilities.

The recommendations do not lend themselves to regulation; however, they are conducive to encouragement and monitoring by the NRC. The sponsoring of workshops for heterogeneous groups of plant staff is one mechanism. An alternative may be that an organization such as INPO, with the NRC's endorsement, provide the means to develop such programs. The NRC should periodically assess, possibly with surveys or similar means, whether changes are being implemented.

1. Utility management should actively pursue a policy of increased interpersonal relations and effective communications. Survey results indicate that operators

perceive that communications within the company are inhibited and that management disregards their feelings and needs.

Utility management must make a conscious effort to relate their concern for operators and also recognize and solicit operator inputs into matters which concern them, especially where these inputs would greatly improve the overall functioning of the plant.

2. Clear avenues of advancement should be delineated and communicated to operations personnel.

A majority of operators voiced a concern about possible new requirements and existing advancement paths. People need to know the direction of job progression and the requirements to attain each higher position. Utilities that have formulated advancement channels must clearly communicate them to operations personnel. Utilities that have not yet delineated advancement channels should do so.

3. Utilities should commit to creating a sizeable increase in the operator work force.

Operators at most sites visited are currently working what they feel to be an excessive amount of overtime. The only way to ameliorate this situation is to increase the operations staff.

The benefits to be derived from having more operators would be numerous. The availability of more operators would profoundly improve operator satisfaction. It would also lead to an increased assurance of safe and competent operations by reducing overtime requirements and hence assuring that operators are more alert. Increased operating staff will also allow greater flexibility in lateral movement, operator participation in temporary assignments away from the control room and improved shift rotation.

4. Operator salaries should be carefully reviewed in the context of the responsibilities and the requirements imposed upon them, and in relation to other utility occupations.

The largest source of dissatisfaction for operators is salary. Some question exists as to the consistency of salaries for the levels of responsibility and amount of requirements when compared to other utility occupations, both nuclear and fossil fuel. Serious consideration should be given to operator salaries in relation to other plant positions which do not share the responsibility nor the shift and training requirements.

2.10 LICENSE TRAINING INSTRUCTORS

2.10.1 Instructor Requirements

Industry Standards. The "American National Standard for Selection and Training of Nuclear Power Plant Personnel," ANSI/ANS-3.1-1978 (7), does not state requirements for instructors; however, a draft proposed revision to ANSI/ANS-3.1-1978 (8) published in December 1979 specifies the following qualifications for instructors:

> Education. High school diploma and special education consistent with the materials being presented.
>
> Experience. Experience consistent with the materials being presented.
>
> Training. Senior operator, general employee and retraining, or if not licensed, as appropriate for the training being conducted.
>
> Instructors who provide simulator instruction shall hold a senior operator license for a similar unit (PWR, BWR, HTGR) or have been certified at an appropriate plant simulator.
>
> The instructor shall have demonstrated knowledge of instructional techniques and be certified by the Training Manager as a qualified instructor for the material being presented.

The draft revision to ANSI/ANS-3.1-1978 also specifies the following qualifications for Training Coordinators:

> Education. High school diploma.
>
> Experience. Two years of power plant experience, 6 months of which shall be in the on-site training organization.

Training. Necessary training to perform the skills and knowledges required of the position. The training is to be of sufficient duration to develop the proficiency required.

If the Training Coordinator is responsible for the content of training (Training Manager function), he shall also have the following qualifications:

Education. Bachelor degree including some courses in education and technical subjects.

Experience. Four years of professional-level experience of which 2 years shall be nuclear power plant experience.

Training. As required for non-licensed managers and supervisors and general employee training. Some training in educational techniques is required, if not included in the bachelor degree course work.

If the Training Manager does not possess a senior operator license, another individual shall be assigned the responsibility for the content and conduct of the training program for licensed operators. The Training Manager may be located on or off site.

Federal Regulations and NRC Guidance. The only regulatory requirement concerning instructors was implemented by the NRR letter of March 1980 (13) which states:

> Training center and facility instructors who teach systems, integrated responses, transient and simulator courses shall demonstrate their competence to NRC by successful completion of a senior operator examination. Instructors shall be enrolled in appropriate requalification programs to assure they are cognizant of current operating history, problems, and changes to procedures and administrative limitations.

The NRC provides no additional guidance concerning the qualifications of instructors.

2.10.2 Utility Instructor Practices

All sites visited selected individuals from their own operating staffs to teach the plant systems and plant operations phases of training. These instructors were selected on the basis of one or more of the following criteria:

- o Length of operating experience,
- o Previous instructional experience (either Navy or at another plant),
- o Results of interviews conducted with one or more of these individuals,
  - Corporate training manager,
  - Operations supervisor or
  - Site training supervisor/coordinator,
- o Operating proficiency,
- o Demonstration lecture,
- o Education and
- o Interest in training.

Although various combinations of these criteria were used, most training supervisors interviewed indicated that technical competence (evidenced by operating proficiency and experience) and an expressed desire to instruct were the prevailing criteria used in instructor selection.

Most instructors who were responsible for plant systems, plant operations and simulator courses of instruction held senior operator licenses. Others were in the process of obtaining these licenses. Their educational experience satisfied existing requirements for individuals holding senior licenses; that is, they were high school graduates.

While the qualifications of instructors whose training responsibilities involved plant systems and plant operations were relatively consistent, the qualifications and sources of instructors for nuclear fundamentals training varied greatly. These instructors included:

- o Training staff personnel who were licensed operators,
- o Training staff personnel who were unlicensed (with and without operations experience),
- o Guest lecturers from other departments in the plant organization,
- o College instructors,
- o Reactor plant vendor instructors and
- o Training service contractors (with and without operations experience).

At a few utilities visited, instructional teams (two people - one with and one without operations experience) were used for parts of this phase of license training. The instructor without operational experience would discuss the conceptual and theoretical foundations of the subject matter. This information would then be applied, through relevant job-related examples, by the operations-experienced individual.

Most requalification instructors at the sites visited had a senior reactor operator license and operating experience; however, non-licensed individuals were used to instruct the fundamentals (theoretical) aspects of requalification at some facilities.

Although instructional skills were considered by most utilities, a majority of the instructors at the sites visited had not received instruction in improving their skills. One training center did offer workshops and was in the process of formalizing a program. Other utilities offered off-site programs, but job responsibilities (instructing, preparing training materials, etc.) often prevented the instructional staff from attending these programs. Since instructors were selected primarily for their technical competence, the majority had no exposure to either training or education methods other than those observed through their own experience.

Evaluation practices of instructional staff varied considerably between training center or vendor facilities and training departments located on site. Training centers, both utility and vendor, generally considered both technical accuracy and instructional skill (preparation, presentation) in evaluating and selecting the instructional staff. Detailed observation lists were often used to ensure consistency and comprehensiveness. However, no comprehensive mechanisms for instructor evaluations existed at the reactor sites. Although a few utilities evaluated technical competence with the subject matter or the meeting of generalized objectives, the majority did not provide for increasing familiarity with or improving instructional skills. Some utilities used a management-by-objective approach to evaluation, with the instructor and coordinator establishing mutually acceptable objectives. These objectives were characterized by such generalities as "assures the development," "contributes to," "provides for," etc. These terms are verbalizations of normal job duties and may be necessary to job performance, but they neither specify standards of performance nor account for specific skills such as instructional preparation or delivery. Not all utilities used this approach. Some relied exclusively on trainee feedback reaction to the instructor and material. Other sites were planning to implement a mechanism to solicit supervisor evaluations of trainee performance on the job, although this was not yet a practice.

2.10.3 Federal Aviation Administration Practices (26)

The FAA certifies all instructors to provide ground or flight training in accordance with their aircraft rating. To complete this certification, a candidate must satisfy several requirements. To verify minimum acceptable technical knowledge, the candidate must hold a pilot certificate appropriate for the flight instructor rating sought. In addition, the applicant must satisfactorily complete a course of instruction and pass an FAA written examination in the following subjects:

- The learning process,
- Elements of effective teaching,
- Student evaluation, quizzing and testing,
- Course development,
- Lesson planning and
- Classroom instructing techniques.

The applicant must also have satisfactorily completed flight instruction given by a person who has been a certified flight instructor for at least 2 years and has given at least 200 hours of instruction. This flight training must include the following subjects:

- Preparation and conduct of lesson plans for students with varying backgrounds and levels of experience and ability,
- Evaluation of student flight performance,

- o Effective preflight and postflight instruction,
- o Flight instructor responsibilities and certification procedures,
- o Effective analysis and correction of common student pilot flight errors and
- o Performance and analysis of standard flight training procedures and maneuvers appropriate to the flight instructor rating sought.

At the completion of this training, the candidate must pass an FAA-administered oral and practical test on these subject areas.

Upon successful completion of the written, oral and practical examinations, a flight instructor certification is granted by the FAA. This certification is valid for 24 months and may be renewed by one of the following methods:

- o Pass another practical test for a flight instructor certificate,
- o Have a record of instruction that demonstrates competency as an instructor,
- o Have a satisfactory record in an activity involving the regular evaluation of pilots (for example, as a check pilot, chief flight instructor, etc.) and pass any oral test necessary to determine knowledge of current pilot training and certification requirements or
- o Successfully complete an FAA-approved flight instructor refresher course of at least 24 hours of instruction.

2.10.4 Evaluation of License Instructors' Practices

Industry standards and requirements acknowledge the importance of instructional skills to licensed operator instructional staff, although this recognition has occurred only recently. In the past, instructor requirements were synonymous with those for obtaining a license with no delineation of instructional skills. There is still a paucity of requirements and guidance concerning instructors.

Several limitations exist with respect to the proposed revision to ANSI/ANS-3.1-1978. The revised standard, as stated, is somewhat nebulous. The term "knowledge" is subject to differing connotations. Training requirements for instructors recognize only the need for technical training (that is, senior operator, general employee and retraining), but not the instructional skills necessary to perform their jobs. While technical knowledge is necessary, it is not sufficient.

In the past, this reliance on technical competence has provided the principal criterion for instructor selection. Little consideration has been given to instructional skills. This problem is not unique to nuclear power plant facilities, but is characteristic of many sectors of our society. Even universities select professors because of their technical or professional competence (publications). Little regard is given to the ability to impart knowledge effectively.

For individuals who are responsible for the training of the systems, operations and simulator phases of instruction, the requirements specifying a senior operator license (13) should provide for the minimum technical qualifications necessary to provide adequate instruction in these areas. The use of appropriately qualified non-licensed instructors for theoretical aspects of license training and requalification is deemed acceptable as long as a mechanism is provided for answering trainees' questions related to application. The "team concept" of an academic instructor and a senior operator should provide the appropriate mechanism to allow the instruction of relevant, job-related knowledge. The use of a non-operations individual without the input of an operations staff member is problematic in that the material may not be relevant to a reactor operator.

The majority of instructors interviewed have not participated in any workshop or course dealing with instructional technique. In many cases where programs were offered, the instructional staff could not attend because of instructional responsibilities. The lack of emphasis on instructional training has allowed the following deficiencies:

- o Inadequate planning (the writing of objectives which are nebulous and inconsistent),
- o Lack of knowledge in learning, instructional methods, questioning and evaluation techniques,

- o Inability to present information in different contexts and from different perspectives and
- o Tendency to "teach the licensing examination" from known or reconstructed examination questions.

Efforts must be made by the utilities to provide their instructors with the tools they need to do their jobs effectively and competently.

Interviews with training staff personnel indicated that, at some sites, there was no effective mechanism to keep training materials current; for example, training department copies of plant procedures were not updated with changes, and design changes were not reflected in visual aids, handouts and lesson plans. Training instructors' schedules generally did not provide sufficient time to update lesson plans or other training materials. Several instructors and operations personnel related that misinformation was being presented because instructors were not being kept current on plant conditions.

The issue of a lack of relevant information afforded instructors was a problem for all phases of instruction; however, the largest impact was on the requalification instructors. Interviews with plant personnel revealed that requalification lectures often contained invalid and outdated information on procedures or specifications. Superceded procedures or specifications were sometimes used. Another problem expressed by plant personnel was that requalification instructors have "lost touch" with plant operations because of their physical removal from the plant. It was also observed that many requalification trainees have more extensive experience than their instructors.

Some facilities visited had commendable means with which to evaluate the effectiveness of their instructors. Most, however, had no mechanism with which to adequately evaluate instructional staff. As with instructor selection practices, these evaluation criteria were generally aimed at technical accuracy rather than instructional delivery. Furthermore, individuals conducting the evaluations did not possess the "tools" to evaluate instructional skills. As long as an individual could impart correct information in one context, that instructor was deemed technically satisfactory. The instructional skill of imparting information from different perspectives or in different contexts was never evaluated. In most instances, supervisors or coordinators could not provide constructive feedback on instructional technique due to some degree by their being products of the same or similar backgrounds as their instructors (that is, high school graduates with extensive operations experience and little exposure to training methodology). While experience is conducive to improving skills in certain areas, the use of inadequate methods is perpetuated by this process. Individuals whose only exposures to training techniques were as students or as trainees had little opportunity to adequately equip themselves with these instructional skills and knowledges.

The use of trainee feedback or reaction to the course is, by itself, unsatisfactory. Students are notorious for biased evaluations, both positive and negative, of instructors. Furthermore, students are not sufficiently prepared to recognize deficiencies in instructional delivery or content; however, trainee reaction to a course, when coupled with more objective and knowledgeable evaluation results, can provide some useful information.

If used appropriately, the management-by-objective approach is perhaps the most valid evaluation method, although it too should be used in conjunction with other measures. Training supervisors and instructors should mutually agree upon objectives which are specific and measurable and provide performance standards. Objectives and methods to improve instructor awareness of and skill in instructional techniques should also be included.

2.10.5 Conclusions and Recommendations for License Training Instructors

2.10.5.1 Conclusions

1. Training instructors are a group of conscientious individuals who are trying to do the best job possible. Similar to other plant personnel, they are confronted with many tasks and not enough time. Many facilities visited had understaffed training departments.

   For instructors whose training responsibilities involved license training, most utilities and training centers used individuals who:

- o Were products of the utility's training program,
- o Were licensed or certified and
- o Had operational experience at the RO or SRO level.

2. The current requirement (13) that an instructor, whose responsibilities include systems, integrated responses, transient and simulator courses, hold an SRO license (or NRC certification at the SRO level) is adequate certification of technical competence in these areas.

   Instructors who train in content areas that lend themselves to increased proficiency through experience (plant specifics) should be technically competent by virtue of their experience and training.

3. A significant discrepancy currently exists in the level of proficiency of instructors with respect to instructional skills. There is a paucity of guidance concerning the qualifications of instructional staff. Almost all instructors interviewed had received little or no formal training in these skills and hence deficiencies existed in the following areas:

   - o Planning,
     - Preparation of lesson plans,
     - Writing of observable, measurable behavioral objectives,
   - o Methods,
     - Use of advanced orgar.
     - Knowledge of learning p. 'es and methods,
     - Use of training aids,
     - Questioning techniques and
     - Testing and evaluation.

   While some utilities rotate operating personnel to training for extended periods, which is a viable job-enrichment scheme, or use permanent instructors, the assignment of technically qualified individuals to training departments without additional training in instructional practices is unsatisfactory.

Few utilities offered workshops or training programs in instructional skills for their instructors. In some cases, workshops were available but the instructors were unable to attend them due to their instructional commitments.

4. Training centers do a commendable job of evaluating instructional staff. In contrast, training departments at reactor sites lack comprehensive means to evaluate instructional skills.

2.10.5.2 Recommendations

1. Before any instructional assignments, all training personnel (including Training Managers) should be required to attend a certified course or program specifically aimed at the familiarization with and application of instructional methods and techniques.

   At a minimum, the content of such a course should include those areas that were noted as deficiencies in Conclusion 3. Other content areas that should be considered are:

   - Motivation,
   - Effective communications,
   - Training needs assessment,
   - Training materials development,
   - Types and theories of learning,
   - Environments conducive to learning and
   - Control of disruptions.

   Ample time for observation and practice under the auspices of a qualified instructor should be allotted. Courses could be certified by a suitable organization such as INPO or an accreditation board.

2. Periodic audits should ensure that instructional staffs have received training or possess the equivalent education necessary to demonstrate effective training practices.

Audits can be conducted by the NRC, an accreditation board or other external, NRC-endorsed organizations, preferably with expertise in both the subject matter and instructional techniques. Audits should be designed to both note discrepancies and to provide the necessary feedback to correct such deficiencies.

3. Although not amenable to NRC regulation, utilities should consider the implementation of periodic workshops or retraining programs for assessing and improving instructional skills. Such programs can provide the mechanism to upgrade instructional staff and conduct periodic evaluations. Like other skills, training skills are subject to degradation over time. Conducting periodic workshops or retraining will allow this assessment along with providing a forum on state-of-the-art methodology.

4. In evaluating their instructors, utilities should consider several of the following measures:

   - Meeting of well-stated, valid objectives,
   - Periodic observation by an instructional specialist,
   - Trainee feedback,
   - Trainee performance on the job (supervisor feedback) and
   - Training Coordinator or senior instructor observation using a detailed, structured observation list.

3. NON-LICENSED OPERATING, MAINTENANCE AND TECHNICAL SUPPORT PERSONNEL

3.1 INTRODUCTION

This chapter evaluates the responsibilites of non-licensed operating, maintenance and technical support personnel for the purpose of determining whether additional personnel, other than reactor operators and senior reactor operators, should be licensed or certified. To avoid confusion, since functional titles of utility personnel vary widely across the industry, the following conventions will be used when referring to specific positions:

Radiation Protection Technician. Person responsible for conducting radiation surveys and other radiation protection tasks.

Engineers and Technical Support Personnel. Persons responsible for conducting periodic and pre-operational tests, monitoring reactor performance, and other engineering and technical tasks.

Maintenance Personnel. Mechanics or electricians who perform periodic and corrective maintenance of plant components, including safety-related equipment (not including carpenters, riggers, sheet metal workers, pipe coverers, painters, cleaners, burners and chippers or helpers).

Chemistry Technicians. Personnel responsible for performing radiochemistry analyses and other plant chemistry-related tasks.

Instrumentation and Control Technicians. Persons responsible for maintenance, calibration and testing of plant instruments and controls.

Quality Assurance and Quality Control Inspectors. Persons responsible for inspection, examination and testing of nuclear power plants or who conduct audits or surveillance of plant operations and procedures.

Auxiliary Operators. Non-licensed operators responsible for operation of systems and components as directed by licensed operators.

Shift Technical Advisor. Person on shift assigned to evaluate plant conditions and advise the Shift Supervisor during plant transients and accidents.

Managers. The plant manager and the members of the operating organization who have overall responsibility for plant operation, maintenance or technical service activities.

Independent Review Personnel. Persons who are members of one or more of the independent review boards established in Section 6 of the plants' technical specifications.

For purposes of evaluation, the immediate supervisors of these technical personnel are included under the appropriate functional title.

The following three-part approach was taken to evaluate whether licensing or certification should be required for any of the personnel positions described previously:

1. A job analysis was conducted for each of the functional positions. The product of this analysis was a task inventory by position. These tasks were then individually evaluated on the basis of a criterion provided by the NRC. That criterion was "consideration of the health and safety of the general public and the impact on safe and competent (plant) operation." The aggregate of these "safety-related" tasks, by position, provided the basis for identifying the importance of the position with respect to the safety of the plant and the general public. This analysis is the subject of Section 3.2.

2. The next step was a review of current requirements and practices with respect to the training and qualification of these non-licensed plant personnel. This review is the subject of Section 3.3.

3. Finally, training and qualification requirements and practices were compared to the safety-related tasks of each position to determine whether these requirements and practices provide the necessary assurance that non-licensed plant personnel can perform their safety-related tasks in a safe and competent

manner. Where deficiencies were identified, recommendations for improvement were provided. This evaluation and associated recommendations are provided in Section 3.4.

3.2 JOB TASK ANALYSIS

A fundamental requirement for providing recommendations concerning additional plant personnel positions that should be certified or licensed was to determine the tasks that define each position. This effort was completed through a job task analysis, a systematic method of collecting and analyzing work data to produce objective and complete work requirements.

Figure 3.1 shows the steps used in developing the job task analysis for non-licensed plant personnel. Step 1, development of a data-collection plan, was completed by first identifying job information that was expected to be available at each plant or training center and then conducting a literature review of published non-licensed personnel job analyses. This data-collection plan identified the following as appropriate sources of information:

- o Interviews with non-licensed personnel and their supervisors and managers,
- o Plant operating and administrative procedures,
- o Emergency Plan,
- o Surveillance, operational test and maintenance procedures,
- o Technical specifications,
- o Related job descriptions and
- o Training program descriptions.

In addition, literature review indicated that reports describing the TMI-2 accident and lessons learned from the accident (2, 3, 4, 5) would be valuable information sources.

Step 2a, collecting data through site visits, was coordinated by checklists developed in Step 1. Upon completion of each site visit, the data-collection plan (checklists) was reviewed on the basis of information collected at previous sites, and changes were made as appropriate. Appendices G and H contain these checklists. From the data collected at early site visits, preliminary inventories were developed (Step 3). Thus, at subsequent

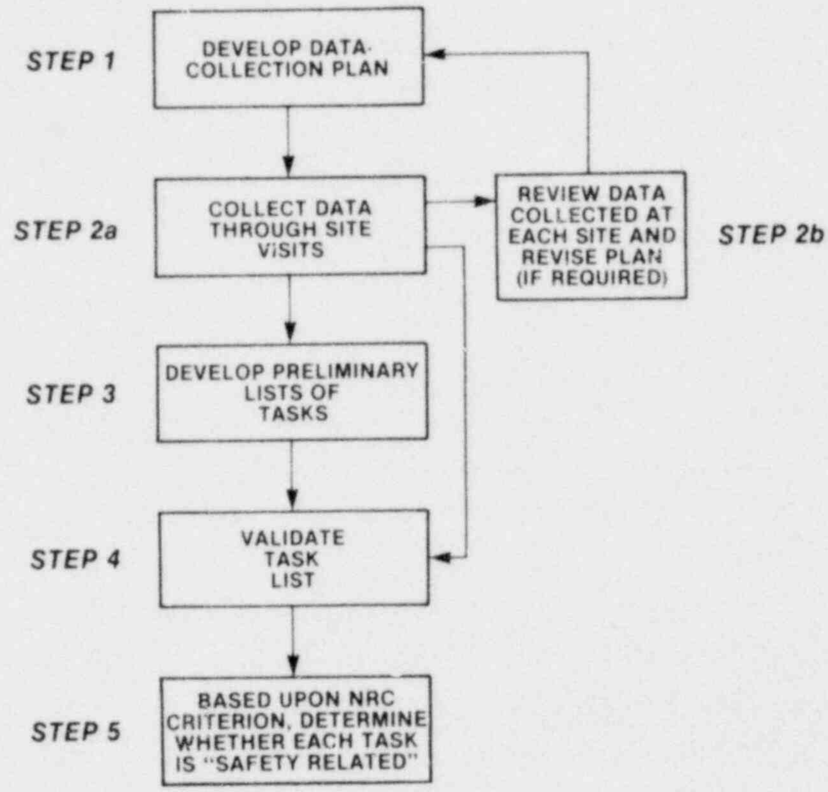


Figure 3.1 Task Analysis Flowpath

site visits, this list could be validated through interviews, comparison of job descriptions, procedures, etc. Upon completion of all site visits, further validation of the tasks was conducted by a more in-depth comparison between individual plant data, as well as a review of applicable literature (Step 4). A complete task inventory for each functional position is provided in Appendix F. While these task inventories were developed at a generic (rather than plant-specific) level, it is recognized that for some plants specific tasks identified for a particular functional position may be assigned to other personnel. It is further recognized that the tasks identified for a functional position (that is, engineers and technical support personnel) are probably not all performed by a single individual.

The criterion provided by NRC for evaluation of these task inventories was "consideration of the health and safety of the general public and the impact on safe and competent (plant) operation." In implementing this criterion (Step 5), the task inventories of Appendix F were reviewed to determine whether improper completion of each task could directly or indirectly contribute to:

- The release of significant amounts of radioactivity beyond the site boundary,
- The failure or improper operation of a component or system that is critical to safe plant operation (that is, safety related) or
- The exposure of plant personnel, the general public or plant visitors to radiation in amounts exceeding federal regulations.

The results of this evaluation are shown in Table 3.1. For each functional position, at least three safety-related tasks were identified. The fact that each of these functional positions involves the performance of some safety-related tasks indicates that there is a need for utilities to have training and qualification programs to provide assurance that personnel can adequately perform these tasks. The next section describes NRC requirements and utility practices with respect to these non-licensed plant personnel.

TABLE 3.1
LIST OF NON-LICENSED PLANT PERSONNEL SAFETY-RELATED TASKS

FUNCTIONAL POSITION	TASK
Radiation Protection Technician	1. Operate and calibrate portable monitoring and sampling instruments. 2. Set up and operate a radiation control zone. 3. Prepare radiation work permits in accordance with procedures. 4. Conduct loose contamination surveys and calculations. 5. Conduct radiation level surveys and calculations. 6. Issue, use and control personnel dosimetry devices. 7. Use and issue personnel respirators. 8. Operate counting room and environmental sampling equipment. 9. Conduct decontamination of equipment and spaces. 10. Serve as a member of emergency response groups, including fire brigade, search and rescue, recovery and re-entry and medical-assistance teams.
Engineers and Technical Support Personnel	1. Write procedures and procedural changes. 2. Verify initial and prerequisite conditions for tests. 3. Ensure conduct of tests is in accordance with utility and federal requirements and regulations. 4. Identify and resolve test discrepancies. 5. Ensure safety of personnel during tests. 6. Ensure restoration of safety-related components or systems upon completion of tests. 7. Analyze test data to verify acceptance criteria are met.

TABLE 3.1 (continued)
LIST OF NON-LICENSED PLANT PERSONNEL SAFETY-RELATED TASKS

FUNCTIONAL POSITION	TASK
Engineers and Technical Support Personnel (continued)	8. Control fuel station management. 9. Conduct reactor physics and heat transfer calculations (reactor flow, power distribution, instrumentation readings, reactivity, refueling, etc.). 10. Conduct engineered safety features (ESF), leak rate, valve stroke, and other surveillance and performance tests. 11. Maintain special nuclear materials control and accountability (fuel storage inventory, core verification, burnup calculations, etc.). 12. Serve as member of emergency response groups.
Maintenance Personnel	1. Prepare maintenance work requests. 2. Determine functional verification (retest) requirements. 3. Conduct functional verification (that is, retest). 4. Determine safety hazards associated with maintenance (radiation, chemicals, etc.). 5. Inspect, test, disconnect, remove, disassemble, repair, reassemble, reinstall, connect, calibrate, check and return to service plant components, including safety-related equipment. 6. Conduct operational tests (hydrostatic, leak rate, etc.). 7. Set control and relief points of components (for example, relief valves). 8. Serve as a member of emergency response groups including recovery and re-entry teams.
Chemistry Technicians	1. Perform radiochemical and conventional chemical analyses to ensure that water chemistry and radioactivity content of liquids, solids and gases discharged from the plant are maintained within required limits as set forth in plant instructions or federal regulations.

TABLE 3.1 (continued)
LIST OF NON-LICENSED PLANT PERSONNEL SAFETY-RELATED TASKS

FUNCTIONAL POSITION	TASK
Chemistry Technicians (continued)	2. Collect, prepare and determine the gross radioactive content of liquid, solid, and gaseous samples using alpha, beta, and gamma activity-counting instruments described in the plant procedures.
	3. Collect samples and make routine conventional chemical and radiochemical analyses of reactor water, feedwater, condensate, steam and other plant water supplies.
	4. Add or give instructions to add the proper amounts of chemicals to maintain the water analysis of certain chemically treated plant systems within prescribed limits.
	5. Serve as a member of emergency response groups, including fire brigade and medical-assistance team.
	6. Operate station chemical support systems.
Instrumentation and Control Technicians	1. Prepare maintenance work requests.
	2. Determine functional verification (that is, retest) requirements.
	3. Conduct functional verification (that is, retest).
	4. Inspect, test, disconnect, remove, disassemble, repair, reassemble, reinstall, connect, calibrate, check and return to service instruments and controls that measure pressure, temperature, vacuum, draft, liquid level, flow and other plant parameters (including safety-related equipment, particularly reactor protection equipment).
	5. Serve as a member of emergency response groups, including recovery and re-entry teams.
Quality Assurance and Quality Control Inspectors	1. Review maintenance work requests.
	2. Identify "holds" on work requests.

TABLE 3.1 (continued)
LIST OF NON-LICENSED PLANT PERSONNEL SAFETY-RELATED TASKS

FUNCTIONAL POSITION	TASK
Quality Assurance and Quality Control Inspectors (continued)	3. Identify nonconforming items. 4. Conduct quality assurance surveillances. 5. Verify equipment critical to safe operation is performing as designed. 6. Verify that personnel are following approved procedures in the operation, maintenance and engineering of equipment related to safety. 7. Review plant instructions, procedures, records and procurements to ensure quality-related requirements are met. 8. Review revisions to technical specifications and ensure complicance. 9. Review plant modifications to ensure quality assurance requirements are met.
Auxiliary Operators	1. Check status and condition of plant components including safety-related equipment. 2. Conduct valve line-ups of plant systems. 3. Operate plant equipment not operated from the control room including safety-related systems. 4. Put in service and take out of service plant components. 5. Recognize out-of-normal indications for plant parameters and components. 6. Control system parameters (levels, pressures, etc.). 7. Verify operation of radiation monitors. 8. Prepare work requests for maintenance. 9. Assist control room operator to perform routine surveillance and operating tests (leakage tests, trip tests, hydrostatic tests, maintenance retests, etc.).

TABLE 3.1 (continued)
LIST OF NON-LICENSED PLANT PERSONNEL SAFETY-RELATED TASKS

FUNCTIONAL POSITION	TASK
Auxiliary Operators (continued)	10. Move fuel in spent fuel pool. 11. Assist in transfer of radioactive material. 12. Follow station directives and normal, abnormal and emergency operating procedures. 13. Take manual or backup control of functions normally operated from the control room. 14. Perform tasks during emergencies as directed by RO or SRO (security force, fire brigade, search and rescue team, etc.).
Shift Technical Advisor	1. Evaluate plant conditions and provide advice to the Shift Supervisor during plant transients and accidents. 2. Evaluate the plant normal operations from the point of view of safety. 3. Monitor the operating experience at other plants of similar design for information valuable to safe operation of the plant.
Managers	1. Plan, coordinate and direct the operations, maintenance, engineering and administration of the plant. 2. Serve as a member of an independent review board. 3. During an emergency, function as emergency director, which includes: o Recognizing accident conditions, o Identifying results of radiation surveys, o Coordinating support to operating shift personnel, o Determining additional or supporting personnel required, o Recommending actions to appropriate authorities and o Controlling off-site and on-site monitoring and reporting.

TABLE 3.1 (continued)
LIST OF NON-LICENSED PLANT PERSONNEL SAFETY-RELATED TASKS

FUNCTIONAL POSITION	TASK
Independent Review Personnel	1. Review all procedures, except common site procedures, required by technical specifications, and any other proposed procedures or changes thereto as determined by the Unit Superintendent to affect nuclear safety.
	2. Review all proposed tests and experiments that affect nuclear safety.
	3. Review all proposed changes to technical specifications.
	4. Review all proposed changes or modifications to plant systems or equipment that affect nuclear safety.
	5. Investigate all violations of the technical specifications and prepare and forward a report covering evaluation and recommendations to prevent recurrence to the System Superintendent Nuclear Operations and to the Chairman of the Nuclear Review Board.
	6. Review events requiring 24-hour notification to the NRC.
	7. Review facility operations to detect potential safety hazards.
	8. Perform special reviews and investigat'ons and report thereon as requested by the Chairman of the Nuclear Review Board.
	9. Render determinations in writing with regard to whether or not items consititute an unreviewed safety question.
	10. Review plant security and Emergency Plans and implementing procedures.
	11. Perform special reviews, investigations and reports.

TABLE 3.1 (continued)
LIST OF NON-LICENSED PLANT PERSONNEL SAFETY-RELATED TASKS

FUNCTIONAL POSITION	TASK
Independent Review Personnel (continued)	12. Provide independent review and audit of designated activities in the areas of: o Nuclear power plant operations, o Nuclear engineering, o Chemistry and radiochemistry, o Metallurgy, o Instrumentation and control, o Radiological safety and o Mechanical and electrical engineering.

3.3 REQUIREMENTS AND PRACTICES CONCERNING NON-LICENSED PERSONNEL TRAINING AND QUALIFICATION

3.3.1 NRC Requirements

The only federal regulation concerning the training or qualifications of non-licensed plant personnel is Paragraph 50.34 of 10 CFR Part 50 (45), which requires that applications for a license to operate a nuclear power plant include information concerning organizational structure, personnel qualifications and related matters. Regulatory Guide 1.8 is the only additional NRC guidance. This guide endorses ANSI N 18.1-1971, "Selection and Training of Nuclear Power Plant Personnel" (46), [which has been superseded by ANSI/ANS-3.1-1978," American National Standard for Selection and Training of Nuclear Power Plants" (7)].

The training requirements of ANSI N 18.1-1971 are as follows:

> General Aspects
>
> A training program and schedule shall be established for each nuclear power plant to initially develop and maintain an organization fully qualified to be responsible for operation, maintenance, and technical aspects of the nuclear power plant involved. The program shall be formulated to provide the required training based on individual employee experience and intended position. The program shall also satisfy AEC licensing requirements. The training program shall be such that fully trained and qualified operating, maintenance, professional, and technical support personnel are available in the necessary numbers at the time required. In all cases, the objective of training programs shall be to ensure safe and efficient operation of the facility. Training programs shall be kept up-to-date to reflect plant modifications and changes in procedures. A continuing program shall be used after plant startup for training of replacement personnel and for retraining necessary to ensure that personnel remain proficient.
>
> Training of Personnel Not Requiring AEC Licenses
>
> A suitable training program shall be established for managers, supervisors, professionals, operators, technicians, and repairmen to properly prepare them for their assignments, and to meet the requirements established by the facility licensee. The issuance and continuance of a facility license depends, in part, on AEC evaluation of the experience and qualifications of unlicensed, as well as licensed, personnel in the organization. These unlicensed personnel also direct or perform activities important to safe and efficient operation of the nuclear power plant.

Training for Technicians and Repairmen

Technicians and repairmen shall be trained by on-the-job training, by participation in initial calibration, testing, and equipment acceptance programs, or by related technical training to meet the qualifications set forth in Section 4.5.

General Employee Training

All persons regularly employed in the nuclear power plant shall be trained in the following areas:

Appropriate Plans and Procedures
Radiological Health and Safety
Industrial Safety
Plant Controlled Access Areas and Security Procedures
Use of Protective Clothing and Equipment

Temporary maintenance and service personnel shall also be trained in the above areas to the extent necessary to assure safe execution of their duties.

Retraining and Replacement Training

A training program shall be established which maintains the proficiency of the operating organization through periodic training exercises, instruction periods, and reviews covering those items and equipment which relate to safe operation of the facility and through special training sessions for replacement personnel. Means should be provided in the training program for appropriate evaluation of its effectiveness.

ANSI 18.1 1971 qualification requirements for non-licensed personnel are as follows:

General

Nuclear power plant personnel shall have a combination of education, experience, health, and skills commensurate with their functional level of responsibility which provides reasonable assurance that decisions and actions during normal and abnormal conditions will be such that the plant is operated in a safe and efficient manner.

Technicians

Technicians in responsible positions shall have a minimum of two years of working experience in their speciality. These personnel should have a minimum of one year of related technical training in addition to their experience.

Maintenance Personnel

> Repairmen in responsible positions shall have a minimum of three years in one or more crafts. They should possess a high degree of manual dexterity and ability and should be capable of learning and applying basic skills to maintenance operations.

For personnel responsible for nuclear power plant inspection examination and testing, Regulatory Guide 1.58, "Qualification of Nuclear Power Plant Inspection, Examination and Testing Personnel," (47) [which endorses ANSI/ASME N 45.2.6-1978, "Qualification of Inspection, Examination, and Testing Personnel for Nuclear Power Plants" (48)] provides much more in-depth requirements concerning training and qualification. ANSI/ASME N 45.2.6-1978 and the associated Recommended Practice SNT-TC-1A (June 1975), "Recommended Practice for Nondestructive Testing Personnel Qualification and Certification", (49) describe a written certification of qualification program based upon evaluation of a candidate's education, experience, training, test results or capability demonstration. The certification program includes provisions for re-evaluation of all certified personnel at 3-year intervals, plus re-evaluation of certified personnel who do not perform inspection, examination or testing activities for a period of 1 year. The recommended practice provides the framework for a qualification and certification program and recommended educational, experience and training requirements for different test methods. Supplementary documents include questions and answer lists which may be used in composing examinations for nondestructive testing personnel. The testing program is administered by the American Society for Nondestructive Testing. Examination methods are detailed and include the makeup of and grading criteria for physical, written (general and specific) and practical evaluations. Recommended training courses are described, including an outline and instruction hours for each subject.

In addition to current requirements and guidance, several draft or proposed standards and guidelines are relevant to non-licensed personnel training and qualification.

In December 1979, a draft revision to ANSI/ANS 3.1-1978 was released for comment. In terms of qualifications of non-licensed plant personnel, the primary changes in the proposed standard are to call for personnel in management positions and lead professional-technical positions to have appropriate bachelor degrees. Provisions are made, however, to acknowledge alternative qualifications to a degree. Experience requirements for non-licensed personnel would also be increased to include more years of general experience and more plant activity experience. The primary changes proposed for non-licensed personnel training are:

- o A task analysis (knowledge and skill necessary to perform the job) would be required (each individual's experience and knowledge would be compared to this task analysis and training provided where deficiencies were identified),
- o Written examinations (for non-licensed operators only) and
- o Increased frequency of evaluations of retraining (annually) with the evaluation to be performed by persons other than those responsible for training.

A proposed revision to Regulatory Guide 1.8, "Personnel Selection and Training," (10) was prepared in February 1979. This proposed guide would specify additional education and experience requirements for the Radiation Protection Manager (RPM) and individuals who direct preoperational tests. The guide endorses the power reactor health physics certification of the American Board of Health Physics as meeting RPM qualification requirements.

A proposed revision to Regulatory Guide 1.58, "Qualification of Nuclear Power Plant Inspection, Examination and Testing Personnel," was issued in March 1979. This guide endorses ANSI N 45.2.6-1978 with some clarifications, such as including not only personnel who perform tests but also those personnel who direct or supervise such tests.

3.3.2 Description of NRC and Utility Practices

3.3.2.1 Utility Practices

A wider range of utility practices exists for the training, qualification and certification of non-licensed plant personnel than of licensed operators. For most utilities, these practices are being either evaluated or changed as a result of the TMI-2 accident. Variability of practices is not limited to differences among utilities. At the same utility, marked differences between the formality, level of detail and quality of programs for different non-licensed functional positions were noted. The following descriptions of representative non-licensed personnel training and qualification programs are presented to illustrate this variability in utility practices:

Utility A Instrumentation and Control Technician Training and Qualification Program

This utility had three categories of instrumentation and control (I&C) technicians: apprentices, journeymen and Senior I&C technicians. Individuals were classified as apprentices until they had satisfactorily completed a 3-year training program, at which time they were advanced to journeymen. Journeymen were selected for Senior I&C Technician training, which consisted of 8 months of training. Upon satisfactory completion of this training program, personnel were qualified as Senior I&C Technicians. These Senior I&C Technicians must either supervise or actually conduct all work on safety-related I&C equipment. The 3-year journeyman training program consisted of 12 months of technical training at a utility-operated central training center, followed by 2 years of on-the-job training at a power plant. Classroom instruction was conducted by an instructor with power plant operating background and academic qualifications to instruct in mathematics and the physical sciences. Detailed lesson plans, including training objectives, were used. Trainees' progress was monitored through weekly quizzes. Approximately 20 percent of trainees failed to complete the course of instruction. The 2-year, on-the-job training program was structured and time allotments for training modules were based upon a task analysis. Upon completion of the 3-year program, trainees were required to complete a comprehensive oral examination administered by a standing review committee. The 8-month Senior I&C Technician training course was conducted in two parts: 6 months at the utility's central training center, followed by 2 months o. practical equipment maintenance at individual plants. Final oral and written examinations were administered.

The entire program as described above was jointly approved and administered by the union, technical management and corporate personnel representatives.

Utility A Engineer Training and Qualification Program

This training program was conducted entirely at the facility, with no support provided by the central training center. Training could be performed by any engineer or engineering associate who had completed training. The outline of the training program did not have any meaningful detail. Representative items in the outline were:

- o Read applicable facility procedures,
- o Site tour,
- o Review of applicable surveillance instruction,
- o Facility drawings and
- o Specific instruction in operation.

There were no lesson plans for this instruction. Methods for providing training were not identified. For example, "Systems" was one item identified for specific training. The only guidance provided concerning training on systems read as follows: "All incoming engineers will be assigned systems to become familiar with as cognizant engineers. This will enable them to assist with problems or to develop tests for specific systems."

The training was divided into three phases with an oral or written examination by the supervisor or qualified engineer required in four areas for each phase. These areas were:

- o Phase I - General Training
  - Procedures/instructions
  - Tours/layout
  - Gen[illegible]
  - He[illegible] physics/safety

- o Phase II - General Training
  - Group organization
  - Policies
  - Tour/files/drawings
  - Instructions/references

- o Phase III - Specific Training
  - Equipment/test areas
  - Routine group duties
  - Specific responsibilities
  - Systems

Utility A Chemistry Technician Training and Qualification Program

This program was in use. The training program consisted of 12 months of training: 14 weeks at the central training center, followed by the remainder of the year in plant. The 14-week training program included:

- o Basic mathematics,
- o Chemistry,
- o Basic nuclear physics,
- o Analytical and radiochemistry,
- o Power plant chemical methods,
- o Radioactive counting,
- o Nuclear plant systems,
- o Chemical operations,
- o Radwaste,
- o Safety and
- o Health physics.

The in-plant phase of training included about 1300 hours of practical training in these areas:

- o Plant organization, structure and policy,
- o Plant instructions, manuals and documents,
- o Site familiarization,
- o Plant system familiarization,
- o Laboratory policy and safety,
- o Procedure performance documentation ana
- o Special projects.

Trainees were given comprehensive examinations upon completion of each part of the training. Any individual who did not satisfactorily complete an examination was given a re-examination. Failure of a re-examination resulted in termination in the program. Individuals who successfully completed the program were certified as chemistry technicians by the Plant Superintendent.

Utility B Electrical Maintenance Training Program

This utility provided a self-study course to new personnel, who were hired as electrical helpers, to allow them to progress to electricians. These personnel were provided 2 hours per day for self-study during a period of approximately 6 months. The course material was prepared by a training services vendor. The curriculum consisted of 15 modules, with the last 5 being plant specific. These included:

- o Utility electrical blueprints,
- o Safety,
- o Utility electrical systems,
- o Quality assurance and
- o Tagging procedures.

Requirements did not include a formal examination. There were no formal, on-the-job training requirements or certification criteria for qualifying electricians to perform particular maintenance actions.

The utility was committed to a maintenance requalification training program, which relied heavily upon on-the-job experience; however, no mechanism for providing or documenting on-the-job experience was provided. The only formal requalification training identified was in three general areas:

- o Plant systems,
- o Selected technical programs and
- o Selected specialized programs.

Methods of implementing training in these areas were not specified.

Utility C Quality Assurance and Quality Control (Inspection and Test) Personnel Training and Qualification Program

This program was an implementation of requirements and guidance provided by ANSI/ASME N45.2.6-1978 and Recommended Practice SNT-TC-1A. All of the training, qualification and certification requirements were consistent with and directly linked to these standards. For these personnel, there were no plant training or qualification requirements imposed in addition to those of the associated standards, other than general employee training.

Utility D Chemistry Technician Training and Qualification Program

This program consisted entirely of on-the-job training conducted under the supervision of experienced chemistry technicians. To be qualified to conduct chemistry procedures or analysis, trainees must have demonstrated proficiency in the conduct of the particular procedure. This proficiency was documented by a signature on the trainee's qualification record. This signature authorized the individual chemistry technician to subsequently conduct the particular procedure or analysis without direct supervision.

General Comments Concerning Other Programs

The reliance upon on-the-job training of non-licensed plant personnel was the most common training method. In some cases, on-the-job training was supplemented with infrequent lectures concerning LERs or other problem areas. Not all of the utilities that relied upon on-the-job training required written certification of qualification. Some relied upon the individual's supervisor to know, on the basis of subjective judgments, whether the individual was qualified to perform a particular activity.

As stated in the beginning of Section 3.3.2.1, many utilities' non-licensed personnel training and qualification programs were undergoing revision, with the thrust of these revisions being in the direction of more formality and documentation of training and qualification. Based upon interviews with plant personnel, these changes were being implemented for one or more of the following reasons:

- o A recognition, based upon the TMI-2 accident, that more emphasis on non-licensed personnel training was necessary,
- o The expectation of additional requirements (such as the proposed revision to ANSI/ANS-3.1-1978) or
- o Routine implementation of changes in programs scheduled before the TMI-2 accident.

3.3.2.2. NRC Practices

The OLB has no involvement in the evaluation or auditing of utility practices concerning the training and qualification of non-licensed plant personnel. IE has all audit responsibilities for non-licensed plant personnel. This responsibility is divided between on-site (resident) inspectors and regional IE offices. Regional IE inspectors are required to verify annually that overall training activities for non-licensed employees are in accordance with technical specifications and quality assurance program requirements. On-the-job training for the non-licensed personnel listed in Section 3.1 is the only non-licensed personnel training, other than general employee training that is audited in Section 3.1. Training programs that have been changed are reviewed to ensure that the revised program is in compliance with requirements and utility commitments. The audit of on-the-job training is conducted through a review of training records along with interviews with four individuals to verify that training records reflect actual training received.

Resident IE inspectors are required to audit non-licensed personnel training semi-annually. This audit is conducted by direct questioning of personnel to determine that on-the-job training, formal technical training, and training in administrative controls and procedures, radiological health and safety, industrial safety, controlled access and security procedures, Emergency Plan and quality assurance was provided as required by the licensee's program or technical specifications.

At 3-year intervals, regional IE inspectors verify by review of established administrative controls that minimum educational experience or qualification requirements have been established in writing for non-licensed plant personnel.

3.4 EVALUATION OF REQUIREMENTS AND PRACTICES

In Section 3.1, it was concluded that all non-licensed plant personnel in the indicated functional categories had some safety-related tasks and responsibilities. A comparison of the very general NRC requirements concerning non-licensed personnel training and qualification with these safety-related tasks and responsibilities indicates that these requirements alone do not provide the necessary assurance that these personnel can adequately perform their safety-related tasks. The requirements are so general that they have little operational value and will not provide the basis for adequate job performance unless the NRC or other industry organizations take the lead in further defining these requirements. In auditing utility practices in these areas, auditors are instructed to evaluate whether utilities have met their written commitments and not whether the commitments provide necessary training or assurance of qualification. In practice, based upon interviews with utility personnel, these audit practices encourage a minimum of written commitment and documentation by the utilities because the utility becomes accountable only when a written commitment is made. Therefore current NRC practices consisting of a minimum of requirements coupled with the auditing of utilities only against their commitments would appear to contribute to a lack of formality in non-licensed personnel training and qualification programs.

Other than general employee training, on-the-job training is the only technical training for non-licensed personnel that is identified specifically for IE audits. For many utilities, on-the-job training makes up either all or the primary part of non-licensed plant personnel training and qualification programs. As was the case for licensed operator training programs, this situation seems to be clear evidence that some utility non-licensed personnel training programs are primarily concerned with meeting NRC acceptance criteria.

In contrast, some utilities' minimum standards for training and qualification of plant personnel clearly exceeded NRC acceptance criteria. These utilities had well-conceived and effective training and qualification programs. In interviews, personnel at these utilities indicated two opinions:

- That the non-safety-related benefits of having a well-trained and motivated work force (fewer unscheduled plant trips, less maintenance rejected, etc.) were of equal worth to safety-related benefits and

- That they did not understand how their counterparts at other utilities could "get by" with their informal on-the-job training and qualification programs.

When interviewed, many of the immediate managers and supervisors of non-licensed personnel at utilities with informal on-the-job training programs indicated that they felt their training and qualification programs were inadequate. Most of these individuals indicated, however, that this problem was not given the same recognition at higher levels in the organization. Several of these supervisors and managers indicated that they would welcome additional requirements from the NRC concerning the training and qualification of personnel, because they felt this was the only way their supervisors would be convinced of the need for such change. (It is noted that this is not the case with some utilities, and substantive improvements in programs have been or are being implemented.)

The one area concerning non-licensed personnel training and qualification in which utility practices do not exhibit great variation is the training and qualification of nuclear power plant inspection, examination and testing personnel. This difference is attributed to the relatively detailed requirements and guidance of the standard (ANSI/ASME N 45.2.6-1978) and guide (Regulatory Guide 1.58) that apply to the training and qualification of these personnel. This program is administered and controlled, not by the NRC, but by the American Society for Nondestructive Testing. Certification examinations are administered either by the utility itself or a contractor. This process is in contrast to the operator licensing process, which is administered and controlled entirely by the OLB. The certification program for inspection and testing personnel appears to provide the more detailed requirements and more consistent implementation, while requiring NRC involvement only in auditing the utility against its commitments, not in administering examinations.

3.5 CONCLUSIONS AND RECOMMENDATIONS RELATING TO PRACTICES FOR NON-LICENSED OPERATING, MAINTENANCE AND TECHNICAL SUPPORT PERSONNEL

3.5.1 Conclusions

1. Plant personnel in the following functional job descriptions perform tasks that have a potential effect on the safe operation of the plant and on the health and safety of the public:

   - o Radiation protection technicians,
   - o Engineers and technical support personnel,
   - o Maintenance personnel,
   - o Chemistry technicians,
   - o Instrumentation and control technicians,
   - o Quality assurance and quality control inspectors,
   - o Auxiliary operators,
   - o Non-licensed shift technical advisors,
   - o Supervisors of these personnel,
   - o Plant managers and other technical managers reporting to plant managers and
   - o Independent review personnel.

2. Many utility training and qualification programs for non-licensed personnel are inadequate. Some utilities have quality programs or are taking positive steps to make substantial improvements in their programs; however, other utilities have shown no indications of making the commitment necessary to establish adequate training and qualification programs for non-licensed personnel.

   A wider range of practices exists for training, qualification and certification of non-licensed personnel than for licensed operators. At one end of the scale are programs that are as comprehensive as any licensed operator training and qualification programs. They include up to 2 years of classroom training, formal on-the-job training including practical factors, written, oral and performance examinations, and formal certification by the facility. The utilities that operate such programs have justifiable pride in their programs and have seen a dramatic improvement in the performance of personnel who complete such programs.

Unfortunately, comprehensive training, qualification or certification programs are not the norm in the industry. For the majority of non-licensed personnel, informal, on-the-job training is the primary method for establishing qualification. In many cases, there is no utility commitment to conduct a formal training or qualification program for non-licensed personnel. As a result, day-to-day operational commitments take priority over training and most training that is conducted is on a piecemeal or not-to-interfere basis. A common comment from supervisors of non-licensed personnel was that they recognized the need for upgrading the qualifications of their personnel and had recommended the same to their management. However, the concensus was that, until specific requirements for training or qualification were promulgated, the development and implementation of comprehensive programs would not occur. The implementation of such programs requires a commitment at the highest levels of the organization because substantial increases in personnel costs are associated with development of curricula, hiring of instructors and setting aside of additional time for training.

3. A comprehensive evaluation needs to be conducted for each of the functional positions listed in Conclusion 1 to develop criteria for satisfactory qualification. Current guidance concerning qualifications provided in ANSI/ANS-3.1-1978 is too general for this purpose. (ANSI/ANS-3.1-1978 only defines qualifications in terms of years of experience, education and "related" training.)

3.5.2 Recommendation

1. The NRC should require that utilities formally certify the qualifications of all non-licensed plant personnel identified in Conclusion 1. The NRC should work with the industry, including INPO, to develop industry-wide criteria for this certification. The criteria should be based upon a task analysis for each functional job description. The utility certification procedure should include a method for determining and documenting that each individual is proficient in all skills and knowledges that

affect the health and safety of the public and the safe operation of the plant. Those aspects cf non-licensed personnel positions that are not related to safety need not be included in the utilities' certification.

4. NRC OPERATOR LICENSING ORGANIZATION

4.1 INTRODUCTION

In Chapter 2, recommendations concerning the training and licensing of ROs and SROs were provided that have implications for the staffing of the OLB with regard to selection, training, certification and retraining of individual examiners as well as for the OLB organizational structure, including geographical location.

Based upon the analyses, conclusions and recommendations in Chapter 2, "Licensed Operating Personnel," this chapter addresses the following OLB examiner issues:

- Minimum education and experience requirements,
- Initial training requirements,
- Certification and
- Retraining.

This chapter also addresses the following OLB staffing issues:

- The use of part-time examiners, including their qualifications, training and retraining,
- The use of utility and vendor training staff personnel to assist in licensing activities and
- The type of organization required to administer the operator licensing program, including consideration of resident examiners at facilities and training centers and those examiners at regional offices, as well as those at a central headquarters.

4.2 SELECTION, TRAINING, CERTIFICATION AND RETRAINING OF OLB EXAMINERS

4.2.1 Selection of Examiners

Criteria for selection of examiners generally fall into two areas -- education and experience. Current criteria used by the Chief of the OLB are informal but include the following:

> Education. Baccalaureate degree with engineering discipline.
>
> Experience. Approximately 3 years of reactor operations experience at commercial nuclear power plants, Navy nuclear propulsion plants, national laboratories or research facilities. Higher grade level examiners are usually required to have had more direct involvement in the training of personnel.

Interviews with IE personnel at regional and headquarters offices indicated that these requirements are roughly equivalent to those applied to the selection of IE reactor operations inspectors.

For OLB examiners to have credibility with the industry and the public, the basic criterion that examiners should have education and experience qualifications at least equal to those of the personnel they are examining appears justified. In addition, a baccalaureate degree in engineering or related sciences (or equivalent) would provide greater assurance that a candidate would have technical knowledge sufficient to permit effective application of proper examination methods and principles. On the other hand, performance-related licensing and requalification examinations (such as those recommended in Section 2.6.4.2) could also be administered by highly experienced and capable nuclear power plant operators who might not have college degrees. Examiners with this background would at least meet education requirements for SROs, but the foundation for their credibility as examiners would rest on their credentials as experienced operators. Current proposed requirements for college-level instruction for SROs in related technical areas (references 8 and 15 and Recommendation 1 of Section 2.5.4.5) would provide educational backgrounds equivalent to those of degreed examiners in areas important to the job functions of reactor operators.

Based upon these considerations, the following are recommended selection criteria for OLB examiners:

- o A baccalaureate degree in engineering or related sciences, plus 3 years of nuclear reactor operating experience, or

- o A high school diploma or General Education Development Program Certificate, plus 4 years of experience as a licensed senior operator at a nuclear facility (a training center instructor who has successfully passed a senior operator examination with 4 years of training experience would also qualify).

4.2.2 Initial Training of Examiners

The OLB currently provides an informal program for training new examiners. In the past, this program has included the following:

- o A 2-week PWR (or BWR) advanced technology course provided by the IE Career Management Branch,
- o A 7-day PWR (or BWR) simulator course also provided by the IE Career Management Branch and
- o Three to 4 months of on-the-job training under the tutelage of an OLB examiner.

Although the technology and simulator courses are formal, they are designed around the needs of IE inspectors and not OLB examiners. The on-the-job training portion of the program has no formally established requirements. As described by the Chief of the OLB, training programs for examiners have historically been more of an "orientation" type of training program.

A general criterion that seems appropriate for examiners is that they possess skills and knowledges similar to those of the candidates they examine. This criterion can be justified on the basis that examiners can only be capable of scoring a question response when they know the elements of a correct response and the importance of various omissions in a less-than-adequate response. In addition, Sections 2.6 and 2.7.1 identified the need for more performance-related licensing and requalification examinations. These types of examinations will place an even greater emphasis on examiners possessing skills and knowledges equivalent to those of someone who holds an SRO license.

On the other hand, different standards for examiner skills and knowledges can also be justified. For example:

- Examiners should not be required to memorize technical specifications, but rather should know how to locate these technical specifications in reference material.

- Examiners should not be required to establish or maintain a particular proficiency level on plant controls, but rather should have sufficient knowledge to recognize candidate proficiency levels on plant controls.

Therefore, concerning examiner technical skills and knowledges, the composite of RO and SRO training program content areas identified in Section 2.4 would define the content areas for an examiner training program. While the content areas of RO and SRO training programs should be the same, the training objectives for examiner training programs would be less rigorous than those necessary for operator training programs. Therefore, examiner training programs should be shorter than combined RO and SRO training programs.

As described in Section 2.4, RO and SRO training programs include the following phases:

I. Nuclear power plant fundamentals,
II. Plant systems,
III. Plant operations,
  - Simulator and
  - Control room operation,
IV. Review and
V. Utility certification.

In assessing OLB examiner initial technical training needs, Phases I, II and III of operator training programs were reviewed with respect to the current examiner training program and the education and experience levels of typical new examiners.

Nuclear Power Plant Fundamentals

The current examiner training program does not provide any formal training in nuclear power plant fundamentals. Based on typical education and experience levels of new examiners, a valid argument could be made that in most cases formal training in this area would not be necessary. On the other hand, since an examiner is required to evaluate varying depths of operator knowledge in these fundamental areas, some formal assessment of an examiner's knowledge of these areas relative to their application to the types of reactor plants for which the examiner will be conducting examinations is appropriate. The following two-part approach is recommended for conducting this assessment:

1. Following initial hiring of an examiner, the Chief of the OLB or his designated representative should conduct a review with the new examiner of the knowledge requirements for conducting examinations in the nuclear power plant fundamentals subject areas. The purpose of this review would be to identify knowledge areas requiring upgrading based on the education and experience of each new examiner. It is anticipated that a suitable program of self-study would correct any recognized deficiencies.

2. Satisfactory completion of a formal examiner certification, such as that discussed in Section 4.1.3, would provide the necessary assurance of the adequacy of examiner knowledge in these areas.

Plant Systems

The current PWR/BWR advanced technology courses as described in the IE Career Management Branch training syllabus (January 1, 1979) (50) provide working knowledge of the following areas as they apply to PWR/BWR design:

- o System interrelationships,
- o Standardized technical specifications,
- o Analysis of operational and transient conditions,
- o Facility computer usage and application of available data,
- o Facility procedures and applications and
- o Facility design and operational problems and generic issues.

If a student's background in PWR/BWR design and operation is not sufficient to support this level of technical information, the IE Career Management Branch also provides an appropriate preparatory course which covers the following subject areas of PWR/BWR systems:

- o Design,
- o Functions,
- o Instrumentation,
- o Interlocks,
- o Design problems and
- o Technical specifications (bases).

Appropriate use of these available courses with consideration of a new examiner's experience would provide adequate generic level knowledge of PWR/BWR systems. However, an examiner must evaluate operators to a significant degree on their plant-specific knowledge. The lack of plant-specific questioning was a weakness in licensing examinations expressed by several training supervisors interviewed. An on-the-job training program, such as that described below for the "plant operations" phase of training, and an examiner certification program, such as that described in Section 4.1.3, will help improve the plant-specific aspects of examinations.

Plant Operations

As described in the syllabus of courses offered by the IE Career Management Branch, the objective of the 7-day simulator course attended by OLB examiners is to provide a working knowledge of the following areas:

- o Control room instrumentation and how it is used to evaluate plant operating conditions,
- o Technical specifications evaluation and application to control room conditions,
- o Evaluation of systems alignments for operability requirements,
- o The use and application of normal and emergency procedures and
- o The use and application of facility surveillance procedures.

In the past, when license examinations have consisted principally of written and oral walk-through examinations, the degrees of familiarity provided by a simulator course of this length could be considered adequate. However, new license examinations (such as the type recommended in Section 2.6 and proposed in the May 1980 draft revision to 10 CFR Part 55), which include an operating test conducted on a simulator, will require examiners to have more operator performance-related skills and knowledges. To adequately conduct these operating tests, examiners will require more "hands-on" experience on full-scope simulators than can be provided by a single 7-day course designed around the needs of IE inspectors.

As discussed previously in Section 4.2.2, an examiner should not be required to establish or maintain a particular proficiency level on plant controls, but rather should have sufficient knowledge to recognize operator proficiency levels. To accomplish this objective, a greater depth of simulator training is needed than that provided under the current examiner training program. This simulator training should concentrate on development of examiner skills and knowledges necessary to adequately conduct and evaluate operating tests for licensing and requalification. As a result, this program should be designed around the criteria that will be used by examiners to conduct these operating tests.

A second aspect of plant operations training involves the need for knowledge in areas such as various aspects of routine operation of nuclear power plants, location of components, operations conducted outside the control room, etc. An examiner needs this type of knowledge to support oral walk-through examinations at reactor plants. Some examiners, due to their backgrounds relative to the facilities for which they would have examination responsibilities, would require no additional training of this nature; however, other examiners would need some on-the-job training at operating facilities to provide them with the knowledge needed in these areas.

Interviews with IE personnel at headquarters, region and resident inspector levels indicated that a feasible method for providing valuable training and experience of this nature would include temporary assignment (for example, 1 month) of new examiners at IE resident inspector offices. During this assignment period, the examiner would be required to complete specific on-the-job training assignments, including system tracing, component location, observation of plant operations, etc. As indicated in these IE interviews, routine inspection requirments for resident inspectors would support some training requirements of this nature. It should be emphasized that such a program should have established formal requirements that relate to the objective of providing an examiner with plant-specific knowledge and general plant operating knowledge necessary for the performance of examiner functions.

Although technical skills and knowledges are important for an examiner, knowledge and application of examination methods are also necessary. Examiner candidates should receive formal training in examination methods in the following areas:

- o Test measurement methods,
  - Validity,
  - Reliability,
- o Test construction,
  - Objectives,
  - Content,
  - Test item development and selection,
- o Test scoring and analysis,
  - Rating effectiveness,
  - Systematic observation techniques,
- o Development of a testing program,
  - Functions,
  - Qualities desired,
  - Priorities,
- o Logistics of testing,
  - Scheduling,
  - Preparation of candidates for testing,
  - Environment,
  - Administration and
  - Reporting results.

This training program should include classroom instruction in these areas, followed by practical exercises in construction, scoring and administration of RO and SRO written, oral and operating tests.

One other content area that should be included in an examiner candidate training program is the evaluation and auditing of RO and SRO initial training and requalification programs. This program should provide initial classroom sessions describing objectives and methodology followed by practice audits and evaluations.

It is recognized that the program described above addresses the basic skills and knowledges associated with the job of OLB examiner and that, by virtue of their education and experience, many examiner candidates may have sufficient knowledge and skills in some or all areas. The total program described is not expected to be required for most candidates. Training should be provided to compensate for candidate deficiencies identified by comparing the individual's experience and knowledge to an examiner job task analysis.

With the exception of the proposed period of on-the-job training at an operating facility and the longer simulator program, the examiner training program described in this section should not require a significantly longer training period than now practiced by the OLB. Examiners without significant commercial power reactor operating experience would, however, require a longer program which would include these segments.

4.2.3 Examiner Certification

Reliable and equitable administration of the operator licensing process is critical to ensuring that only safe and competent individuals are licensed as ROs and SROs. A means is required to ensure that examiners:

- o Possess the required skills and knowledges,
- o Are qualified to properly administer written, oral and operating tests and
- o Are qualified to evaluate and audit RO and SRO training programs.

The present qualification process as described in the OLB "Examiner's Manual" (36) requires only that an experienced examiner be present to observe the first examination administered by a new examiner and subsequently discuss that examination with the new examiner. As a result, this qualification process lacks the formality and depth necessary to provide these assurances.

The OLB should establish a formal certification program for examiners. As a minimum, this program should contain the following elements:

- Identification of facility types for which the examiner will be certified to give operator examinations (for example, PWR, BWR, test and research reactors, etc.),

- Successful completion of a required training program,

- Preparation, administration and scoring of written, oral and operating tests to the satisfaction of the Chief of the OLB or his designated representative,

- Evaluation and auditing of RO and SRO training programs to the satisfaction of the Chief of the OLB or his designated representative and

- Succesful completion of an oral examination conducted by a board of three examiners appointed by the Chief of the OLB. This examination should evaluate the examiner candidate's knowledge of nuclear power plant fundamentals, plant systems, plant operations and examination methods.

The Chief of the OLB should be the final certification authority, once the above elements have been completed. Examiners could be certified to examine without being certified to conduct evaluations or audits of training programs and vice versa.

4.2.4 Retraining of Examiners

As was identified in Section 2.6, examiner training is one of the primary methods for improving or maintaining the reliability of subjective examination methods, such as oral examinations, operating tests and written examinations that employ essay questions. The method recommended for this training in Section 2.6.4.2 was periodic OLB examiner workshops and training sessions to provide examiners with an opportunity to compare their scoring standards to those of other examiners. Because of the importance of consistent examination standards and the difficulty in maintaining consistent subjective standards, it is recommended that these examiner workshops be held semiannually.

Examiners who routinely administer operator licensing examinations should not require retraining in most technical areas because they are continually exposed to this technical material in performing their jobs. In practice, examiner skills and knowledges in these areas should actually improve over time, particularly if examiners are not allowed to ask the same questions routinely on each examination but are required to administer and score a variety of question responses in all RO and SRO skill and knowledge areas. Full-time examiners would be expected to require additional technical training only in regard to new information that has been developed since their initial certification. This information includes:

- o LERs and other unusual and abnormal events that occurred at plants and that are indicative of generic operator deficiencies,

- o Plant transients that have occurred and that are worthy of factoring into operator examinations to ensure operator ability to properly respond,

- o Studies related to operator performance or training,

- o Changes to plant designs that affect plant operations or procedures and

- o Changes to regulations or requirements that affect plant operations or impact on training programs.

The technical training described above could be integrated into the semiannual OLB examiner workshops. It is anticipated that these workshops would be approximately 1 week long, with the subject matter divided between examination methods and technical issues. Since a stated objective of these workshops would be to improve the reliability of all parts of licensing examinations, at least one of these workshops each year should be conducted at a control room simulator facility and emphasize operating tests.

In addition to the retraining just described, one other requirement is judged to be necessary to ensure the continued competency of examiners -- a periodic evaluation of each examiner's performance in administering and scoring operator licensing examinations. The mechanism for such an evaluation is already in place in the OLB "Examiner's Manual," which indicates that "at intervals not exceeding one year, each examiner shall be accompanied by the Chief of the OLB, or his designated alternate, during the administration of a written examination and a minimum of one operating test." However, in the past, the OLB has been unable to conduct this annual review regularly due to a shortage of personnel.

4.2.5 Recommendations for Selection, Training, Certification and Retraining of OLB Examiners

1. The OLB should adopt the following criteria for selection of OLB examiners:

    - o A baccalaureate degree in engineering or related sciences, plus 3 years of nuclear reactor operating experience, or

    - o A high school diploma or General Education Development Program Certificate, plus 4 years of experience as a licensed senior operator at a nuclear facility (a training center instructor who has successfully passed a senior operator examination with 4 years of training experience would also qualify).

    Examiners who satisfy these criteria will meet or exceed the education and experience qualifications of the personnel they will be examining and provide assurance of technical knowledge sufficient to permit effective application of proper examination methods and principles. In addition, highly experienced and capable licensed operators with training and operating experience that could be considered equivalent to a college degree would also be eligible for examiner selection.

2. The OLB should establish a formal training program that includes the following components:

Nuclear power plant fundamentals. Includes a self-study program determined from review of an examiner's education and experience.

Plant systems. Includes satisfactory completion of the basic and advanced PWR/BWR technology courses of the IE Career Management Branch.

Plant operations

- Simulator. Includes a basic simulator course such as the 7-day program provided by the IE Career Management Branch and an advanced simulator course to be conducted following on-the-job training. This course should be designed around the development of examiner skills and knowledges necessary to adequately conduct and evaluate operating tests for licensing and requalification of operators.

- On-the-job training. Includes a period of time (for example, 1 month) assigned to the office of an IE resident inspector. This part of the program should have specific requirements for accomplishment by the examiner candidate during this period.

Examination methods

- Classroom training. Includes formal instruction on subjects such as testing measurement, construction, scoring and analysis, logistics, etc.

- On-the-job training. Includes observation and practice in development, administration and evaluation of written, oral and operating examinations under the tutelage of a certified examiner.

Evaluation and auditing of RO and SRO training programs. Includes classroom instruction on objectives and methodology followed by on-the-job practice audits and evaluations.

The time required to complete each of these components would be dependent upon examiner education and experience. Formalizing existing programs, which currently rely heavily on on-the-job training and lack specific objectives, would improve examiner training efficiency and, hence, not result in any significant increase in training program length.

3. The OLB should establish a formal certification program for examiners that certifies their ability to administer operator examinations and audit training programs at specific types of facilities. This certification should include demonstration of adequate technical knowledge and knowledge of examination methods to a certification board. In addition, this certification should include performance of job-related functions (for example, examinations and audits) to the satisfaction of the Chief of the OLB.

4. Examiner retraining programs should consist of semiannual workshops and periodic evaluation of examiner performance in job-related functions. Objectives for semiannual workshops should include:

   - o Retraining of examiners for improving examination reliability and
   - o Upgrading of examiner knowledge of:
     - Operating events,
     - Design changes and
     - Policy and requirements changes

   that impact on operator performance or training programs.

4.3 STAFFING OF THE OPERATOR LICENSING BRANCH

4.3.1 Background

The OLB is presently staffed by approximately 12 full-time examiners who operate out of a central organization in Bethesda, Maryland. Historically, the staffing objective of OLB has been to use these permanent personnel to accommodate approximately 80 percent of the expected examination workload. Part-time (consultant) examiners (approximately 20 persons) are used to handle the remainder of the workload and to help account for workload fluctuations that occur periodically and place an excessive demand on the permanent staff.

The prospect of significantly increasing the functional responsibilities of the OLB necessitates an evaluation of an appropriate organization for administering the operator licensing program and an evaluation of alternatives for alleviating near-term or long-term shortages in OLB staff. The NRC has projected funding plans sufficient to increase the OLB staff to 69 examiners by the end of fiscal year 1985; however, the current shortage of qualified individuals within the nuclear industry (discussed in Section 2.9) provides little optimism for being able to meet that staffing plan on schedule. Considering these facts, Section 4.3.2 addresses the use of part-time examiners and Section 4.3.3 discusses the feasibility of using licensed senior operators on utility and vendor training staffs to assist in licensing functions. The results of evaluation of possible types of organizations suitable for conducting the operator licensing program are presented in Section 4.3.4.

4.3.2 Part-Time Examiners

Part-time examiners have been selected from universities, national laboratories and other research or training reactor facilities. Selection of individuals from these sources provides individuals who are extremely knowledgeable in nuclear fundamentals. In most cases these individuals have had considerable experience in the operation of research and training reactors but little or no experience in the operation of commercial nuclear power plants. As a result, these individuals would appear to be highly qualified to conduct operator examinations on all facilities licensed by the NRC except commercial nuclear power plants. Their qualifications to administer commercial power plant examinations are questionable when compared to those qualifications of permanent OLB examiners. In the past, the OLB has not experienced significant problems with the administration of written examinations by part-time examiners. Special procedures, such as OLB headquarters review of each written examination developed by part-time examiners, have assisted in this area. However, there are indications of problems with the administration of oral examinations by part-time examiners as compared to those administered by permanent OLB examiners. As evidenced from interviews with operators and training staff personnel at the reactor sites visited, the oral examinations administered by part-time examiners are generally weighted heavily toward theoretical rather than practical knowledge. In addition, deficiencies in examiner practical knowledge could pose problems in conducting valid performance-related operating tests on control room simulators.

Part-time examiners provide flexibility and diversity to the OLB staff. For these reasons, they should still be used. Resolution of the problems relating to their administration of examinations for commercial nuclear power plant operators can best be achieved by consistent application of formal requirements for training, certification and retraining to <u>all</u> examiners, either part-time or permanent.

The OLB should first implement a formal training program such as that recommended in Section 4.2.5. Through a review of the qualifications of each part-time examiner the Chief of the OLB should determine the class of facility for which each examiner should be certified (for example, research reactor, training reactor, PWR, BWR, etc.). The part-time examiner must then complete the portions of the training program appropriate for the certification desired. The Chief of the OLB would have the authority to modify the program as appropriate for the education and experience of the part-time examiner. It is expected that examiners with qualifications similar to present part-time examiners would require little, if any, technical training to be certified to examine operators for research and training reactors, but training on OLB examination methods would be necessary.

Although the training program could be tailored to the needs of the examiner, the formal certification of a part-time examiner for a particular class of facility should be just as rigorous as that required for permanent examiners. For part-time examiners who are to be certified to give examinations at commercial power plants, consistent application of certification criteria (such as those discussed in Section 4.2.3) would determine if these individuals have adequate technical knowledge of PWR and BWR facilities to administer performance-related operator licensing examinations.

It is certainly conceivable that increasing the training and certification for part-time examiners may result in a majority of them certifying only on research, training or critical facilities and not on commercial power reactors. Since the OLB is responsible for licensing operators at approximately 68 research, training or critical facilities as well as approximately 70 commercial power reactors, part-time examiners would still provide greater depth of the OLB staff by assuming the majority of licensing responsibilities at the non-commercial facilities. The use of licensed senior operators and regionalization of the OLB (discussed in Sections 4.3.3 and 4.3.4, respectively) would provide the flexibility that might be lost by having most part-time examiners only certified to give non-commercial power reactor examinations.

The final area relating to the use of part-time examiners involves retraining of these individuals. Again, the basic criterion that should be applied to these individuals is the application of consistent standards to <u>all</u> examiners. As a result, part-time examiners should be required to participate in periodic retraining programs (such as those described in Section 4.2.4) appropriate for their certification. For example, part-time examiners who are not certified to administer commercial power reactor examinations would not be required to attend retraining sessions on administration of operating tests on full-scope simulators. These individuals would attend workshops on other examination methods, policy changes, significant events, etc. Part-time examiners certified to give commercial power reactor examinations would be expected to attend all retraining sessions.

4.3.3 Licensed SRO Examiners

In addition to the use of part-time consultant examiners, a second approach to providing increased flexibility and depth to the OLB staff involves using licensed senior operators on utility and vendor training staffs to assist in licensing activities. These individuals would be similar to the "check airmen" (discussed in 2.7.1.6) who assist FAA examiners in the pilot recertification.

Although the use of more senior, highly experienced, SROs would provide significant depth to the OLB staff, the principal drawback to this system involves the potential for conflict of interest. For the OLB to adopt such a program on an interim or permanent basis requires the existence of sufficient impetus to justify this type of program. This impetus is provided by the prospect of near-term implementation of performance-related licensing and requalification operating tests on control room simulators and the resulting increased assurance of operator competency.

Sections 2.6 and 2.7 addressed the deficiencies in current licensing and requalification programs that do not adequately examine an operator's ability to perform under normal, abnormal, offnormal and emergency conditions. It was also concluded that comprehensive operating tests in control room simulators were the only means available for conducting such evaluations during initial licensing and periodic requalification. Review of current OLB examiner assets and the prospects for increasing the OLB staff to currently programmed levels indicates that it could require several years before the OLB could administer all licensing operating tests and all annual operating tests for requalification of the present 2500 licensed operators. Although the long-term goal should be for the OLB to administer all licensing and requalification operating tests, the use of licensed SROs is a feasible method for 100 percent implementation of this requirement in the near term.

If it is agreed that the positive impact on assuring operator competency in the near term justifies this type of program, then two questions must be answered -- who should conduct these operating tests, and what administrative controls are necessary to ensure consistent application of standards?

As indicated previously, two groups of experienced SROs are available -- utility instructors and vendor instructors. As indicated in Section 2.10, survey trips to reactor site training facilities indicated that several of these staffs are presently overworked and also are not accustomed to passing judgment on operators from other utilities. On the other hand, vendor instructors are already accustomed to performing NRC certification functions as part of the licensing process (reactor startup certification). Customer utilities are also accustomed to the independent nature of these evaluations provided by vendor training staffs. Based on these considerations, it is recommended that the SRO "Check Operators" be selected from senior instructors at vendor training centers. The OLB examiners would still need to administer these operating tests for facilities that use their own simulators.

Concerning administrative controls to ensure consistent application of standards, it is noted that vendor training centers are accustomed to applying NRC criteria to reactor startup certification examinations. Although these criteria are very limited in scope, the precedent is set for implementation of additional criteria. With this in mind, the following administrative controls are recommended for this type of program:

- o The NRC should develop detailed, specific criteria for administration of licensing and requalification operating tests.

- o Check Operators should be selected from senior instructors at vendor training centers based on the recommendations of Training Supervisors.

- o Check Operators should be certified by the OLB to administer operating tests using the criteria provided.

- o Consistent with staffing limitations, the OLB should administer all operating tests for initial licensing (however, as an interim measure, Check Operators should be permitted to conduct operating tests when OLB staffing is not adequate to support administration of these tests).

- o Check Operators should conduct annual requalification operating tests (see Recommendation 7, Section 2.7.1.9) at vendor training centers. An OLB examiner should evaluate each Check Operator annually while the Check Operator conducts an operating test.

Although this Check Operator program is recommended to help alleviate OLB staffing limitations, it is emphasized that this program is not intended to relieve the OLB of its responsibilities for ensuring the competency of licensed operators. In fact, the intent of such a program should be to provide increased assurance of operator competency by permitting the administration of performance-related operating examinations that might otherwise be excluded due to OLB staffing limitations.

This program is intended to be an interim measure for augmenting the OLB staff. In the long term, a clear objective should be established by the NRC to increase the permanent staff of the OLB and to phase out the Check Operator program.

4.3.4 Operator Licensing Organization

The following types of organization structures were analyzed for their advantages and disadvantages in administering the operator licensing program:

- o Central organization only,
- o Central organization with regional offices and
- o Central organization with resident examiners at reactor facilities or training centers.

In the evaluation of these possibilities, interviews were conducted at the headquarters, regional and resident inspector levels of the Office of Inspection and Enforcement (IE). These interviews were selected because the IE organization includes all three tiers in its structure and its personnel are most aware of the advantages and disadvantages of this type of organization.

All three possibilities for the OLB organization include a central headquarters organization. This will be necessary to permit consistent program definition; that is, establishment of consistent training program and examination criteria, OLB policy development, etc. Although locating all examiners at a central location permits better control of examiners by the Chief of the OLB there are some decided disadvantages. These include extensive travel time and expense, difficulty examiners have in gaining in-depth, plant-specific knowledge of the facilities they examine, difficulty in recruiting new examiners, and difficulty for examiners to remain current on plant operational and design changes. Administration of license and requalification examinations is, to some extent, a routine inspection function. The experience of the NRC Office of Inspection and Enforcement and other regulatory agencies (for example, FAA) has shown that routine inspection functions are best administered by personnel located closer to facilities.

Two options appear feasible for conducting this expansion: the use of resident examiners at reactor facilities or training centers or the establishment of OLB groups at regional locations.

There are some decided disadvantages to establishing resident examiners. The most serious of these is the potential for resident examiners to lose their objectivity and begin to associate themselves with utility staffs. This problem is commonly referred to as "capture." To reduce this problem, the IE organization employs strict rules of conduct for their resident inspectors and follows a job rotation practice that limits resident inspector tours to a nominal 3-year period at any specific site. As expressed by IE personnel interviewed, this necessary job rotation scheme has a very negative impact on the recruiting of new inspectors.

Other disadvantages with the use of resident examiners include difficulty in maintaining consistent examinations across the industry, potential for a facility to "fingerprint" its examiner (that is, to know what questions are most likely to be asked), communication and administration problems with the central organization and loss of peer review of examiner practices. Although resident examiners would be expected to gain the plant-specific knowledge necessary for their examinations, these disadvantages discussed above outweigh the benefit of plant-specific knowledge.

The use of a central organization with regional groups of OLB examiners appears to present the best combination of advantages with the fewest disadvantages. Regional location of groups of OLB examiners should permit examiners to gain more plant-specific knowledge of facilities within the region than permitted by the central organization concept. Assignment of several examiners to one office in the region will permit peer review of examinations and provide greater assurance of examination consistency between examiners when compared to the resident examiner approach. Distributing examiners into regions should aid in recruiting new examiners who would prefer to remain in a particular region. In addition, examiners could expect to work out of the region office for a larger number of years without necessity for periodic relocation as would be required for resident examiners. Finally, since examiners will be closer to the sites they are examining, travel time and expenses would be reduced.

An additional benefit can be gained by incorporating regional OLB groups into existing IE regional offices. IE inspectors can be a valuable source of technical information for specific plants. In addition, interchange between IE and OLB personnel will provide for increased awareness of plant technical and personnel problems that warrant investigation by either group.

4.3.5 Recommendations for Staffing of the Operator Licensing Branch

1. The NRC should commit to a long-term goal of staffing the OLB with sufficient permanent and part-time examiners to permit performing all licensing and requalification functions identified in Chapter 2. Part-time examiners should continue to be used to provide flexibility to the OLB.

   Requirements for permanent examiners for training, certification and retraining recommended in Section 4.2 should be applied consistently to part-time examiners. It is expected that application of training and certification requirements to part-time examiners might result in fewer part-time examiners being able to certify to examine at commercial nuclear power plants. However, based on their current positions and experience, it is expected that most of these part-time examiners could readily be certified to examine at noncommercial reactor facilities.

2. As an interim measure until the OLB can reach full complement to perform all licensing and requalification examination functions, the NRC should use SRO licensed senior instructors at vendor training centers to administer certain

operating tests on control room simulators. These senior operators should administer licensing and requalification operating tests that might otherwise be excluded due to OLB staffing limitations. The OLB should implement administrative controls to ensure consistent application of standards for the operating tests. These controls should include development of specific test criteria, certification of senior operator examiners, use of these senior operators only as necessary to preclude deletion of operating tests due to limitations on OLB staffing and annual evaluation of these senior operators by a certified OLB examiner.

3. The OLB should decentralize its present organization to include groups of OLB examiners at IE regional offices. These examiners would be responsible for examinations and audit functions at facilities located within the region. The central headquarters organization should retain a program definition and audit function. Responsibility for ensuring consistency of facility examinations and audits among regions should reside with the central organization.

5. ADEQUACY OF REGULATORY REQUIREMENTS AND NRC IMPLEMENTING GUIDANCE

This chapter addresses the adequacy of current NRC requirements and implementing guidance regarding the selection, training, examination and requalification of operating personnel. In the conduct of this evaluation, each of the following documents was reviewed for adequacy in light of the recommendations presented in Chapters 2 and 3 and current industry practices and procedures:

- o 10 CFR Part 55, "Operators' Licenses,"
- o 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities,"
- o Regulatory Guide 1.8, "Personnel Selection and Training,"
- o Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operation),"
- o Regulatory Guide 1.114, "Guidance on Being Operator at the Controls of a Nuclear Power Plant,"
- o Regulatory Guide 1.134, "Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator Licenses,"
- o Regulatory Guide 1.16, "Reporting of Operating Information - Appendix A Technical Specifications" (41),
- o Seven Commission Papers - SECY-79-330 through SECY-79-330F and
- o NUREG-0094, "NRC Operator Licensing Guide."

In this chapter, each of these documents is addressed individually and recommendations for changes are presented. Where applicable, recommendations presented previously in this report are referenced.

5.1 FEDERAL REGULATIONS

5.1.1 10 CFR Part 55, "Operators' Licenses" (11)

The September 1, 1978, version of 10 CFR Part 55 and the May 14, 1980, proposed revision to 10 CFR Part 55 (15) were reviewed. The changes presented in the May 1980 proposed revision are considered appropriate except where modified by the following additional recommended changes to 10 CFR Part 55:

General

- Throughout this part, reference to the written examination and operating test should be modified to three parts of the licensing examination -- written examination, oral examination and operating test. (Recommendation 1, Section 2.6.4.2)

- Examination subjects listed in 10 CFR Part 55 and its proposed revision are suitable as an interim measure. A long-term goal, however, should be adopted to redesign the written, oral and operating tests around required RO and SRO skills and knowledges based on a generic job task analysis. 10 CFR Part 55 should then be updated based on the results of this work.

Section 55.10 -- Contents of Applications

- The facility should be required to submit, with the medical examination, a description of the program used to identify signs of unsuitable personality dysfunction. Such a program should include a psychological interview by a psychiatrist or certified psychologist, administration of a self-report inventory and a suitable background investigation. Programs of equivalent scope and depth would be acceptable. (Recommendation 2, Section 2.5.1.7)

- A summary of applicant performance during each phase of the program should be required to be submitted for review. This summary should include a record of trainee performance on all quizzes, phase completion examinations, oral examinations and simulator operational examinations. (Recommendation 2, Section 2.5.2.6)

Section 55.11 -- Requirements for the Approval of Application

- A requirement should be included that indicates that, if by approval of the application an operator will be licensed on more than one facility, the operating organization must commit to a program to maintain familiarity on all facilities for which an operator holds a license. A suitable program would require periodic rotation between (among) facilities to maintain operating proficiency. (Conclusion 6, Section 2.6.4.1)

Section 55.21 -- Content of Operator Written Examinations and Section 55.22 -- Content of Senior Operator Written Examination

- The subject areas in the May 1980 proposed revision should be accepted as an interim measure. In the long term, these written examinations should be reorganized around required operator and senior operator skills and knowledges as determined from a generic job task analysis and these sections subsequently updated. (Recommendation 2, Section 2.6.4.2)

New Section -- Content of Operator and Senior Operator Oral Examinations

- This section should identify an oral examination as a separate part of the overall licensing examination. This section should indicate that this oral examination will concentrate on the skills and knowledges suitable for examination during a walk-through of the facility with emphasis on the operations and functioning of equipment and systems. (Recommendation 3, Section 2.6.4.2)

- In addition, subjects presently listed as items (c) through (e) and (g) through (l) of Section 55.23, "Scope of Operator and Senior Operator Operating Tests," are more suitable for this type of oral examination and should be listed in this new section.

Section 55.23 -- Scope of Operator and Senior Operator Operating Tests

- This section should indicate that the operating test will be administered using a control room simulator. Subject items (a) and (b) presently listed in this section are suitable for this type of practical demonstration. In addition, the scope of the operating test should be expanded to include evaluation of applicant performance in:

    - Recognizing emergency conditions and carrying out the appropriate actions of emergency operating procedures and Emergency Plan,

- Recognizing abnormal, offnormal and alarm conditions and carrying out the actions of appropriate procedures and

- Carrying out normal plant operations in accordance with appropriate procedures (not limited to a reactor startup).

(Recommendation 4, Section 2.6.4.2)

Section 55.25 -- Administration of Operating Test Prior to Initial Criticality

o The provisions of this section should be expanded to require that, after a certain date, license training and administration of an operating test prior to initial criticality must be conducted on a plant-specific simulator. In the interim, each facility not able to comply must have submitted to the NRC for prior approval a plan for providing the training in RO and SRO skills and knowledges that cannot be acquired by the use of a generic simulator. (Recommendation 6, Section 2.4.5.2)

o Item (d) of this section should be revised to require that these reactor control mechanism and instrumentation systems be in such condition to permit effective administration of an oral examination.

Section 55.31 -- Conditions of Licenses

o Item (e) of this section should define more clearly the criteria for determining that "a licensee has not been actively performing the functions of an operator or senior operator for a period of 4 months or longer." In particular, the applicability of these requirements to facility staff personnel who are licensed to provide backup operator capability should be specified.

o The May 1980 draft revision to 10 CFR Part 55 would amend item (e) to establish requirements to require recertification on a simulator as demonstration of an operator's capabilities after 4 months of licensed duty inactivity. Since these situations should be considered on a case basis, it is recommended that the wording of this paragraph be such as to provide the OLB the flexibility not to require this recertification if it is not deemed appropriate.

Section 55.33 -- Renewal of Licenses

- o As a part of the medical examination report required for license renewal, a reappraisal of the operator's psychological stability conducted by a psychiatrist or certified psychologist should be submitted. This appraisal need not require the in-depth evaluation required for the initial license application (Recommendation 2, Section 2.5.1.7), but should be adequate to verify that unsuitable personality dysfunctions have not developed since the previous evaluation.

Appendix A -- Requalification Programs for Licensed Operators of Production and Utilization Facilities

Appropriate paragraphs in this appendix should be modified to include the following requirements:

- o As a part of the requalification program approval process, each facility should be required to submit the results of a formal assessment of the ability of the program to provide adequate retraining for RO and SRO skills and knowledges not reinforced during normal plant operations. This assessment should be based upon a plant-specific job task analysis and identify the methods used to provide the required retraining for each skill and knowledge. (Recommendation 1, Section 2.7.1.9)

- o In addition to the May 1980 proposed revision, which would require simulator training as a part of requalification, minimum time requirements for these simulator programs and maximum allowable intervals between this training should also be specified. (Recommendation 2, Section 2.7.1.9)

- o In a manner similar to the recommended change to section 55.25, this appendix should require requalification training to be conducted on a plant-specific simulator following an appropriate date. In the interim, as a part of the requalification program approval process, facilities with no plant-specific simulator available must submit a plan for providing retraining in the RO and SRO skills and knowledges that require requalification training, but that cannot be acquired by the use of a generic simulator. (Recommendation 3, Section 2.7.1.9)

- o In the introduction to this appendix where guidelines are provided for requalification of operators who provide backup capability, requalification programs should be required to specify procedures for providing adequate in-plant operating experience at intervals sufficiently frequent to ensure that skills and knowledges necessary for routine plant operations are reinforced. These procedures could be tailored to account for the different functional responsibilities of these individuals.

- o The "Requirements" section of this appendix should be modified to describe a requalification program such as that presented in Recommendation 7 of Section 2.7.1.9. This description should specify utility and NRC requirements. Training on lessons learned from operating experience should require practical training, where appropriate, conducted on a simulator or in plant. (Recommendation 4, Section 2.7.1.9)

<u>Appendix B (Proposed) -- Qualification of Commercial Power Plant Applicants for Operator and Senior Operator Licenses</u>

This appendix, presented in the May 1980 proposed revision to 10 CFR Part 55, should be incorporated into 10 CFR Part 55 and modified by the following additional recommended changes:

- o Certification of RO and SRO candidates should be required to include demonstrated performance to a predetermined level of proficiency on a simulator. This certification should include satisfactory performance of:

  - General plant operations in addition to reactor startup,
  - Emergency operating procedures,
  - Procedures for abnormal, offnormal or alarm conditions,
  - Emergency actions not completely addressed by procedures, including multiple casualties and
  - Unannounced casualties for the purpose of evaluating diagnostic skills.

  For SRO applicants, this certification should address supervisory skills. (Recommendations 3 and 5, Section 2.4.5.2)

- Where this appendix requires simulator training, it should be indicated that, after a certain date, this training should be conducted on a plant-specific simulator. In the interim, each facility not able to comply must have submitted to the NRC for prior approval a plan for providing the training in RO and SRO skills and knowledges that cannot be acquired by the use of a generic simulator. (Recommendation 6, Section 2.4.5.2)

- Experience requirements for RO license applicants should be modified to require 1 year of experience as a non-licensed operator at the facility for which a license is sought (or a similar facility). (Recommendation 4, Section 2.5.1.7)

5.1.2 10 CFR Part 50, "Domestic Licensing of Production and Utilization Facilities" (45)

The following changes are recommended to the indicated sections of 10 CFR Part 50.

Section 50.54 -- Conditions of Licenses

- Paragraph (i-1), which requires that changes to requalification programs receive NRC approval, should be expanded to require NRC approval of changes to license training programs (cold or hot) as well. (Recommendation 12, Section 2.4.5.2)

- The May 14, 1980, proposed revision to 10 CFR Part 50 (15) would include a new paragraph (r) that requires administrative procedures to provide assurance that an operator or senior operator is proficient at manipulating the controls or supervising the manipulation of controls. This paragraph should also require procedures to ensure that an operator is familiar with current plant conditions before assuming responsibility for manipulating controls or supervising manipulation of controls. These procedures should specifically address individuals who are licensed to provide backup operator capability and operators who are licensed on more than one facility. (Recommendation 6, Section 2.7.1.9, and Conclusion 7, Section 2.6.4.1)

Interim General Statement of Policy -- Protection Against Accidents in Nuclear Power Reactors

- This statement should be modified to recognize the importance of a properly trained and capable operating staff in providing protection against accidents in nuclear power reactors. This statement describes the NRC's three-level approach to meet its safety objectives of assuring the risk from normal operation and postulated accidents is maintained at an acceptably low level and assuring that the likelihood of more severe accidents is extremely small. This approach should include a fourth level that recognizes the importance of the operator in achieving these objectives.

5.2 REGULATORY GUIDES

5.2.1 Regulatory Guide 1.8, "Personnel Selection and Training" (10)

Regulatory Guide 1.8 and the February 1979 proposed revision 2 to Regulatory Guide 1.8 (14) were reviewed. Regulatory Guide 1.8 endorses the standard ANSI N 18.1-1971, "Selection and Training of Nuclear Power Plant Personnel" (46). However, this standard is no longer in existence, since it was totally revised and reissued in 1978 as ANSI/ANS-3.1-1978 (7). The February 1979 proposed revision to Regulatory Guide 1.8 recognizes this fact and would endorse ANSI/ANS-3.1-1978. However, since the approval of ANSI/ANS-3.1-1978 and the development of the proposed revision 2 to Regulatory Guide 1.8, the accident at Three Mile Island has occurred, prompting many changes in the areas of personnel selection and training, including the drafting of a proposed revision to ANSI/ANS-3.1-1978. In light of this changing situation, the following actions are recommended concerning Regulatory Guide 1.8:

- The NRC should hold the proposed revision 2 to Regulatory Guide 1.8 in abeyance until the December 1979 proposed revision to ANSI/ANS-3.1-1978 can be completed and approved. It is recognized that the NRC participates in the working committee to revise ANSI/ANS-3.1-1978.

- Following this post-TMI upgrading of ANSI/ANS-3.1-1978, the new standard should be reviewed by the NRC in its entirety. The results of this review and consideration of the conclusions and recommendations of Chapters 2 and 3 of this report would serve as a basis for a complete revision of Regulatory Guide 1.8.

5.2.2 Regulatory Guide 1.33, "Quality Assurance Program Requirements (Operation)" (51)

This regulatory guide endorses ANSI N18.7-1976/ANS-3.2, "Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants" (52), subject to some additional specifications. The following recommendations for changes to this regulatory guide are presented:

- o Paragraph C.4 of this regulatory guide indicates that the audit program requirements of ANSI N18.7-1976/ANS-3.2 for performance, training and qualifications of facility staff should be satisfied at least once every 12 months. In addition to this audit frequency requirement, this regulatory guide should require that these audits evaluate the effectiveness of training provided (rather than just compliance of these programs with requirements and guidelines). (Recommendation 4, Section 2.4.5.2)

- o Paragraph C.5 indicates that the guideline provided in the standard for checking plant operating procedures during the testing program is considered a requirement. This guideline, which states that the suitability of these procedures should be checked to the maximum extent possible during the preoperational and initial start-up test programs, should be strengthened by this regulatory guide to also require checking these procedures (where appropriate) by use of a suitable control room simulator. Instructors at training centers visited indicated that facilities that used their draft procedures during license training often identified problems that required procedure changes.

5.2.3 Regulatory Guide 1.114, "Guidance on Being Operator at the Controls of a Nuclear Nuclear Power Plant" (53)

This regulatory guide should be modified to address the issue of maximum periods of time that an operator is allowed to stand shift at the controls of a nuclear power plant. As discussed in Appendix D, it is recommended that, except during emergency plant conditions, an operator should not be permitted to stand shift longer than 12 hours and should receive at least as much time off shift as required to stand on shift.

5.2.4 Regulatory Guide 1.134, "Medical Evaluation of Nuclear Power Plant Personnel Requiring Operator Licenses" (35)

This regulatory guide endorses ANSI N546-1976 (ANS 3.4) (34) for providing an acceptable method for determining medical qualifications for license applicants subject to some additional specifications. These requirements of ANSI N546-1976 (ANS 3.4) and

Regulatory Guide 1.134 are considered adequate for determining the medical qualifications of operators except that more comprehensive programs for identifying unsuitable personality dysfunction should be required. Such a program should include:

a. A psychological interview by a psychiatrist or certified psychologist (rather than a medical practitioner). This interview should serve as a rough screening tool to assess overt personality traits.

b. A self-report inventory (psychological test) administered to all applicants. Those showing signs of dysfunction should be referred to in-depth clinical diagnosis by a psychiatrist or certified psychologist. These tests should be reliable and valid, with recent norms.

c. A background investigation to identify undesirable characteristics indicated by police and court record checks, credit and employment history, etc. It is anticipated that prospective employees for operator positions would be required to sign a waiver of the Privacy Act to permit adequate investigation. (Recommendation 2, Section 2.5.1.7)

5.2.5 Regulatory Guide 1.16, "Reporting of Operating Information, Appendix A -- Technical Specifications" (41)

Section 2, "Reportable Occurrences," of this regulatory guide should be modified to recognize the importance of reporting events resulting from operator errors. Operator errors that result in events such as those listed in that section or operator errors that can be categorized as caused by:

- o Deficiences in operator skills and knowledges (training related),
- o Limitations in procedures or equipment design or
- o Negligence or serious judgment error

should be required to be reported. For these reportable occurrences, the facility should be required to conduct an evaluation to determine the fundamental cause of the error.

The facility should identify if this error is indicative of a deficiency in the facility's training and qualification program and commit to a program of corrective action. (Recommendation 3, Section 2.7.2.3)

5.3 OTHER GUIDANCE

5.3.1 Seven Commission Papers -- SECY-79-330 through SECY-79-330F (38, 54 through 59)

These seven papers are reports made to the NRC Commissioners from the Director, Office of Nuclear Reactor Regulation, during the period from May 14, 1979, to September 11, 1979. These reports provided information and recommendations in a number of areas relating to operator training and licensing. The specific subject areas of these reports are the following:

REPORT NUMBER	TITLE	INFORMATION REPORTED?	RECOMMENDATIONS PROVIDED?
SECY-79-330	"Plant Superintendents and Assistant Superintendents Who Hold, Or Have Held, Operator Licenses" (54)	Yes	No
SECY-79-330A	"A Statistical Profile Of Licensed Operators and Senior Operators and a Statistical Profile of Commercial Airline Pilots and Merchant Marine Engineering Personnel" (55)	Yes	No
SECY-79-330B	"Operator Emergency Response Training Required by Other Agencies, Using Simulator Training" (56)	Yes	Yes
SECY-79-330C	"Results of Examinations Administered to Licensed Operators as Part of the Requalification Program" (57)	Yes	No
SECY-79-330D	"Comparison of the Navy and NRC/Industry Training and Requalification Programs" (58)	Yes	No
SECY-79-330 E/F	"Qualifications of (Power) Reactor Operators" (38, 59)	Yes	Yes

The information provided in these reports was reviewed for accuracy in areas where parallel investigations were conducted as a part of this study. No inconsistencies in information content were found.

The recommendations provided in reports SECY-79-330B, E and F were also reviewed in light of analyses and recommendations presented in Chapter 2, "Licensed Operating Personnel." Each of these SECY-79-330 (series) recommendations are addressed in the following paragraphs.

5.3.1.1 Recommendations of SECY-79-330B

Recommendations

SECY-79-330B identified the following changes that were viewed by NRR as worthy of consideration in the operator licensing program:

(1) Require all operators to be trained on a full-scope simulator representative of their facility.

(2) Administer all license examinations on a full-scope simulator representative of their facility.

(3) Require periodic retraining and recertification on a full-scope simulator representative of their facility.

(4) Require an individual who has not been performing licensed duties for a period of 4 months or greater to be recertified on a full-scope simulator representative of his facility.

(5) Specify a minimum list of emergency procedures which must be successfully completed during initial simulator training and periodic simulator retraining.

(6) Provide additional training and periodic retraining for the present NRC examiners, including the part-time examiners. In order to remain as a part-time examiner, the individual must make himself available for this training, in addition to the time previously required for the normal examining workload.

(7) Establish a cadre of "Check Senior Operators" drawn from utility and training center staffs who are licensed and periodically recertified by the NRC.

(8) Adjust the OLB staffing level so that headquarters examiners can take on the additional duties of recertifying the "Check Senior Operators" and auditing the simulator training and retraining programs.

(9) Maintain specialization within groups of the OLB examiners. Eliminate examination assignments at reactors outside of the area of specialization or provide specific cross-training, including simulator training, if such an assignment must be made.

Review Comment

Recommendations (1), (2) and (3) are endorsed. The reader is referred respectively to the following recommendations in this report which expand on these issues:

- o Recommendations 5 and 6, Section 2.4.5.2,
- o Recommendations 1 and 4, Section 2.6.4.2 and
- o Recommendations 2, 3 and 7, Section 2.7.1.9.

Recommendation (4) provides a valid method for accomplishing the requirements of paragraph (e) of Section 55.31, "Conditions of the Licenses", of 10 CFR Part 55. Current requirements of this paragraph should be clarified to provide the NRC with the flexibility to conduct such an evaluation on a simulator, but should not require that it be conducted in all cases. Situations of this type must be considered on a case basis. However, if some form of examination appears to be necessary based on OLB review of the case, a performance-related examination such as that conducted on a simulator is recommended.

Recommendation (5) should be expanded to include an established list of practical training requirements in more areas than just emergency procedures. Recommendations 5, 10 and 12 of Section 2.4.5.2 and Recommendation 2 of Section 2.7.1.9 of this report address simulator training and retraining requirements that would accomplish this objective.

Chapter 4, "NRC Operator Licensing Organization," addresses the subject areas identified by SECY-79-330B recommendations (6) through (9). Section 4.3.2 of this chapter provides recommendations for initial training certification and retraining of part-time examiners. Section 4.3.3 recommends the use of "Check Operators" as an interim measure to provide sufficient numbers of examiners to permit near-term implementation of requalification requirements for simulator operating tests. In addition, methods for assuring the consistency of examinations conducted by Check Operators are recommended. Section 4.2.3 also addresses the need for a program to formally certify examiners based on different classes of facilities and recommends elements for such a program.

5.3.1.2 Recommendations of SECY-79-330E

Recommendation

(1) The experience requirements regarding power plant operations for senior operator applicants should be increased. Adoption of Option 1 is recommended to achieve this.

Option 1

Require the following experience for senior operator applicants: Applicants for senior operator licenses shall have 4 years of responsible power plant experience. Responsible power plant experience should be that obtained as a control room operator (fossil or nuclear) or as a power plant staff engineer involved in the day-to-day activities of the facility, commencing with the final year of construction. A maximum of 2 years of power plant experience may be fulfilled by academic or related technical training, on a one-for-one time basis. Two years shall be nuclear power plant experience. At least 6 months of the nuclear power plant experience shall be at the plant for which he seeks a license.

Review Comment

The May 1980 proposed revision to 10 CFR Part 55 modified these recommended requirements of SECY-79-330E for SROs to include 3 years of power plant experience and 2 years of nuclear power plant experience, with no academic or technical training allowed to be substituted for this experience. Our study concluded that the experience requirements of this proposed revision to 10 CFR Part 55 in combination with increased education requirements (Recommendation 1, Section 2.5.4.5) would provide appropriate upgrading of requirements for senior operators.

Recommendation

(2) Establish requirements for applicants for senior operator licenses after the plant achieves criticality to be licensed as an operator for 6 months. Option 2 is recommended to achieve this.

Option 2

Modify the hot training programs so that the training concentrates on the responsiblities and functions of the operator, rather than the senior operator. All individuals who satisfactorily complete this hot training program will be allowed to apply for an operator license, but must have at least 6 months of experience as a licensed operator before applying for a senior operator license.

Review Comment

The NRR letter of March 1980 to all power reactor applicants and licensees (13) implemented a 1-year requirement in place of this recommendation for 6 months of operator experience. The conclusions of this study supported the new 1-year requirement. (Conclusion 2, Section 2.5.4.5)

Recommendation

(3) Establish requirements for participation in plant shift operations prior to licensing. Option 3 is recommended to achieve this.

Option 3

Require that the 3-month continuous on-the-job training for hot operator applicants be as an extra man on shift in the control room. Require the hot senior operator applicants to have 3 months of continuous on-the-job training as an extra man on shift in training.

Review Comment

The NRR letter of March 1980 implemented this requirement. Conclusion 4, Section 2.4.5.1, of this report endorses the requirement. To make these periods of on-the-job training more effective, however, utilities should be required to significantly upgrade and formalize on-the-job training requirements. Recommendation 2, Section 2.4.5.2, addresses this issue.

Recommendation

(4) Establish requirements that simulators be used in training programs for hot applicants. Option 6 is recommended to achieve this.

Option 6

In addition to the presently approved training programs, require that all replacement applicants participate in simulator training programs, as applicable for their facility. Exception may be made for licensees at older facilities whose facility features and operating characteristics are not similar to present facilities, providing suitable alternatives are substituted.

Review Comment

We concur in this recommendation. Recommendations 5 and 6, Section 2.4.5.2, discuss additional improvements necessary in this area.

Recommendation

(5) NRC should audit training programs more closely, including administration of certification examinations. Option 5 that specifies administering some of the certification examinations is recommended rather than Option 4 that specifies administration of all the certification examinations.

Option 4

NRC examiners should administer all the cold certification examinations at the simulator training centers.

Option 5

NRC examiners should routinely administer some (approximately 10%) of the certification examinations at the simulator training center.

Review Comment

This recommendation addresses two issues -- auditing training programs and conducting simulator certification examinations. Recommendation 9, Section 2.4.5.2, provides recommended improvements in the auditing of cold and hot training programs. Section 2.6 of this report concluded that an operating test conducted on a control room simulator should be included as part of the licensing examination. Recommendation 4, Section 2.6.4.2, addresses the scope of this operating test and recommends an implementation plan that includes operating tests conducted by OLB examiners and vendor training center personnel. As indicated in Recommendation 4 and discussed in greater detail in Section 4.3.3, the use of vendor personnel should be considered an interim measure.

Recommendation

(6) Develop eligibility requirements for instructors. Option 7 is recommended as a first step to achieve this.

Option 7

Require that Phase II, III and IV cold training program instructors and all hot training program instructors that provide instruction in nuclear power plant operations hold senior operator licenses and be required to successfully participate in applicable requalification programs to maintain their instructor status.

Review Comment

This recommendation was implemented as a requirement by the NRR letter of March 1980. This study concluded that this requirement is adequate certification of technical competence for instructing in these phases of license training (Conclusion 2, Section 2.10.5.1). Recommendation 1, Section 2.10.5.2, however, includes additional proposed requirements that relate to instructor qualifications, specifically addressing training received in instructional methods and techniques.

Recommendation

(7) In addition to the present operator requalification program requirements, all licensees should be required to participate in periodic retraining and recertification on a full-scope simulator representative of their facility. Adoption of Options 8 and 9 are recommended to achieve this.

Option 8

In addition to the present operator requalification program requirements, we shall require that all licensees participate in periodic retraining and recertification on a full-scope simulator representative of their facility. The frequency of training should be on an annual basis. Exceptions may be made for licensees at old facilities, whose facility features and operating characteristics are not similar to present facilities, providing suitable alternatives are substituted.

Option 9

Presently, individuals who have not been performing licensed duties for 4 months or longer, are required to participate in an accelerated requalification program and receive our approval, prior to resuming licensed duties. In addition to the present requirements, these individuals should be required to be recertified on a full-scope simulator, representative of his facility. Licensees at older facilities may be excepted, providing suitable alternatives are provided.

Review Comment

Recommendation 7, Section 2.7.1.9, presents a proposed requalification program that would implement this SECY-79-330E recommendation. Option 8 indicates that the frequency of simulator retraining should be on an annual basis. Recommendation 2, Section 2.7.1.9, describes a systematic approach to determining minimum time requirements for these simulator programs and maximum allowable intervals between this training. The Option 9 requirement for recertification on a simulator for individuals who have not been performing licensed duties for 4 months or longer was addressed previously as Recommendation (4) of SECY-79-330B.

Recommendation

(8) Establish more explicit requirements regarding exercises to be included in simulator requalification programs. Adoption of Option 10 is recommended to achieve this.

Option 10

Establish more explicit requirements regarding exercises to be included in simulator training programs. These requirements should assure performance of exercises in a broad spectrum of normal and abnormal operations and response to transients and emergencies and shall include consideration of multiple failures, compound abnormalities and imperfect initialization. The requirements should not be rigid so that the flexibility and spontaneity in training programs are precluded. We, and ANS 3, have initiated effort in this direction.

Review Comment

This study concluded that more explicit requirements are needed regarding exercises to be included in both license training and requalification programs. Recommendations 5, 10 and 12 of Section 2.4.5.2 and Recommendation 2 of Section 2.7.1.9 address this need.

Recommendation

(9) An increased level of confidence in the effectiveness of requalification programs should be provided by NRC examiners administering annual requalification examinations. We recommend Option 12 that provides for administering some, rather than all, requalification examinations as indicated in Option 11.

Option 11

NRC to administer and grade all the annual written examinations and administer all the oral evaluations associated with requalification programs.

Option 12

NRC to administer some (approximately 10%) of the requalification examinations and oral evaluations, rather than all of the examinations, as indicated in Option 11.

Review Comment

This study concluded that an annual written examination of similar scope and depth as the NRC licensing examination is, by itself, an inappropriate tool for judging operator competency and this practice also has several disadvantages (Conclusion 9, Section 2.7.1.9). Recommendation 7, Section 2.7.1.9, describes a requalification program that uses evaluative criteria that are more performance-related and more suitable for identifying unsatisfactory operators. This program would include an annual NRC operating test conducted on a simulator, supplemented by oral examination if weaknesses are noted, and a comprehensive NRC written and oral examination conducted in conjunction with Upgrade Training every 5 years.

Recommendation

(10) The scope of the written examinations should provide increased emphasis on understanding of thermodynamics, hydraulics, and related matters. Adoption of Option 13 will accomplish this without changing the format of our examinations and is recommended rather than Options 14 and 15 that change the format.

Option 13

The content of the existing written examination should be expanded to include more selection essay type questions on thermodynamics, hydraulics, fluid flow, and heat transfer. This should be done using the same categories that now exist for the RO and SRO examinations. The length and complexity of the written examinations will increase from the present requirements.

Option 14

The content of the existing written examination should be expanded to include more selective essay type questions on thermodynamics, hydraulics, fluid flow, and heat transfer. This should be done by creating new categories for the RO and SRO examinations as appropriate. The length and complexity of the written examinations will increase.

Option 15

NRC should adopt a different approach to the written examination, such as one that would relate to only elemental questions and leave the exploratory questions to the oral examination. Such an examination could be restructured to include multiple choice and true and false type questions.

Review Comment

Although Option 13 was recommended in SECY-79-330E, Option 14 was authorized by the Commissioners. The results of this study support the conclusion of SECY-79-330E that emphasis in these subject areas is needed to improve the content validity of the written examination. Option 14 is a feasible method for implementing this change. However, as indicated in Conclusion 2, Section 2.6.4.1, there are other improvements needed to make the written examinations more valid. Recommendation 2, Section 2.6.4.2, provides additional changes that should be made to the written examinations.

Recommendation

(11) Applicants for operator and senior operator licenses should be examined at a nuclear power plant simulator. Option 16 is recommended to achieve this.

Option 16

Require part of the oral/operating test to be administered using existing nuclear power plant simulators.

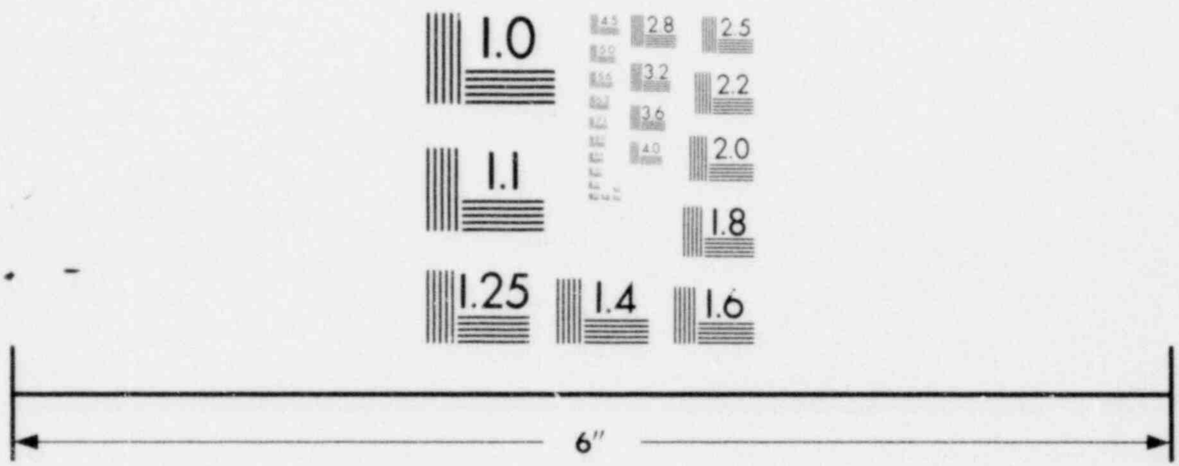
Review Comment

We concur with this recommendation. Recommendation 4 of Section 2.6.4.2 suggests the scope of this operating test.

IMAGE EVALUATION
TEST TARGET (MT-3)

6"

IMAGE EVALUATION
TEST TARGET (MT-3)



Recommendation

(12) Senior operator applicants who hold operator licenses should be required to take an oral test as well as the written examination. Adoption of Option 17 will achieve this.

Option 17

Require senior applicants who hold an operator's license to take an oral test in addition to the senior portion of the written examination.

Review Comment

This study concluded that a combination written, oral and operating examination is required to conduct the best comprehensive evaluation of whether license applicants will be safe and competent operators (Conclusion 1, Section 2.6.4.1). Therefore, senior operator applicants should be required to take all portions of the licensing examination with evaluative criteria applied at the senior operator level.

Recommendation

(13) The passing grade of written examination should be increased to 80% or greater overall and 70% or greater in each category. Adoption of Option 18 will achieve this.

Option 18

Increase the overall passing grade for operator and senior operator written examinations to 80% and require at least 70% in each category.

Review Comment

In Section 2.6.3.4 of this report, pass/fail criteria for examinations were discussed. As indicated in that section, while the 80-percent and 70-percent criteria seem acceptable as interim measures, in the long term it would be preferable to have performance-based examinations with criterion-referenced validity where a quantitative basis for a minimum passing score could be developed.

Recommendation

(14) NRC should inform facility management of the results of each examination so that remedial training may be instituted, as applicable. Adoption of Option 19 will achieve this.

Option 19

OLB should provide facility management with the detailed results of NRC initial examinations so that individuals may be immediately enrolled in the requalification programs.

Review Comment

Interviews at facilities visited indicated that this practice would be a highly desirable method for feeding back to facilities information that could be used to improve their training programs. This recommendation is endorsed.

Recommendation

(15) ANSI/ANS 3.5-1979, "Nuclear Power Plant Simulators for Use in Operator Training," should be reviewed and revised and a Regulatory Guide reflecting NRC endorsement be developed. Adoption of Option 20 will achieve this.

Option 20

Establish requirements that ensure that simulators, in order to receive credit in operator training and licensing activities, have the capability to accommodate a sufficient number and variety of abnormal and emergency conditions. This can be accomplished by appropriate revision to the standard ANSI/ANS 3.5-1979 or by separate NRC requirements.

Review Comment

Recommendation 6 of Section 2.4.5.2 endorses this SECY-79-330E recommendation.

Recommendation

(16) The present part-time examiners should be augmented by utility and vendor training personnel and formal training programs should be instituted for examiners. Adoption of Options 21 and 23 will achieve this.

We also considered eliminating all part-time examiners. We believe this would be detrimental to our program. We recommend that Option 22 not be adopted.

Option 21

The present part-time examiners will continue to be recruited from universities and national laboratories. Formal training and retraining programs shall be developed for all OLB examiners. The training programs will be prepared and conducted by OLB with assistance from the IE Career Management Branch. Training shall also be provided at simulator training centers. In order to remain as a part-time examiner, the individual must make himself available for this training, in addition to the time previously required for the normal examining workload; thus, a commitment of about 55 days per year will become a requirement.

Option 22

Eliminate all part-time examiners and increase OLB manpower to meet all operator licensing requirements. Manpower hiring requirements should restrict hiring to those individuals who have held or currently hold a senior operator license or equivalent for a nuclear power plant. Examiners should be assigned to administer examinations at specific types of reactors. Only after proper training should they be assigned to examine on other types of facilities.

Option 23

Augment the part-time examiners that are currently employed by OLB. Obtain from the utility and vendor training staffs licensed SROs to assist OLB in licensing activities. This select group of "Check Senior Operators" would be comparable to the FAA's "Check Airmen." The "Check Airmen" are considered the elite among the airline pilots. Usually they are selected from the better flight instructors and are given additional training. They are certified by the FAA as being qualified to evaluate other crew members. They assist FAA examiners in recertifying pilots. All initial FAA examinations are administered by FAA employees. Likewise, the "Check Senior Operators" would be the elite of nuclear plant training staffs. They would be used to administer the requalification examinations, including that portion using simulators.

Review Comment

This SECY-79-330E recommendation is an extension of changes that were considered by NRR as worthy of consideration and presented to the Commissioners in SECY-79-330B. As a result, the content of this recommendation has been addressed previously in the discussion of SECY-79-330B proposals in Section 5.3.1.1.

5.3.1.3 Recommendations of SECY-79-330F

SECY-79-330F was issued by the NRC Office of Nuclear Reactor Regulation to supplement SECY-79-330E by providing information for implementation and rulemaking decisions for the recommendations presented in SECY-79-330E. Since the release of SECY-79-330F, the implementation steps recommended in this paper have been carried out (for example, new requirements implemented by the NRR letter of March 1980) or are in the process of being carried out (for example, development of a proposed revision to 10 CFR Part 55). Considering these facts, the implementation rationale and steps presented in this paper were reviewed. It was concluded that the ideas presented in this paper were both adequate and appropriate.

5.3.2 NUREG-0094, "NRC Operator Licensing Guide" (12)

A document such as NUREG-0094 is valuable because it provides amplifying information to assist facilities in understanding the content and administration of operator licensing regulations. When considering changes to NUREG-0094, one must consider new requirements that have been implemented since the most recent publication of this document (for example, requirements implemented by the NRR letter of March, 1980) and proposed changes to applicable federal regulations (for example, the May 1980 draft revision to 10 CFR Part 50 and 55 and the recommendations of this report). Changes to NUREG-0094 could most effectively be implemented in two steps. Initially, a change should be issued that incorporates near-term operator licensing changes that have already been implemented or will be implemented following final approval of the May 1980 proposed revision to 10 CFR Parts 55 and 50. At a later date, as changes to federal regulations that incorporate long-term improvements recommended by this and other studies are made, NUREG-0094 should be updated. The following changes to NUREG-0094 are recommended based on recent changes in requirements and proposed revisions in federal regulations (both NRC-originated proposed revisions and revisions resulting from the recommendations of this report).

Part I -- Introduction

- No changes appear necessary.

Part II -- Contents of Applications

- This section of NUREG-0094 should address the fact that new requirements (13) have specified that the highest level of corporate management responsible for plant operation should sign facility certifications of applicant competence. NUREG-0094 should provide guidance for the conduct of this certification which includes the points discussed in Conclusion 3 and Recommendation 1 of Section 2.5.3.6 of this report.

- Section 5.1.1 presented recommended changes to 10 CFR 55.10, "Contents of Applications," relating to facility programs to screen candidates for unsuitable personality dysfunctions and submittal of a summary of applicant training program performance with the license application. If adopted, these recommended changes to 10 CFR 55.10 should be reflected in this part of NUREG-0094.

- Appendix B of the proposed revision to 10 CFR Part 55 of May 1980 provides the minimum qualifications of commercial power plant applicants for education experience, training and certification. If adopted, these changes should be reflected in this part of NUREG-0094 and made a part of federal regulations.

- Section 5.1.1 presented a recommended change to 10 CFR 55.11 to require that the operating organization commit to a program to maintain familiarity on all facilities licensed in the cases of applicants being licensed on multiple units. This part of NUREG-0094 should identify that, if applicable, the facility should describe this program in the application for license.

Part III -- Establishment of an Examination Schedule

- Changes to this part will be a function of scheduling changes necessitated by inclusion of an operating test on a full-scope simulator as part of the licensing examination.

Part IV -- Content of the Operator Written Examination

- In the near term, this part of NUREG-0094 should be changed to include the new category ("Principles of Reactor Plant Operation") of the written examination proposed in the May 1980 draft revision to 10 CFR Part 55. In the long term, the written examination should be reorganized around required operator skills and knowledges determined from a generic job task analysis (Recommendation 2, Section 2.6.4.2). Subsequent changes to 10 CFR Part 55 should then be included in this part of NUREG-0094.

Part V -- Content of Senior Operator Written Examination

- The near-term and long-term changes identified as necessary for Part IV of NUREG-0094 are also applicable for this part. The new category added to this examination by the proposed revision to 10 CFR Part 55 was "Theory of Reactor Plant Operation."

Part VI -- Relationship of Categories

- No changes appear to be needed.

Part VII -- Operating Test Administrative Considerations

- Recommendations provided in this report and NRC proposed changes to 10 CFR Part 55 include administration of the operating test at a full-scope simulator for most facilities in the future. Since it is recognized that, for some cases, administration of the operating test at the facility might still be desirable (for example, if no appropriate simulator exists), it is recommended that this guidance be retained. In addition, similar guidance wou appear to be needed which addresses administration of the operating test on full-scope simulator.

New Part -- Content of Operator and Senior Operator Oral Examinations

- This new part of NUREG-0094 would correspond to a new section of 10 CFR Part 55 which was recommended in Section 5.1.1 to identify the oral examination as a separate part of the overall licensing examination. This new part should indicate that this oral examination will concentrate on skills and knowledges suitable for examination during a walk-through of the facility, with emphasis on the operations and functioning of equipment and systems. (Recommendation 3, Section 2.6.4.2)

- As an interim measure, items 2, 4, 5, 7, 8, 9, 10, 11, 13 and 15 listed under Part VIII, "Scope of Operating Test for Operators," and all of the items listed under Part IX, "Scope of Operating Test for Senior Operators," could be appropriately listed under this new part of NUREG-0094 since they are suitable for oral examination.

- In the long term, the scope of the oral examination for operators and senior operators should be revised as determined by the results of a generic job task analysis conducted to reorganize NRC written, oral and operating examinations around required skills and knowledges.

Part VIII -- Scope of Operating Test for Operators

- This part of NUREG-0094 should be revised to address the fact that, in most cases, the operating test will be administered using a control room simulator. A list of items normally included in the test should be developed and included in this part. Items 1, 3, 6, 9, 12 and 14 in the list currently provided in this part are appropriate for inclusion in an operating test on a simulator. However, a complete list should be generated based on functional requirements identified from a generic job task analysis.

- This part should also identify that, in some special cases, the operating test might be administered at the facility rather than on a control room simulator. Criteria for administering such operating tests in these cases should be developed and included in this part. It is anticipated that operating tests of this type would require plant manipulation during drill scenarios.

Part IX -- Scope of Operating Test for Senior Operators

- Some of the differences between the operator and senior operator tests described in this part currently focus on areas evaluated by the oral examination. Once criteria for administration of operating tests on simulators are developed, this part should be updated to focus on the operating demonstration part of the overall licensing examination. Based on the SRO job task analysis conducted as a part of this study, the scope of operating tests for senior operators would be expected to emphasize performance during casualties and demonstration of supervisory skills. (Recommendation 3, Section 2.4.5.2)

Part X -- Waiver of Examination and Test Requirements

- Although this study noted no serious deficiencies in OLB waiver methods, waivers generally should not be encouraged and automatic waivers of any licensing requirements are not appropriate. This part of NUREG-0094 is an appropriate place to express such a philosophy if considered desirable by the OLB.

Part XI -- Administration of Operating Test Prior to Initial Criticality

- o This part needs to be updated to recognize that the oral examination and an operating test on a control room simulator are separate portions of the licensing examination.

Parts XII, XIII, XIV -- Issuance of Licenses, Expiration of Licenses, Timely Renewal Applications

- o The May 1980 proposed revision to 10 CFR Part 55 would place a 6-month limit on the extension of the expiration date of a license. If adopted, this change should be reflected in Part XIV of NUREG-0094.

Part XV -- Content of Renewal Applications

- o The May 1980 proposed revision to 10 CFR Part 55 would require additional information in renewal applications for applicants who have not completed all requalification program requirements. If adopted, this change should be discussed in this part.

- o In addition, Section 5.1.1 of this report recommended that, as a part of the medical examination required for license renewal, a reappraisal of the operator's psychological stability be conducted by a psychiatrist or certified psychologist. This requirement should be incorporated into this part of NUREG-0094.

Parts XVI through XIX -- Renewal of Licenses, Denial of Applications, Notification of Disability Subsequent to Licensing

- o No changes to these parts are recommended.

Appendices

- Appendix F, "Eligibility for Examination With No Reactor Startup Demonstration," is the only appendix in NUREG-0094 that provides implementing guidance to facilities. In the past, this appendix has provided basic guidance for development of facility hot license training programs. It is recommended that this appendix be deleted. If recommendations for a three-part licensing examination (written examination, oral examination, and operating test on a simulator) are adopted by the NRC, this appendix will no longer be applicable since the licensing process will no longer require a reactor startup as the only manipulation conducted during the examination. Recommendation 7, Section 2.4.5.2, describes an approach that the NRC should take to develop license training program approval criteria that would be applicable to hot and cold programs. Although these criteria should definitely be included in the NRC Standard Review Plan, they could also be communicated to facilities by incorporating them into Regulatory Guide 1.8, "Personnel Selection and Training."

6. CONCLUSIONS AND SUMMARY OF RECOMMENDATIONS

At the outset of this study, Analysis & Technology was asked to provide to the NRC an independent assessment of current requirements and practices regarding the selection, screening, training, licensing, requalification and performance of nuclear power plant control room operators. We were asked to base this study on information collected through visits to appropriate offices of the NRC and to a group of nuclear power plant and training center sites selected as representative of all existing facilities. During reactor site and training center visits, we found a broad spectrum of practices in almost all of these subject areas and a climate of revision and change for these practices. This recognition of the need for change was readily apparent at the NRC as well. Although the desire for significant improvement exists in both the industry and the NRC, a clear definition of the means to realize that goal has not yet been developed.

Individuals in the industry who are responsible for the selection, training, requalification and performance of licensed operators are professional, hard-working and genuinely interested in the safe operation of nuclear power plants. Many of these individuals are modifying their programs to make them more formal and comprehensive. Historically, both license training and requalification programs have been designed to address areas covered by NRC licensing examinations, not to reflect a systematic definition of the required functions, responsibilities and performance standards of RO and SRO licensed operators. As a result, deficiencies exist in the content of classroom, on-the-job and simulator training and retraining that limit the ability of these programs to provide complete training of required skills and knowledges. In addition, some methodologies employed during simulator and in-plant training do not ensure effective development of required skills.

Varying degrees of utility corporate management involvement and interest in operator selection, training and performance above the plant superintendent level were noted. At facilities where a higher degree of interest exists, these programs have apparently benefited. Because of the substantial personnel and monetary resources required, corporate management interest and commitment is essential to improving operator qualification and performance. By demonstrating its own increased interest in these areas, the NRC can foster more involvement by utility corporate management.

Operators are a valuable resource and are in short supply at most facilities. As a result, utility corporate management should be sensitive to their needs. For the most part, operators are dedicated and motivated individuals. Many have positive feelings about their jobs. In contrast to these positive feelings, however, there exists a general dissatisfaction with advancement paths, overtime requirements, salaries, and company communications and decision-making processes. A conscious effort by utilities to encourage people-oriented management can have a substantial positive effect in improving operator job satisfaction.

OLB requirements and practices have provided a much needed standard for evaluating the qualifications of operators and, hence, have resulted in a significant contribution to the safety of nuclear power plants. Although these efforts have been conscientiously directed with the goal of operational safety in mind, new approaches to training and evaluation, which have been developed in recent years, can be applied by the NRC to significantly improve its practices and provide increased assurances of operational safety.

The NRC has not used a strong management approach in regulating the industry in areas relating to the selection and training of operators and assuring the continued competency of operators. The resultant paucity of definitive guidance has fostered a broad spectrum of practices within the industry with little standardization and varying degrees of comprehensiveness and effectiveness. Industry training personnel responsible for these operator programs feel a need for more definitive guidance and more specific criteria for program content. However, just as the industry has never conducted an in-depth, systematic study of training program requirements, so has the NRC never conducted a similar determination of training program acceptance criteria.

The NRC process for licensing operators has not used available techniques in the best combinations to provide comprehensive evaluations of whether RO and SRO applicants will be safe and competent operators. Content areas for written, oral and operating examinations have not been based on any systematic approach to defining RO and SRO functional requirements. Written examinations lack content and criterion-referenced (that is, relating to job performance) validity in predicting if an applicant has sufficient skills and knowledges to function as an RO or SRO. In addition, the current written examination format makes it difficult to ensure reliability of the examination. Oral examination methods provide no means to ensure consistent scoring and cannot be audited. Comprehensive operating tests using control room simulators, which are potentially the most valid measure of whether or not an applicant will be a safe and competent operator, have not been used in the past. Since the NRC has placed so much emphasis on written examinations, many utility training and qualification programs are structured more toward ensuring that applicants pass OLB licensing examinations than on comprehensive task-related criteria. As a result, there is a general lack of performance-related training and evaluation within the industry, and many utility training programs lack comprehensive training in the same areas in which the OLB examinations are deficient. In addition, the use of an annual written examination of comparable scope and depth as the NRC licensing examination has fostered development of requalification programs designed around passing these examinations, has had a negative effect on operator motivation and is, by itself, an ineffective tool for evaluating many aspects of operator competence.

Assuming a stronger management role in regulating the industry will require that the OLB expand its staff. In conducting this expansion, the advantages identified for utilities of having formal, well-designed training and certification programs also apply to the OLB. In addition, expanding its role will include OLB assumption of additional examination and audit responsibilities and necessitate decentralization of the OLB for it to perform these functions more effectively.

Although a number of areas requiring improvement have been identified in this study, all of these improvements are achievable through implementation of an integrated plan of near-term and long-term actions. Each section of this report has provided conclusions and recommendations that should be considered by the NRC in development of such a plan. Table 6.1 provides an index of the conclusions and recommendations for each subject area of this report. In addition, a summary of all recommendations is included as Table 6.2. Each recommendation is discussed in greater detail in the indicated section of this report.

Some of the recommendations of this study can be implemented in the near term (for example, within 1 year of approval). Others identify needs for which more time will be required before full implementation can be realized. We feel that the outlook for improvement is optimistic. Responsible individuals at all levels in the industry and the NRC are increasingly aware of the importance of the operator (and of personnel in general) in the safe and competent operation of nuclear power plants. The resources available in the industry and the NRC include sophisticated technology and dedicated and talented personnel who are knowledgeable in a variety of applicable disciplines.

The remaining ingredient needed is a commitment -- a commitment by the NRC and the industry to a coordinated effort to provide near-term and long-term improvements and a continued awareness of the importance of the operator in assuring the operational safety of nuclear power plants.

TABLE 6.1
SUBJECT AREAS OF CONCLUSIONS AND RECOMMENDATIONS

SUBJECT	REPORT SECTION	
	CONCLUSIONS	RECOMMENDATIONS
Performance Predictive Indices	2.3.6	--
RO and SRO License Training	2.4.5.1	2.4.5.2
Selection of RO Candidates	2.5.1.7	2.5.1.7
Screening of RO Candidates During Training	2.5.2.6	2.5.2.6
Certification of RO Candidates	2.5.3.6	2.5.3.6
Selection of SRO Candidates	2.5.4.5	2.5.4.5
Licensing	2.6.4.1	2.6.4.2
Licensed Operator Requalification	2.7.1.9	2.7.1.9
Operator Error Reporting	2.7.2.3	2.7.2.3
Upgrading of Licensed Operators	2.8.2.1	2.8.2.2
Operator Compensation, Status and Motivation	2.9.3.1	2.9.3.2
License Training Instructors	2.10.5.1	2.10.5.2
Non-Licensed Operating, Maintenance and Technical Support Personnel	3.5.1	3.5.2
Selection, Training, Certification and Retraining of OLB Examiners	--	4.2.5
Staffing of the OLB	--	4.3.5

TABLE 6.2
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.4.5.2 RO AND SRO LICENSE TRAINING	1. Facilities conduct formal assessment of RO and SRO license training programs using a plant-specific job task analysis.	X		X	X
	2. Facilities upgrade and formalize on-the-job training requirements.	X		X	X
	3. Facilities upgrade SRO license training programs to provide more emphasis on SRO functional requirements, and development of leadership, management and supervisory skills. Include detailed and formal on-the-job training requirements and SRO simulator training.	X		X	X
	4. Facilities provide more emphasis in classroom training on advanced integrated plant topics. Review classroom training techniques for adequate formality to assure satisfactory training of all operators. Develop programs for periodic evaluation of the effectiveness of training provided.	X		X	X
	5. Require control room simulator training for all hot and cold license training programs. Expand operator certification requirements. Establish minimum time requirements for simulator programs based on consideration of training objectives and operational experience of candidates. Expand current hot license requirement for 1 week of simulator training.	X		X	X

*Near-term implementation is defined as suitable for completion within 1 year of NRC approval.

TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.4.5.2 RO AND SRO LICENSE TRAINING (cont'd)	6. Establish requirements for the use of simulators in training control room operators. Establish requirements for all facilities to conduct training on a simulator specific to the plant.		X	X	X
	7. Develop license training program approval criteria based on a determination of training content requirements derived from RO and SRO functional requirements. Use a generic job task analysis as the basis for a systematic approach to the development of these criteria.	X			X
	8. Assign all operator training responsibilities (program approvals, audits and evaluations of practices, licensing of operators) to one organization within the NRC, preferably the OLB.		X		X
	9. Upgrade audit programs to include hot as well as cold license training. Expand emphasis of audits to include adequacy of facility internal requirements for training and actual conduct of training. Formalize all audits and include training centers.	X			X
	10. Adopt a practice similar to that of the FAA in approving control room simulator training programs. Require facilities to submit a list of detailed training objectives and specific practical training intended to be accomplished at the simulator. Evaluate proposed simulators for their capability to provide complete training relative to the actual facility. For deficient areas, require simulator training to be supplemented with in-plant training.	X			X

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.4.5.2 RO AND SRO LICENSE TRAINING (cont'd)	11. Require hot and cold license programs submitted for review in the FSAR to be developed from a fully detailed, systematic approach. Increase requirements for program descriptions submitted with the FSAR.		X	X	X
	12. Adopt a strong management approach to license training, similar to that employed by the FAA and U.S. Navy. Become more involved in the content and conduct of training.	X			X
2.5.1.7 SELECTION OF RO CANDIDATES	1. As a part of the operator selection process, utilities adopt an integrated program for evaluating a potential employee's aptitude for completing non-licensed and licensed operator training, including personal interviews, academic and employment performance review and aptitude and achievement tests. (NRC involvement here is not appropriate.)	X		X	
	2. Require that, as a part of the operator selection process, facilities employ a program to identify signs of unsuitable personality dysfunction, including psychological interview, self-report inventory and background investigation.		X	X	X
	3. During initial selection, utilities adopt a practice of combining in-depth interviews conducted by plant operations personnel with the use of appropriate personality inventories to evaluate congruence between applicant interests and operator job characteristics.	X		X	

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.5.1.7 SELECTION OF RO CANDIDATES (cont'd)	4. Require that, before licensing, an RO candidate should have performed the functions of a non-licensed operator at the facility for which a license is sought (or similar facility) for a period of 1 year.	X		X	X
	5. Utilities use a combination of criteria (rather than relying solely on seniority) when selecting non-licensed operators for RO license training, with application of these criteria directed toward selecting candidates who are most suitable for advancement.	X		X	
	6. Adopt the education requirements for RO license applicants proposed in the May 1980 draft revision to 10 CFR Part 55 (that is, high school diploma or General Education Development Program Certificate).	X			X
2.5.2.6 SCREENING OF RO CANDIDATES DURING TRAINING	1. Require that, as a part of their license training, utilities establish a formal method for certifying satisfactory knowledge and performance for each applicable phase of the programs.	X		X	X
	2. Require facilities to maintain a record of trainee performance on all quizzes, phase completion examinations, oral examinations and simulator operational examinations and to submit a summary of candidate performance during each phase of the program in the application for license.	X		X	X

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.5.3.6 CERTIFICATION OF RO CANDIDATES (also applicable for SRO candidates)	1. Utility corporate management currently required to sign certifications of license candidates' competence participate actively in the certification process by considering more personal issues beyond those of technical competence and training received and by conducting interviews to assess candidates' appreciation of reactor safety responsibilities and obligations to the utility and the general public.	X		X	
	NRC establish a practice of interfacing with utilities at the Vice President of Operations level on major issues affecting operator training and licensing to help foster more corporate management involvement in operator training.	X			X
2.5.4.5 SELECTION OF SRO CANDIDATES	1. Adopt, as an interim measure, the education requirements for SRO license applicants proposed in the May 1980 draft revision to 10 CFR Part 55, (that is, high school diploma or General Education Development Program Certificate and 30 semester-hours of college-level instruction in related technical subjects). In the long term, NRC use the results of plant-specific job task analyses conducted at facilities to identify more specifically the content areas and expected number of hours needed to be included in the college-level instruction.		X	X	X
	2. Utilities use a combination of criteria (rather than relying solely on seniority) when selecting SRO candidates.	X		X	

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.6.4.2 LICENSING	1. Require applicants to pass a three-part licensing examination which includes a written examination, oral test administered at the applicant's facility and an operating test administered on an appropriate control room simulator.	X			X
	2. Revise RO and SRO written examinations to improve their content validity and reliability by organizing the examinations around RO and SRO skills and knowledges, developing more operation-oriented questions that evaluate knowledge to a greater depth and implementing an integrated program to improve reliability, including workshops on testing methods and use of more objective questions.		X		X
	3. Revise the oral test to limit its scope of those skills and knowledges that have been determined to be suitable for examination by a walk-through of the applicant's facility and revise the procedure for administration of the oral test to provide for more reliable and auditable results.	X			X
	4. Expand the scope of the operating test to include evaluation of applicant performance in: o Recognizing emergency conditions and carrying out the appropriate actions of emergency operating procedures and the Emergency Plan,	X			X

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.6.4.2 LICENSING (cont'd)	o Recognizing abnormal, offnormal and alarm conditions and carrying out the actions of appropriate procedures and				
	o Carrying out normal plant operations in accordance with appropriate procedures (not limited to reactor startup).				
	5. OLB take a systematic approach to revising operator licensing methods by assigning to a separate functional group the responsibility for development and implementation of a program for revisions.	X			X
2.7.1.9 LICENSED OPERATOR REQUALI-FICATION	1. Require facilities to conduct a formal assessment of their requalification training programs derived from a plant-specific job task analysis to ensure that adequate retraining is provided for all RO and SRO required skills and knowledges not reinforced during normal plant operations.	X		X	X
	2. Require control room simulator training as part of each facility's requalification program and establish minimum time requirements for these simulator programs and maximum allowable intervals between this training.	X		X	X
	3. As with license training, require that all facilities conduct requalification training on a control room simulator specific to the plant.		X	X	X

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TABLE 6.2
SUMMARY OF RECOMMENDATIONS (Cont'd)

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.7.1.9 LICENSED OPERATOR REQUALI-FICATION (cont'd)	Require, as an interim measure, that facilities with no plant-specific simulator currently available submit for approval a plan for providing retraining in the RO and SRO skills and knowledges that require requalification training, but cannot be acquired by the use of a generic simulator.	X		X	X
	4. Require that, as a part of their requalification program, utilities commit to conducting formal training on lessons learned from operating experience, including practical training, where appropriate, conducted on a simulator or in plant.	X		X	X
	5. As with license training programs, expand audits of requalification programs to include adequacy . facility internal requirements and actual conduct of retraining.	X			X
	Assign all requalification audit responsibilities to the OLB.		X		X
	Increase requalification program requirements for individuals who are licensed to provide backup operator capability to account for the fact that these individuals do not routinely perform operating functions. Establish requirements that these individuals obtain in-plant operating experience at intervals sufficiently frequent to ensure that skills and knowledges necessary for routine plant operations are reinforced.	X		X	X

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.7.1.9 LICENSED OPERATOR REQUALI-FICATION (cont'd)	7. Adopt a comprehensive program for assuring continued operator competency (such as described in Section 2.7.1.9) that uses an effective combination of evaluative tools integrated into a requalification program that is more performance-related, less repetitious and more challenging to operators than current programs.		X	X	X
2.7.2.3 OPERATOR ERROR REPORTING	1. Revise operator error reporting criteria and procedures to place more emphasis on serious errors. Establish more in-depth review of licensee reportable occurrences related to operator errors to ensure that root causes of errors are determined and appropriate corrective actions identified and completed.		X	X	X
	2. NRC and industry cooperate to implement a comprehensive system for analysis of operating experience (including serious personnel errors) and provide results to appropriate facilities in sufficient detail to permit effective training.		X		X
	3. For reportable occurrences resulting from personnel error, require facilities to conduct an evaluation to determine if the error is indicative of a deficiency in the facility's training and qualification programs. Require resident IE inspectors to review these evaluations for adequacy and applicability for followup action by the OLB.	X		X	X

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.7.2.3 OPERATOR ERROR REPORTING (cont'd)	4. OLB review for disciplinary action (that is, suspension or revocation of license) those operator errors indicative of negligence or serious faults in judgment. For serious operator errors due to deficiencies in skills or knowledges or due to equipment design or procedural limitations, administer training program audits or operator re-examinations to evaluate the effectiveness of facility corrective action.	X			X
	5. OLB assure continued operator competence by applying emphasis on the conduct of effective requalification programs . OLB should not adopt any system for continuous accounting of specific errors to individual operators.	X			X
2.8.2.2 UPGRADING OF LICENSED OPERATORS	1. Require of all presently licensed operators a special certification of competence to operate a control room simulator under normal (in addition to reactor startup), abnormal and emergency conditions.	X		X	X
	2. Require that all facilities provide a period of upgrade training in appropriate subjects of nuclear power plant fundamentals to licensed operators whose initial training programs were deficient as compared to current standards and requirements.		X	X	X
	3. Facilities submit for approval a plan for providing 30 semester-hours of college-level instruction in related technical subjects to presently licensed SROs who do not already satisfy this requirement.	X		X	X

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.9.3.2 OPERATC COMPENSATION, STATUS AND MOTIVATION	Utility management actively pursue a policy of increased interpersonal relations and effective communications. Utility management make a conscious effort to relate their concern for operators and also recognize and solicit operator inputs into matters which concern them.	X		X	
	2. Utilities delineate clear avenues of advancement and communicate them to operations personnel.	X		X	
	3. Utilities commit to creating a sizeable increase in the operator work force.		X	X	
	4. Review operator salaries in the context of the responsibilities and the requirements imposed upon them and in relation to other utility occupations.	X		X	
2.10.5.2 LICENSE TRAINING INSTRUCTORS	1. Before any instructional assignments, all training personnel (including Training Managers) attend a certified course or program specifically aimed at the familiarization with and application of instructional methods and techniques.		X	X	X
	2. During periodic audits, ensure that instructional staffs have received training or possess the equivalent education necessary to demonstrate effective training practices.		X		X
	3. Utilities implement periodic workshops or retraining programs for assessing and improving instructional skills.	X		X	

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
2.10.5.2 LICENSE TRAINING INSTRUCTORS (cont'd)	4. In evaluating instructors, utilities consider several measures, including the following: o Meeting of well-stated, valid objectives, o Periodic observation by an instructional specialist, o Trainee feedback, o Trainee performance on the job (supervisor feedback) and o Training Coordinator or senior instructor observation using a detailed, structured observation list.	X		X	
3.5.2 NON-LICENSED OPERATING, MAINTENANCE AND TECHNICAL SUPPORT PERSONNEL	1. Require that utilities formally certify the qualifications of all non-licensed plant personnel who perform tasks that have a potential effect on safe operation of the plant and on the health and safety of the public. NRC and industry develop industry-wide criteria for this certification, based upon a task analysis for each functional job description.		X	X	X
4.2.5 SELECTION, TRAINING, CERTIFICATION AND RETRAINING OF OLB EXAMINERS	1. OLB adopt the following criteria for selection of OLB examiners: o A baccalaureate degree in engineering or related sciences, plus 3 years of nuclear reactor operating experience, or	X			X

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
4.2.5 SELECTION, TRAINING, CERTIFICATION AND RETRAINING OF OLB EXAMINERS (cont'd)	o A high school diploma or General Education Development Program Certificate, plus 4 years experience as a licensed senior operator at a nuclear facility or training center.				
	2. OLB establish a formal training program for examiners that includes nuclear power plant fundamentals (self-study), plant systems (IE PWR/BWR technology courses), plant operations (basic and advanced simulator training and training on site), examination methods (classroom and on-the-job training) and audit practices (classroom and on-the-job training).	X			X
	3. OLB establish a formal certification program to certify ability to administer operator examinations and audit training programs at specific classes of facilities. Include in this certification, satisfactory performance of job-related functions as well as demonstration to a board of examiners of adequate technical knowledge and knowledge of examination methods.	X			X
	4. OLB implement a retraining program consisting of periodic evaluation of examiner performance in job-related functions and semiannual workshops for improving examination reliability and upgrading examiner knowledge of operating events, design changes and policy and requirements changes that impact on operator performance or training programs.	X			X

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TABLE 6.2 (continued)
SUMMARY OF RECOMMENDATIONS

REPORT SECTION	RECOMMENDATION	IMPLEMENTATION			
		NEAR TERM*	LONG TERM	LICENSEE ACTION	NRC ACTION
4.3.5 STAFFING OF OLB	1. NRC commit to a goal of staffing the OLB with sufficient permanent and part-time examiners to permit performing all licensing and requalification functions. Apply consistently to part-time examiners the proposed requirements for permanent examiners for training, certification and retraining.		X		X
	2. As an interim measure, use SRO-licensed senior instructors at vendor training centers to administer operating tests on control room simulators which might otherwise be excluded due to OLB staffing limitations.	X			X
	3. Decentralize the present OLB organization to include groups of OLB examiners at IE regional offices. Regional examiners perform examination and audit functions within regions. Central headquarters organization retain a program definition and OLB audit function.		X		X

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*Also available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

**Regulatory Guides are available for purchase from the NRC/GPO Sales Program, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

APPENDIX A

RO/SRO JOB TASK ANALYSIS

APPENDIX A

RO/SRO JOB TASK ANALYSIS

The job task analysis separated RO and SRO tasks and elements into the following task areas:

TABLE A.[illegible].
CARRY OUT EMERGENCY ACTIONS NOT COMPLETELY ADDRESSED BY PROCEDURES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Recognize conditions as indicative of an emergency condition.	Perceptual Processes			Operator, without reference to procedures, should identify symptoms indicating an emergency condition, and determine that symptoms are not completely indicative of any individual procedure.
	- Identify cue(s) as indicative of an emergency condition.	X		
	Cognitive Processes			
	- Determine that cues are not completely addressed by any single procedure.	X		
2. Carry out appropriate actions.	Perceptual Processes			Operator, through knowledge of plant operations and interrelations, should correctly respond to conditions not completely addressed by a single procedure.
	- Locate and read indicators and annunciators.	X		
	- Identify technical specifications limiting conditions for operation.	X		
	- Identify display meanings and relationships	X		
	- Locate controls.	X		
	Cognitive Processes			
	- Maintain good judgment and problem-solving performance under stressful and/or physically hazardous environment.	X		
	- Compare and verify indications.	X		
	- Establish priorities.		X	
	- Calculate radiation levels, stay times, etc.		X	
	- Determine whether multiple casualties have occurred.	X		
	- Coordinate actions of two or more procedures.		X	
	- Maintain overall perspective; do not become totally involved in a single operation.		X	

TABLE A.1 (continued)
CARRY OUT EMERGENCY ACTIONS NOT COMPLETELY ADDRESSED BY PROCEDURES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
2. Carry out appropriate actions (continued)	Cognitive Processes (continued)			
	- Use decision rules.		X	
	- Analyze plant conditions.	X		
	Communication Processes			
	- Inform personnel.	X		
	- Direct actions.	X		
	- Recall personnel.		X	
	- Recommend actions to appropriate authorities.		X	
	- Maintain written logs/reports.	X		
	- Receive verbal reports.	X		
	- Receive advice from STA and other technical personnel.		X	
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters (pressure, temperatures, etc.).	X		
	- Operate sampling equipment.	X		
	- Take manual (backup) control of normally automatic functions.	X		
	- Operate controls.	X		

TABLE A.2
CARRY OUT PROCEDURES OF EMERGENCY PLAN

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Recognize conditions requiring implementation of the Emergency Plan.	Perceptual Processes			Operator should recognize conditions requiring implementation of the Emergency Plan without reference to procedures.
	- Identify symptoms (one or more indications) as those requiring implementation of the Emergency Plan	X		
	Cognitive Processes			
	- Determine applicable procedure of the Emergency Plan	X		
2. Carry out applicable actions of the Emergency Plan.	Perceptual Processes			Operator should carry out, through reference to the Emergency Plan and other documentation, all actions of Emergency Plan.
	- Locate and read indicators and annunciators.	X		
	- Read dosimeter.	X		
	- Identify results of area radiation surveys and air samples.	X		
	Cognitive Processes			
	- Maintain good judgment and problem-solving performance under stressful and/or physically hazardous environment.	X		
	- Coordinate actions of all shift personnel.		X	
	- Calculate radiation levels, doses, stay times, etc.		X	
	- Determine additional equipment and/or support required.		X	
	- Establish priorities.		X	
	- Determine steps or procedures needed for recovery.		X	
	- Maintain overall perspective.		X	

TABLE A.2 (continued)
CARRY OUT PROCEDURES OF EMERGENCY PLAN

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
2. Carry out applicable actions of the emergency plan. (continued)	Communication Processes			
	- Recommend protective actions to appropriate authorities.		X	
	- Inform personnel of emergency.	X		
	- Direct actions.	X		
	- Receive advice from STA and other technical personnel.		X	
	- Receive verbal reports.	X		
	- Recall personnel.		X	
	- Maintain written logs/reports.	X		
	Motor Processes			
	- Operate portable equipment (air samplers, etc.)	X		
	- Position components (valves, switches, etc.).	X		
	- Control system parameters.	X		
	- Operate controls.	X		

TABLE A.3
CARRY OUT EMERGENCY OPERATING PROCEDURES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Recognize plant conditions requiring implementation of emergency operating procedures.	Perceptual Processes			Operator should recognize all conditions requiring implementation of emergency operating procedures without reference to plant procedures.
	- Identify cues requiring implementation of emergency operating procedures. [Note: any one of five (5) senses may identify symptoms.]	X		
	Cognitive Processes			
	- Determine applicable emergency operating procedure.	X		
2. Recognize automatic actions.	Perceptual Processes			Operator should recognize automatic actions associated with all plant emergencies without reference to procedures.
	- Locate and read indicators, and annunciators.	X		
	- Identify display meanings and relationships.	X		
	Cognitive Processes			
	- Compare and verify indications.	X		
3. Carry out immediate operator actions.	Perceptual Processes			Operator should carry out, for all plant emergency conditions, immediate operator actions without reference to applicable procedures.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	- Locate controls.	X		
	- Identify technical specifications limiting conditions for operations.	X		
	Cognitive Processes			
	- Compare and verify indications.	X		
	- Coordinate actions of all shift personnel.		X	
	- Analyze plant conditions.	X		
	- Maintain good judgment and problem-solving performance under stressful and/or physically hazardous environment.	X		

TABLE A.3 (continued)
CARRY OUT EMERGENCY OPERATING PROCEDURES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
3. Carry out immediate operator actions (continued)	Cognitive Processes (continued)			
	- Establish priorities.		X	
	- Maintain overall perspective; do not become totally involved in a single operation.		X	
	Communication Processes			
	- Inform appropriate personnel.	X		
	- Direct actions.	X		
	- Receive verbal reports.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters (pressures, levels, etc.).	X		
	- Take manual (backup) control of normally automatic functions.	X		
	- Operate controls.	X		
4. Carry out subsequent operator actions.	Perceptual Processes			Operator should carry out, through reference to applicable procedures, subsequent operator actions of all emergency operating procedures.
	- Locate and read indicators and annunciators.	X		
	- Identify display meaning and relationships.	X		
	- Locate controls.	X		
	- Identify technical specifications limiting conditions for operation.		X	
	Cognitive Processes			
	- Maintain good judgment and problem-solving performance under stressful and/or physically hazardous environment.	X		

TABLE A.3 (continued)
CARRY OUT EMERGENCY OPERATING PROCEDURES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE: RO or SRO	INDIVIDUAL RESPONSIBLE: SRO ONLY	TRAINING OBJECTIVES
4. Carry out subsequent operator actions. (continued)	Cognitive Processes (continued)			
	- Compare and verify indications.	X		
	- Establish priorities.		X	
	- Coordinate actions		X	
	- Maintain overall perspective; do <u>not</u> become totally involved in a single operation.		X	
	- Analyze plant conditions.	X		
	- Determine additional equipment and/or support required.		X	
	- Determine steps or procedures required to recover from emergency.		X	
	Communication Processes			
	- Inform personnel.	X		
	- Direct actions.	X		
	- Receive verbal reports.	X		
	- Recall personnel.		X	
	- Recommend action to appropriate authorities.		X	
	- Receive advice from STA and other technical personnel.		X	
	- Maintain written logs/reports.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters (pressure, levels, etc.).	X		
	- Take manual (backup) control of normally automatic functions.	X		
	- Operate controls.	X		

TABLE A.4
CARRY OUT PROCEDURE FOR ABNORMAL, OFFNORMAL OR ALARM CONDITIONS

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Recognize a condition requiring implementation of these procedures.	Perceptual Processes			Operator should recognize, for all abnormal, offnormal or alarm conditions, the symptoms that require implementation of procedures.
	- Identify cues (one or more indications) as those requiring implementation of procedure. [Note: any one of five (5) senses may identify cues.]	X		
	Cognitive Processes			
	- Determine applicable procedure.	X		
2. Know the automatic actions associated with these conditions and determine whether these actions have occurred.	Perceptual processes			Operator should recognize, for all abnormal, offnormal or alarm conditions, the associated automatic actions.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	Cognitive processes			
	- Compare and verify indications.	X		
3. Carry out immediate operator actions.	Perceptual Processes			Operator should carry out, for all abnormal, offnormal or alarm conditions, immediate operator actions in the proper sequence through reference to applicable procedures.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	- Locate controls.	X		
	- Identify any technical specifications limiting conditions for operations.	X		
	Cognitive Processes			
	- Compare and verify indications.	X		
	- Coordinate actions of all shift personnel.		X	
	- Analyze plant conditions.	X		
	- Maintain good judgment and problem-solving ability under stressful and physically hazardous environment.	X		

TABLE A.4 (continued)
CARRY OUT PROCEDURE FOR ABNORMAL, OFFNORMAL OR ALARM CONDITIONS

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
3. Carry out immediate operator actions. (continued)	Cognitive Processes (continued)			
	- Establish priorities.		X	
	- Maintain overall perspective; do not become totally involved in a single operation.		X	
	Communication Processes			
	- Inform personnel.	X		
	- Direct actions.	X		
	- Receive verbal reports.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters (pressures, levels, etc.).	X		
	- Take manual (backup) control of normally automatic functions.	X		
	- Operate controls.	X		
4. Carry out subsequent operator actions.	Perceptual Processes			Operator should carry out, for all abnormal, offnormal or alarm conditions, subsequent operator actions in the proper sequence through reference to applicable procedures.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	- Locate controls.	X		
	- Identify technical specifications limiting conditions for operation.		X	
	Cognitive Processes			
	- Maintain good judgment and problem-solving performance under stressful and/or hazardous environment.	X		

TABLE A.4 (continued)
CARRY OUT PROCEDURE FOR ABNORMAL, OFFNORMAL OR ALARM CONDITIONS

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
4. Carry out subsequent operator actions. (continued).	Cognitive Processes (continued)			
	- Compare and verify indications.	X		
	- Establish priorities.		X	
	- Coordinate actions.		X	
	- Maintain overall perspective; do not become totally involved in a single operation.		X	
	- Analyze plant conditions.	X		
	- Determine additional equipment and/or support required.		X	
	Communication Processes			
	- Inform personnel.	X		
	- Direct actions.	X		
	- Receive verbal reports.	X		
	- Recall personnel.		X	
	- Receive advice from STA and other technical personnel.		X	
	- Maintain written logs/reports.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters.	X		
	- Take manual (backup) control of normally automatic functions.	X		
	- Operate controls.	X		

TABLE A.5
CARRY OUT GENERAL PLANT OPERATING PROCEDURES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Recognize which procedure(s) are applicable to the required evolution.	Perceptual Processes			Operator, through reference to procedures and/or instructions, should be able to recognize all evolutions for which general plant operating procedures are applicable.
	- Identify intended evolution as being one addressed by general plant operating procedures.	X		
	Cognitive Process			
	- Determine applicable procedure.	X		
2. Establish initial conditions.	Perceptual Processes			Operator should establish, through reference to applicable procedures, initial conditions for all general plant operating procedures.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and locations.	X		
	- Locate controls.	X		
	- Read procedures and other applicable documents.	X		
	Cognitive Processes			
	- Compare and verify indications.	X		
	- Coordinate actions.		X	
	- Analyze plant conditions.	X		
	- Compare plant conditions to required initial conditions.		X	
	- Determine actions required (if any).		X	
	Communication Processes			
	- Inform personnel.	X		
	- Direct actions.	X		
	- Receive verbal reports.	X		
	- Maintain written logs/reports.	X		

TABLE A.5 (continued)
CARRY OUT GENERAL PLANT OPERATING PROCEDURES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
2. Establish initial conditions. (continued)	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters.	X		
	- Operate controls.	X		
	- Take manual control of system/component operation.	X		
3. Carry out steps of procedure.	Perceptual Process			Operator, through reference to procedures, should control and/or conduct all steps of plant operations procedures in proper sequence.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	- Locate controls.	X		
	- Read procedures and other applicable documents.	X		
	Cognitive processes			
	- Compare and verify indications.	X		
	- Coordinate actions.		X	
	- Analyze plant conditions.	X		
	- Determine actions required.		X	
	- Know technical specifications limits related to equipment/systems.	X		
	Communication Processes			
	- Authorize conduct of evolutions.		X	
	- Inform personnel.	X		
	- Direct actions.	X		
	- Receive verbal reports.	X		
	- Maintain written logs/reports.	X		

TABLE A.5 (continued)
CARRY OUT GENERAL PLANT OPERATING PROCEDURES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
3. Carry out steps of procedure. (continued)	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters.	X		
	- Operate controls.	X		
	- Take manual control of system/component operation.	X		

TABLE A.6
CARRY OUT ROUTINE NON-SPECIFIC SHIFT ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Conduct shift turnovers.	Perceptual Processes			Operator should conduct a complete and accurate shift turnover for all plant conditions. SRO should recognize those conditions for which a shift turnover is <u>not</u> appropriate.
	- Locate and read indicators and annunciators.	X		
	- Read written reports and logs.	X		
	Cognitive Processes			
	- Determine conditions that will require particular attention.	X		
	- Establish priorities.		X	
	- Determine conditions that preclude shift turnover.		X	
	Communications Processes			
	- Prepare written reports/logs.	X		
	- Request status information.	X		
	- Advise relief of unusual/abnormal conditions.	X		
	- Answer questions.	X		
2. Control routine liquid and gaseous radioactive waste releases.	Perceptual Processes			Operator should control all liquid and gaseous radioactive waste releases in accordance with station directives/procedures and ensure compliance with technical specifications limits.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	Cognitive Processes			
	- Calculate estimated release.	X		
	- Compare indications to calculated levels.	X		
	- Compare estimated releases to technical specifications limits.		X	
	- Plan releases for appropriate conditions.		X	

TABLE A.6 (continued)
CARRY OUT ROUTINE NON-SPECIFIC SHIFT ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
2. Control routine liquid and gaseous radioactive waste releases. (continued)	Communications Processes			
	- Authorize evolution.		X	
	- Inform personnel.	X		
3. Operate the plant computer.	Perceptual Processes			Operator should be proficient in all plant computer operations. Reference to procedures/instructions is acceptable.
	- Read computer displays.	X		
	- Locate appropriate information.	X		
	Cognitive Processes			
	- Choose the appropriate computer routines.	X		
	- Tabulate the necessary input information.	X		
	Communication Processes			
	- Format instructions properly.	X		
	Motor Processes			
	- Operate computer keyboard.	X		
4. Maintain logs and other routine written reports.	Perceptual Processes			Operator, through reference to station directives (if necessary), should maintain logs and other routine reports in a manner that is legible, clear and consistent with station policies.
	- Identify events/actions.	X		
	Cognitive Processes			
	- Determine whether written report/entries are appropriate.	X		
	Communication Processes			
	- Prepare written reports/entries.	X		
5. Complete Plant Incident Reports and/or other reports on abnormal occurrences.	Perceptual Processes			Operator, through reference to appropriate station directives, should determine abnormal events requiring written reports and prepare such reports in an easily understood manner consistent with station policies.
	- Identify events/actions.		X	

TABLE A.6 (continued)
CARRY OUT ROUTINE NON-SPECIFIC SHIFT ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
5. Complete Plant Incident Reports and/or other reports on abnormal occurrences. (continued)	Cognitive Processes			
	- Determine events requiring completion of a Plant Incident Report		X	
	- Determine causes, nature and sequence of events.		X	
	Communication Processes			
	- Request information required.		X	
	- Prepare written description.		X	
6. Coordinate shift activities to ensure safe, efficient conduct.	Perceptual Processes			Operator should have sufficient knowledge and understanding of all shift activities to identify interferences and safety implications (including radiation exposure). Operator should effectively plan shift activities without off-shift assistance.
	- Read descriptions of all intended/scheduled shift activities.		X	
	- Identify actions associated with shift activities.		X	
	Cognitive Processes			
	- Plan activities.		X	
	- Establish priorities.		X	
	- Maintain overall perspective; do not become totally involved in a single activity.		X	
	Communication Processes			
	- Inform affected personnel.		X	
	- Direct actions.		X	
	- Answer questions.		X	
	- Request information.		X	
7. Prepare and approve temporary instructions and changes to instructions on shift.	Perceptual Processes			Operator, through reference to applicable station directives, should prepare temporary instructions and procedure changes as well as identify where such changes are not authorized.
	- Identify events (actions requiring temporary procedures or changes to procedures).		X	

TABLE A.6 (continued)
CARRY OUT ROUTINE NON-SPECIFIC SHIFT ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
7. Prepare and approve temporary instructions and changes to instructions on shift. (continued)	Cognitive Processes			
	- Determine whether the procedure/change in procedure can be authorized on shift.		X	
	- Review procedure for safety/policy compliance.		X	
	Communication Processes			
	- Prepare a written procedure/change.		X	
8. Provide training for plant personnel.	Perceptual processes			Operator should provide effective instruction to plant personnel without jeopardizing plant safety or operation.
	- Observe actions of trainees.	X		
	Cognitive Processes			
	- Plan training evolutions.		X	
	- Determine whether training evolutions can be conducted on the plant.		X	
	- Evaluate the actions of personnel.	X		
	Communication Processes			
	- Direct actions.	X		
	- Simulate conditions/responses.	X		
	- Request information.	X		
	- Advise trainees on deficiencies observed.	X		
9. Comply with applicable station administrative directives.	Perceptual Processes			Operator should ensure, through reference to applicable directives (if required), compliance on shift with all station administrative directives.
	- Identify action or event desired/required.	X		
	Cognitive Processes			
	- Determine whether station directive applies.	X		

TABLE A.6 (continued)
CARRY OUT ROUTINE NON-SPECIFIC SHIFT ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
9. Comply with applicable station administrative directives. (continued)	Communication Processes			
	- Instruct other personnel to act as required.	X		
10. Maintain proper core physics.	Perceptual Processes			Operator should accurately and reliably perform reactor physics calculations through reference to applicable procedures and plant status information.
	- Locate and read indicators and annunciators.	X		
	- Read procedures and other applicable directives.	X		
	Cognitive Processes			
	- Compare and verify indications (control rods, power level, etc.) for signs of core power imbalance, quadrant power tilt, etc.	X		
	- Calculate parameters (shutdown margin, xenon reactivity changes, heat balance, estimated critical rod position, etc.).	X		
	- Determine technical specifications limiting conditions for operation.	X		
	Communication Processes			
	- Prepare written log/report entries.	X		
	- Inform personnel of results.	X		
	Motor Processes			
	- Operate computer/keyboard.	X		
11. Conduct valve/switch lineup checks.	Perceptual Processes			Operator should locate, operate and determine position of all valves/switches in the plant.
	- Locate components in the plant.	X		
	- Locate and read position indicators on plant components.	X		

TABLE A.6 (continued)
CARRY OUT ROUTINE NON-SPECIFIC SHIFT ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
11. Conduct valve/switch lineup checks. (continued)	Cognitive Processes			
	- Diagnose abnormal condition/operation of plant components.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		

TABLE A.7
CONTROL SHIFT MAINTENANCE ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Review proposed maintenance actions (for example, Work Request, Job Order or Maintenance Request).	Perceptual Processes			Operator should determine, through reference to technical specifications and/or other applicable directives and with his knowledge of plant status, which maintenance activities can be conducted for all plant conditions.
	- Read description of maintenance activity.		X	
	- Identify actions/conditions associated with activity.		X	
	Cognitive Processes			
	- Determine whether any plant conditions or other activities would preclude this activity.		X	
	Communication Process			
	- Request any additional information required.		X	
2. Establish plant conditions suitable for conduct of maintenance, and tag out appropriate components.	Perceptual Processes			Operator should establish, through reference to applicable directives, appropriate plant conditions for all plant-related maintenance activities.
	- Identify and locate components to be isolated and tagged.	X		
	- Inspect isolation/tag-out for correctness.		X	
	Cognitive Processes			
	- Choose components to be isolated to provide necessary safety.		X	
	- Choose operators to support activity in consideration of allowable radiation exposure.		X	
	Communication Processes			
	- Direct operator on how to isolate components/systems.		X	
	- Direct operator to prepare tags for identified components.		X	
	- Inform supervisor that tag-out/isolation is completed.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Operate controls.	X		
	- Control system parameters (pressure, levels, etc.).	X		

TABLE A.7 (continued)
CONTROL SHIFT MAINTENANCE ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
3. Approve proposed maintenance activities.	Perceptual Processes			Operator should determine, through review of isolation and knowledge of plant status, whether plant maintenance actions can be performed, for all plant conditions.
	- Identify that component(s) is(are) appropriately isolated.		X	
	- Identify possible conflicts/interferences.		X	
	Cognitive Processes			
	- Determine that plant conditions are suitable for conduct of maintenance.		X	
	Communication Processes			
	- Authorize conduct of evolution.		X	
4. Upon completion of maintenance actions, review re-test requirements.	Perceptual Processes			Operator should determine, through reference to re-test procedure and knowledge of plant status, whether any re-test can be conducted.
	- Identify that maintenance activity has been completed.		X	
	- Read re-tests requirements.		X	
	- Identify activities to be conducted.		X	
	Cognitive Processes			
	- Determine whether plant conditions or other activities would preclude re-test.		X	
	Communication Processes			
	- Request clarification and/or additional information.		X	
5. Establish plant conditions suitable for conduct of re-test.	Perceptual Processes			Operator should establish, through reference to re-test procedure and/or other applicable documents, plant conditions suitable for conduct of all re-tests.
	- Identify actions to be conducted (tags to be cleared, etc.).	X		
	- Locate components to be operated or positioned.	X		

TABLE A.7 (continued)
CONTROL SHIFT MAINTENANCE ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
5. Establish plant conditions suitable for conduct of re-test. (continued)	Cognitive Processes			
	- Analyze plant conditions.		X	
	- Choose operators to support activity in consideration of radiation exposure.		X	
	Communication Processes			
	- Direct operators to carry out actions (remove tags, position components, etc.).		X	
	- Inform personnel of actions.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Operate controls.	X		
	- Control system parameters (pressure, tank levels, etc.).	X		
6. Approve conduct of re-test.	Perceptual Processes			Operator should determine, through review of re-test procedure and knowledge of plant status, whether re-tests can be performed for all plant conditions.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	Cognitive Processes			
	- Determine that plant conditions are suitable for conduct of re-test.		X	
	Communication Processes			
	- Authorize conduct of evolution.		X	

TABLE A.7 (continued)
CONTROL SHIFT MAINTENANCE ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE: RO or SRO	INDIVIDUAL RESPONSIBLE: SRO ONLY	TRAINING OBJECTIVES
7. Conduct and/or monitor re-test including approval of results.	Perceptual Process			Operator, through reference to re-test procedure and/or other applicable documents, should conduct and/or monitor re-tests for all plant conditions.
	- Locate and read indicators and annunciators.	X		
	- Identify and display meanings and relationships.	X		
	- Read applicable procedure.	X		
	Cognitive Processes			
	- Compare and verify indications.	X		
	- Analyze plant conditions.	X		
	- Review completed written results.		X	
	Communication Processes			
	- Direct operator actions.	X		
	- Inform personnel of results.	X		
	- Complete written re-test report.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Operate controls.	X		
	- Control system parameters (pressure, tank levels, etc.).	X		
8. Return system/component to service.	Perceptual Processes			
	- Identify actions to be conducted.	X		
	- Identify and locate components in the plant.	X		
	Cognitive Processes			
	- Analyze conditions.	X		

TABLE A.7 (continued)
CONTROL SHIFT MAINTENANCE ACTIVITIES

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
8. Return system/ component to service. (continued)	Communication Processes			
	- Direct actions to be taken.	X		
	- Receive verbal reports.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Operate controls.	X		
	- Control system parameters (pressure, levels, etc.).	X		

TABLE A.8
CONTROL/CONDUCT SURVEILLANCE TESTS*

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
1. Review proposed surveillance tests.	Perceptual Processes			Operator, through reference to technical specifications, applicable directives, etc. and with knowledge of plant status, should determine which surveillance tests can be authorized.
	- Read description of surveillance test.		X	
	- Identify actions to be carried out.		X	
	Cognitive Processes			
	- Determine whether plant conditions, including possible interfering conditions, are appropriate for conduct of tests.		X	
	Communication Processes			
	- Request any additional information required.		X	
	- Receive verbal reports.		X	
2. Establish plant conditions suitable for conduct of surveillance and tag out components (if required).	Perceptual Processes			Operator should establish, through reference to applicable directives, appropriate plant conditions for any surveillance test.
	- Identify and locate components to be isolated/operated.		X	
	- Identify that components are properly positioned.		X	
	Cognitive Processes			
	- Choose components to be operated and/or tagged.		X	
	- Choose personnel for assignment in consideration of possible/allowable radiation exposure.		X	
	Communication Processes			
	- Direct actions to change plant status and/or tag out components.		X	
	- Inform personnel of completion of plant status change/tag-out.	X		

*It is recognized that some surveillance tests (for example, daily RO shift surveillances) may not require completion of all elements. This sequence of elements is intended to envelope all surveillances.

TABLE A.8 (continued)
CONTROL/CONDUCT SURVEILLANCE TESTS*

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
2. Establish plant conditions suitable for conduct of surveillance and tag-out components (if required). (continued)	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters.	X		
	- Operate controls.	X		
3. Approve conduct of surveillance tests.	Perceptual Processes			Operator should determine, for all surveillance tests, appropriate plant conditions (reference to procedures/directives is encouraged).
	- Identify that components are properly positioned/isolated.		X	
	Cognitive Processes			
	- Determine that plant conditions are suitable for conduct of test.		X	
	Communication Processes			
	- Inform appropriate personnel of approval and any cautions/conflicts.		X	
4. Conduct and/or assist technicians in conduct of surveillance test.	Perceptual Processes			Operator, through reference to applicable procedures, should conduct all surveillance tests that are assigned to RO/SROs. Operator should provide assistance to technicians in the conduct of other surveillance tests.
	- Locate and read indicators and annunciators.	X		
	- Identify display meanings and relationships.	X		
	- Read applicable procedure.	X		
	Cognitive Processes			
	- Calculate values.	X		
	- Analyze conditions.	X		

*It is recognized that some surveillance tests (for example, daily RO shift surveillances) may not require completion of all elements. This sequence of elements is intended to envelope all surveillances.

TABLE A.8 (continued)
CONTROL/CONDUCT SURVEILLANCE TESTS*

ELEMENTS	BEHAVIORS REQUIRED	INDIVIDUAL RESPONSIBLE		TRAINING OBJECTIVES
		RO or SRO	SRO ONLY	
4. Conduct and/or assist technicians in conduct of surveillance test. (continued)	Communication Processes			
	- Inform technicians/operators of alarms and indicators.	X		
	- Record results in writing.	X		
	- Direct technicians'/operators' actions.	X		
	- Request status information.	X		
	Motor Processes			
	- Position components (valves, switches, etc.).	X		
	- Control system parameters.	X		
	- Operate controls	X		
5. Determine whether completed surveillance test results are satisfactory.	Perceptual Processes			Operator should determine, through reference to acceptance standards, acceptable results for all surveillance tests.
	- Read completed test results.		X	
	Cognitive Processes			
	- Compare test results to acceptance standard (for example calibration curve).		X	
	- Identify technical specifications limiting conditions.		X	
	Communication Processes			
	- Inform personnel of results/completion.	X		
	- Prepare written reports of abnormal/reportable occurrences.		X	

*It is recognized that some surveillance tests (for example, daily RO shift surveillances) may not require completion of all elements. This sequence of elements is intended to envelope all surveillances.

APPENDIX B

PERFORMANCE PREDICTIVE INDICES

APPENDIX B

PERFORMANCE PREDICTIVE INDICES

B.1 Statistical Tests

Chi-square (χ^2) tests were used for categorical variables to test whether observed frequencies differed from those expected. If the sum of the squared differences exceeds a specified amount, a relationship exists. The specified amount depends on the number of degrees of freedom (df) and the probability of an error which is acceptable in making a decision. For all tests conducted in this study, a probability of less than 5 percent ($p<0.05$) was used in committing a type I error. A type I error is the error one would make in rejecting the null hypothesis of equivalence or independence when it is, in fact, true. Degrees of freedom refers to the number of observations that are free to vary after certain restrictions have been placed on them. For example, if a variable is dichotomous (possessing an attibute), (df=1), after χ per 'ent is placed in one-half of the dichotomy (those with the attribute), the remaining cases must be placed on the other half (those without the attribute) and are not free to vary.

Analysis of Variance (ANOVA) was used for all interval level (continuous) variables (years experience and test scores). The F-test is used to determine whether mean differences exist between groups, given that their variances are homogeneous. In all cases where the F-test was used, this assumption was checked using Bartlett's Test.

B.2 Data

The following frequencies were tested for independence using Chi-square:

SAMPLE	VARIABLE	PERFORMANCE RATING: BELOW AVERAGE	AVERAGE	ABOVE AVERAGE
	COLLEGE EDUCATION			
TOTAL	Some college	17	50	18
	No college	28	51	32
		$\chi^2 = 1.98$, df = 2, p = 0.37		
ROs	Some college	8	20	10
	No college	15	20	6
		$\chi^2 = 3.02$, df = 2, p = 0.22		
SROs	Some college	9	29	7
	No college	14	33	25
		$\chi^2 = 5.53$, df = 2, p = 0.06		
	MILITARY EXPERIENCE			
TOTAL	Military	33	69	38
	No military	12	31	13
		$\chi^2 = 0.52$, df = 2, p = 0.76		
ROs	Military	14	26	13
	No military	9	14	3
		$\chi^2 = 1.93$, df = 2, p = 0.38		
SROs	Military	19	45	24
	No military	3	16	10
		$\chi^2 = 1.92$, df = 2, p = 0.38		

SAMPLE	VARIABLE	PERFORMANCE RATING		
		BELOW AVERAGE	AVERAGE	ABOVE AVERAGE
	NAVY NUCLEAR EXPERIENCE			
TOTAL	Navy nuclear	29	57	31
	Non-Navy nuclear	16	43	20
		$\chi^2 = 0.74$, df = 2, p = 0.68		
ROs	Navy nuclear	11	19	9
	Non-Navy nuclear	12	21	7
		$\chi^2 = 0.38$, df = 2, p = 0.82		
SROs	Navy nuclear	18	39	20
	Non-Navy nuclear	4	22	14
		$\chi^2 = 3.33$, df = 2, p = 0.18		
	NAVY NUCLEAR RATE			
TOTAL	Machinist Mate	10	21	16
	Electronics Technician	2	9	6
	Electricians Mate	9	13	5
		$\chi^2 = 4.04$, df = 4, p = 0.4		
	FOSSIL POWER PLANT EXPERIENCE			
TOTAL	Fossil	11	13	8
	No fossil	34	88	42
		$\chi^2 = 3.05$, df = 2, p = 0.21		
SROs	Fossil	10	13	6
	No fossil	12	48	28
		$\chi^2 = 6.36$, df = 2, p = 0.04		
ROs	Test could not be run: 3 cells with expected frequencies less than 5.			

The following were tested with the F-statistic:

VARIABLE	SAMPLE	SOURCE	df	SS	MSS	F	SIGNIFICANCE
YEARS OF FOSSIL POWER PLANT EXPERIENCE	TOTAL	Total	31	600.87			
		Between	2	3.37	1.68	0.08	1.0
		Residual	29	597.5	20.6		
		Bartlett's Test[1]	2,1692.			2.4	0.08
YEARS AS AUXILIARY OPERATOR	TOTAL	Total	195	879.4			
		Between	2	7.55	3.78	0.83	0.43
		Residual	193	871.8	4.5		
		Bartlett's Test	2,63688.			1.13	0.32
	ROs	Total	78	363.4			
		Between	2	8.54	4.27	0.91	0.4
		Residual	76	354.9	4.67		
		Bartlett's Test	2,9274.			3.02	0.04[2]
	SROs	Total	116	468.8			
		Between	2	23.56	11.8	3.02	0.05
		Residual	114	445.3	3.9		
		Bartlett's Test	2,20439.			0.48	0.61
		Below-Average/ Average Contrast		16.67		4.269	0.03
		Below-Average/ Above-Average Contrast		21.7		5.5	0.01
YEARS AS REACTOR OPERATOR	TOTAL	Total	195	875.7			
		Between	2	3.5	1.76	0.38	0.67
		Residual	193	872.1	4.51		
		Bartlett's Test	2,63429.			2.75	0.06
	SROs	Total	116	427.69			
		Between	2	3.30	1.65	0.44	0.64
		Residual	114	424.38	3.7		
		Bartlett's Test	2,20120.			0.53	0.58
	ROs	Total	78	313.2			
		Between	2	27.4	13.7	3.6	0.03
		Residual	76	285.7	3.7		
		Bartlett's Test	2,9817.			0.33	0.71
		Below-Average/ Above-Average Contrast				7.26	0.007

[1] Bartlett's Test was used to test the homogeneity of variance assumption.
[2] Test violated assumption of homogeneous variances.

VARIABLE	SAMPLE	SOURCE	df	SS	MSS	F	SIGNIFICANCE
MEAN REQUALIFICATION SCORES	TOTAL	Total	173	6491.1			
		Between	2	80.5	40.2	1.07	0.35
		Residual	171	6410.6	37.4		
		Bartlett's Test	2,42604.			0.28	0.75
	SROs	Total	107	3806.8			
		Between	2	12.6		0.17	1.0
		Residual	105	3794.2	36.1		
		Bartlett's Test	2,18089.			0.14	1.0
	ROs	Total	67	2678.0			
		Between	2	201.5	100.76	2.64	0.07
		Residual	65	2476.5	38.1		
		Bartlett's Test	2,6653.			2.14	0.11
AGE	TOTAL	Total	193	9765.3			
		Between	2	58.6	29.3	0.57	0.56
		Residual	191	9706.7	50.8		
		Bartlett's Test	2,63021.			12.0	0.001[2]

[2] Test violated assumption of homogeneous variances.

APPENDIX C

IDENTIFICATION OF TRAINING CONTENT AND INSTRUCTIONAL SETTINGS

APPENDIX C

IDENTIFICATION OF TRAINING CONTENT AND INSTRUCTIONAL SETTINGS

Training objective worksheets were developed for each training objective category as shown below:

The following are definitions of terms used in this appendix:

Instructional Settings. (See Section 2.4.4.1.)

- o Classroom. Includes lectures, seminars, programmed instruction and self-study.

- o In Plant. Includes the use of any plant equipment for training, including the control room, fixed equipment outside the control room and portable equipment located in operating spaces. Walk-through training and actual operation of some equipment would be permitted, as long as these operations would not impact on the plant's ability to maintain its electrical load condition. (This limitation is placed on this setting since it is consistent with the limitation placed on actual in-plant training at all reactor sites visited.)

- o Plant-Specific Simulator. Intended to be a control room simulator that provides high fidelity to the actual plant in terms of system responses, instrumentation, controls and equipment locations.

- o Generic Simulator. Intended to be a control room simulator that has system responses generally similar to those of the actual plant; instrumentation, controls and equipment locations need not be similar.

Critical Requirement. (See Section 2.4.4.1.) The required skills and knowledges associated with responding to emergencies.

Duty Areas. (See Figure 2.5.) RO and SRO duties were segregated into the following duties areas:

- o Emergencies,
- o Abnormal, offnormal and alarm conditions,
- o Normal operations,
- o Routine, nonspecific shift activities and
- o Maintenance and surveillance.

A cross reference of the duty areas and associated task areas and generic elements of the Appendix A RO and SRO job task analysis are provided in foldout Table C.10. Table C.10 can be used as a reference when reviewing Tables C.1 through C.9.

TABLE C.1
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: PRINCPLES OR THEORIES)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
1. Knowledge of health physics principles o Sources o Biological effects o Radiation protection o Contamination control o Personnel monitoring o Detection	C				Yes	X		All duty areas
2. Mathematics fundamentals o Algebra o Logarithms o Exponentials o Trigonometry o Probability and statistics o Basic calculus o Differential equations	C				Yes	X		All duty areas
3. Chemistry o Corrosion o Primary water chemistry o Steam generator water chemistry	C				Yes	X		All duty areas
4. Basic nuclear physics and reactor theory o Atomic structure o Radioactive emission o Nuclear emissions o Fission o Fission products o Moderation o Flux distribution o Reactivity o Subcritical multiplication	C				Yes	X		All duty areas

C - Suitable for complete training of designated skill or knowledge.

TABLE C.1 (continued)
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: PRINCIPLES OR THEORIES)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
5. Instrumentation and control o Temperature o Pressure o Level and flow measurement o Failure modes and indications o Control logic	C				Yes	X		All duty areas
6. Nuclear instrumentation o Detector design o Failure modes and indications	C				Yes	X		All duty areas
7. Electricity o Transmission o Generators o Electrical buses o Interlocks o Relays o Motors and generators	C				Yes	X		All duty areas
8. Heat transfer, fluid flow and thermodynamics o Core hydraulics o Natural circulation o Heat exchangers o Boiling water heat transfer o Saturation conditions o Moellier diagram	C				Yes	X		All duty areas

C - Suitable for complete training of designated skill or knowledge.

TABLE C.1 (continued)
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: PRINCIPLES OR THEORIES)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
9. Electro-mechanical systems and components o Piping o Heat exchangers o Pumps o Valves o Motors o Fans o Operating characteristics	C				Yes	X		All duty areas
10. Safety precautions o Electrical o Hazardous chemicals o Radioactive materials o Security o Fire protection	C				Yes	X		All duty areas

C - Suitable for complete training of designated skill or knowledge.

TABLE C.2
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: COMMUNICATION SKILLS)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
1. Inform personnel	P	C	P	P	Yes	X		Emergencies
	P	C	P	P	No	X		Abnormal, normal, maintenance and surveillance
2. Direct actions		C	P	P	Yes	X		Emergencies
		C	P	P	No	X		Normal, routine, maintenance and surveillance
3. Recall plant personnel	P	C			Yes		X	Emergencies
	P	C			No		X	Abnormal
4. Recommend actions to appropriate authorities	P	C	C	C	Yes		X	Emergencies
5. Maintain written logs and reports	P	C			No	X		All duty areas
6. Receive verbal reports		P	P	P	Yes	X		Emergencies
		P	P	P	No	X		All other duty areas
7. Authorize conduct of evolutions		C	P	P	No		X	Normal, routine, maintenance and surveillance
8. Request status information		C			No	X		Routine, maintenance and surveillance
9. Advise relief of unusual or abnormal conditions		C			No	X		Routine
10. Answer questions		C			No	X		Routine
11. Prepare written descriptions of abnormal or reportable occurrences in accordance with applicable directives	P	C			No		X	Routine, maintenance and surveillance
12. Read applicable procedures, directives, electrical prints, flow diagrams, piping diagrams, etc.	C				No	X		Routine, maintenance and surveillance

P - Suitable for partial training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for complete training of designated skill or knowledge.

TABLE C.2 (continued)
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: COMMUNICATION SKILLS)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
13. Prepare temporary changes in procedures on shift	P	C			No		X	Routine
14. Simulate plant conditions and responses while training personnel		C			No	X		Routine
15. Advise trainees on deficiencies noted		C			No	X		Routine

P - Suitable for partial training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for complete training of designated skill or knowledge.

TABLE C.3
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: MANAGEMENT AND LEADERSHIP)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIREMENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASSROOM	IN PLANT	PLANT SPECIFIC SIMULATOR	GENERIC SIMULATOR				
1. Plan shift activities	P	C			No		X	Routine
2. Evaluate the actions of personnel	P	C			No	X		Routine
3. Comply with and ensure that personnel comply with station directives	P	C			No	X		Routine
4. Maintain overall perspective; do not become totally involved in a single operation			C	C	Yes		X	Emergencies
			C	C	No		X	Abnormal
		C			No		X	Routine
		C			Yes		X	Emergencies (Emergency Plan)
5. Knowledge of how to conduct training evolutions on shift	P	C			No	X		Routine

P - Suitable for partial training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for complete training of designated skill or knowledge.

TABLE C.4
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: APPLICATION OF CONCEPTS AND PRINCIPLES)

	APPROPRIATE INSTRUCTIONAL SETTINGS							
SKILLS AND KNOWLEDGES REQUIRED	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR	CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
1. Calculate radiation levels and doses, stay times, etc.	C				Yes		X	Emergencies
2. Identify results of area radiation surveys and air samples	C	C			Yes	X		Emergencies
3. Compare indications to calculation and acceptance standard		C			No	X		Routine, maintenance and surveillance
4. Plan routine radwaste release for appropriate conditions	P	C			No		X	Routine
5. Identify actions associated with shift activities	P	C			No		X	Routine, maintenance and surveillance
6. Calculate plant parameters (shut-down margin, xenon reactivity changes, heat balance, estimated critical rod position, etc.)	C				No	X		Routine, maintenance and surveillance
7. Choose components to isolate that will provide necessary safety	P	C			No	X		Maintenance and surveillance
8. Inspect isolation and tagout for correctness		C			No		X	Maintenance and surveillance
9. Choose operators to support activities in consideration of allowable radiation exposures		C			No		X	Maintenance and surveillance

P - Suitable for partial training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for complete training of designated skill or knowledge.

TABLE C.5
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: REASONING AND PROBLEM-SOLVING ABILITIES)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
1. Establish priorities			C	C	Yes		X	Emergencies
			C	C	No		X	Abnormal
		C			No		X	Routine
		C			Yes		X	Emergencies (Emergency Plan)
2. Use decision rules			C	C	Yes		X	Emergencies
3. Maintain good judgment and problem-solving performance under stressful or physically hazardous environment			C	C	Yes	X		Emergencies
			C	C	No	X		Abnormal
		C			Yes	X		Emergencies (Emergency Plan)
4. Identify cues (one or more indications) of any emergency condition (NOTE: any of the five senses may be used.)			C		Yes	X		Emergencies
		C			Yes	X		Emergencies (Emergency Plan)
5. Determine that cues are <u>not</u> completely addressed by any single procedure			C		Yes	X		Emergencies
6. Determine whether multiple casualties have occurred			C	C	Yes	X		Emergencies
7. Identify cues as indicative of an abnormal, offnormal or alarm condition			C		No	X		Abnormal
8. Determine conditions that preclude shift activities (turnover, training evolutions, maintenance, etc.)	P	C			No		X	Routine, maintenance and surveillance
9. Determine conditions that require special attention		C			No	X		Routine

P - Suitable for <u>partial</u> training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for <u>complete</u> training of designated skill or knowledge.

TABLE C.5 (continued)
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: REASONING AND PROBLEM-SOLVING ABILITIES)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
10. Identify events and actions requiring written reporting (abnormal and reportable occurrences)	P	C			No		X	Routine
11. Diagnose abnormal conditions and operation of plant components		C			No	X		Routine
			C		No	X		Abnormal
12. Determine additional equipment or support required to combat emergencies		C			Yes		X	Emergencies (Emergency Plan)
13. Analyze plant conditions			C	C	Yes	X		Emergencies
			C	C	No	X		Abnormal and normal
		C			No	X		Maintenance and surveillance

P - Suitable for partial training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for complete training of designated skill or knowledge.

TABLE C.6
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: PROCEDURAL COMPLIANCE)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIREMENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASSROOM	IN PLANT	PLANT SPECIFIC SIMULATOR	GENERIC SIMULATOR				
1. Coordinate actions of two or more procedures			C		Yes		X	Emergencies
2. Carry out actions of the Emergency Plan and emergency operating procedures		C			Yes			Emergencies (Emergency Plan)
			C		Yes	X		Emergencies (emergency operating procedures)
3. Determine steps or procedures for emergency conditions, given applicable cues		C			Yes	X		Emergencies (Emergency Plan)
			C		Yes	X		Emergencies (emergency operating procedures)
4. Identify technical specification limiting conditions for operation without reference to procedures	P		C		Yes	X		Emergencies
	P		C		No	X		Abnormal
	P	C			No	X		Routine, maintenance and surveillance
5. Determine applicable abnormal, offnormal or alarm procedures, given any applicable cues			C	C	No	X		Abnormal
6. Carry out actions of abnormal, off-normal and alarm procedures in proper sequence through reference to procedures			C		No	X		Abnormal
7. Carry out all evolutions addressed by normal operating procedures in proper sequence through reference to procedures			C		No	X		Normal
8. Know whether procedure or change to procedure can be authorized on shift	P	C			No		X	Routine

P - Suitable for partial training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for complete training of designated skill or knowledge.

TABLE C.6 (continued)
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: PROCEDURAL COMPLIANCE)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
9. Review completed written procedures (maintenance surveillance, startup checklists, etc.)	P	C			No		X	Maintenance and surveillance

P - Suitable for partial training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for complete training of designated skill or knowledge.

TABLE C.7
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: EXECUTION OF TEAM SKILLS)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
1. Receive advice from STA and other technical personnel			C	C	Yes		X	Emergencies
			C	C	No		X	Abnormal
		C			Yes		X	Emergencies (Emergency Plan)
2. Coordinate actions of all shift personnel			C	C	Yes		X	Emergencies
			C	C	No		X	Abnormal and normal
		C			Yes		X	Emergencies (Emergency Plan)

C - Suitable for complete training of designated skill or knowledge.

TABLE C.8
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: OPERATION AND FUNCTIONING OF EQUIPMENT/SYSTEMS)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIREMENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASSROOM	IN-PLANT	PLANT SPECIFIC SIMULATOR	GENERIC SIMULATOR				
1. Locate and read indicators and annunciators		C	C		Yes	X		Emergencies
		C	C		No	X		Abnormal, normal, routine, maintenance and surveillance
2. Identify display meanings and relationships		C	C	C	Yes	X		Emergencies
		C	C	C	No	X		Abnormal, normal, maintenance and surveillance
3. Locate controls		C	C		Yes	X		Emergencies
		C	C		No	X		Abnormal, normal
4. Compare and verify indications			C	C	Yes	X		Emergencies
			C	C	No	X		Abnormal, normal, routine
5. Locate and operate portable equipment (air samplers, radiation monitors, dosimeters, respirators, etc.)	P	C			Yes	X		Emergencies
6. Operate plant computer		C	C		No	X		Routine
7. Observe actions of a trainee (on [illegible]ft)		C			No	X		Routine
8. Identify and locate components in the plant		C			No	X		Routine, maintenance and surveillance
9. Identify that components are properly isolated/positioned	P	C			No	X		Maintenance and surveillance
10. Know all technical specifications limits and bases related to equipment/systems	C				Yes	X		Emergencies
11. For all primary secondary, electrical and instrumentation systems, understand: o Purpose, o Functions, o Operation, o Interrelationships, o Limitations and o Design basis	C				Yes	X		All duty areas

P - suitable for partial training of designated skill or knowledge; other setting required to ensure complete training
C - suitable for complete training of designated skill or knowledge

TABLE C.9
TRAINING OBJECTIVES WORKSHEET
(TRAINING OBJECTIVE CATEGORY: MANUAL OR MANIPULATIVE OPERATIONS)

SKILLS AND KNOWLEDGES REQUIRED	APPROPRIATE INSTRUCTIONAL SETTINGS				CRITICAL REQUIRE-MENT?	RO AND SRO	SRO ONLY	DUTY AREA
	CLASS-ROOM	IN PLANT	PLANT SPECIFIC SIMU-LATOR	GENERIC SIMU-LATOR				
1. Position components (valves, switches, etc.)			C		Yes	X		Emergencies
			C		No	X		Normal and abnormal
		C				X		Routine, maintenance and surveillance
		P	P		Yes	X		Emergencies (Emergency Plan)
2. Control system parameters (pressure, temperature, level, etc.)			C		Yes	X		Emergencies
			C		No	X		Abnormal and normal
		C			No	X		Maintenance and surveillance
3. Take manual (backup) control of normally automatic functions			C		Yes	X		Emergencies
			C		No	X		Abnormal and normal
4. Operate nonautomatic controls			C		Yes	X		Emergencies
			C		No	X		Abnormal and normal
		C			No	X		Maintenance and surveillance
5. Perform necessary manual and manipulative operations outside the control room (for example, emergency shutdown, refueling equipment)		C			Yes	X		Emergencies
		C			No		X	Normal

P - Suitable for <u>partial</u> training of designated skill or knowledge; other setting required to ensure complete training.
C - Suitable for <u>complete</u> training of designated skill or knowledge.

TABLE C.10
RO/SRO TASK ANALYSIS SUMMARY

DUTY AREAS	TABLE NO.*	TASK AREAS AND GENERIC ELEMENTS
Emergencies	A.1	Carry Out Emergency Actions not Completely Addressed by Procedures A.1.1 Recognize conditions as indicative of an emergency condition A.1.2 Carry out appropriate actions
	A.2	Carry Out Procedures of Emergency Plan A.2.1 Recognize conditions requiring implementation of the emergency plan A.2.2 Carry out applicable actions of emergency plan
	A.3	Carry Out Emergency Operating Procedures A.3.1 Recognize plant conditions requiring implementation of emergency operating procedures A.3.2 Recognize automatic actions A.3.3 Carry out immediate operator actions A.3.4 Carry out subsequent operator actions
Abnormal, offnormal and alarm conditions	A.4	Carry Out Procedures for Abnormal, Offnormal or Alarm Conditions A.4.1 Recognize a condition requiring implementation of these procedures A.4.2 Know the automatic actions associated with these conditions and determine whether these actions have occurred A.4.3 Carry out immediate operator actions A.4.4 Carry out subsequent operator actions
Normal operations	A.5	Carry Out General Plant Operating Procedures A.5.1 Recognize which procedure(s) are applicable to the required evolution A.5.2 Establish initial conditions A.5.3 Carry out steps of procedure
Routine, non-specific shift activities	A.6	Carry Out Routine, Non-Specific Shift Activities A.6.1 Conduct shift turnovers A.6.2 Control routine liquid and gaseous radioactive waste releases A.6.3 Operate the plant computer A.6.4 Maintain logs and other routine written reports A.6.5 Complete Plant Incident Reports and other reports on abnormal occurrences A.6.6 Coordinate shift activities to ensure safe, efficient conduct A.6.7 Prepare and approve temporary instructions and changes to instructions on shift A.6.8 Provide training for plant personnel A.6.9 Comply with applicable station administrative directives A.6.10 Maintain proper core physics A.6.11 Conduct valve and switch lineup checks
Maintenance and surveillance	A.7	Control Shift Maintenance Activities A.7.1 Review proposed maintenance actions A.7.2 Establish plant conditions suitable for conduct of maintenance, and tag out appropriate components A.7.3 Approve proposed maintenance activities A.7.4 Upon completion of maintenance actions, review retest requirements A.7.5 Establish plant conditions suitable for conduct of retest A.7.6 Approve the conduct of retest A.7.7 Conduct or monitor retest including approval of results A.7.8 Return system or component to service
	A.8	Control/Conduct Surveillance Tests A.8.1 Review proposed surveillance tests A.8.2 Establish plant conditions suitable for conduct of surveillance and tag out components (if required) A.8.3 Approve conduct of surveillance tests A.8.4 Conduct or assist technicians in conduct of surveillance test A.8.5 Determine whether completed Surveillance Test results are satisfactory

*Table in Appendix A that addresses that task area.

APPENDIX D

REVIEW OF NUREG/CR-1280, "POWER PLANT STAFFING"

APPENDIX D

REVIEW OF NUREG/CR-1280, "POWER PLANT STAFFING"

The NRC tasked Analysis & Technology to review NUREG/CR-1280, "Power Plant Staffing," (25) with respect to U.S. Navy practices for initial training and requalification of operators whose duties are similar to those of NRC licensed reactor operators and senior operators. This appendix satisfies the above requirement by providing a review of the findings and recommendations of Sections V and VI of NUREG/CR-1280. In addition, the NUREG/CR-1280 recommendations were considered regarding their applicability to the selection, screening, training and requalification of ROs and SROs as discussed in Chapter 2 of this report.

D.1 REVIEW COMMENTS

As indicated in the preface of NUREG/CR-1280, the author's basis for evaluating civilian nuclear power plant practices were documents from three utilities and his background knowledge of such practices. The judgments were not based upon visits to any commercial nuclear power plants. While the author acknowledges this limitation in the preface, in the body of the report he makes generalities concerning industry-wide practices that are not justified. In our visits to nine different power plants and six different training centers, we found some utility practices that were consistent with the author's findings; however, there are also other utilities whose practices concerning the certification, training and requalification of personnel equalled or exceeded Navy nuclear practices and requirements in the similar areas; in other words, the commercial utility practices that the author presents as norms are instead, worst-case practices.

NUREG/CR-1280 does not present a balanced view or comparison between Navy nuclear programs and civilian utility programs. Without exception, the author holds up Navy nuclear practices as the ideal and recommends that the civilian nuclear industry implement similar procedures and practices. We do not agree that an across-the-board transfer of requirements from the Navy nuclear program to the commercial industry is appropriate. For example, we find that the commercial industry has the potential for superior training in responding to emergencies and mitigating the consequences of major accidents due to the availability of simulators for operator training. Our analysis indicated that simulators are the most important aid for both training and evaluation of reactor operators.

While the author provides some valuable recommendations for the commerical nuclear industry, we do not recommend an across-the-board implementation of these recommendations. The following are specific comments concerning NUREG/CR-1280 findings and recommendations related to ROs and SROs (Sections V and VI of NUREG/CR-1280):

1. NUREG/CR-1280 Finding/Recommendation (Section V.C.1 on page 17)

> Industry generally follows the NRC requirements for the selection, training and qualification of its licensed reactor operators. While not legally required to do so, industry follows the guidance as contained in Revision 2 to Regulatory Guide 1.8 and ANSI 3.1 1978. However, there is wide variation throughout the industry as to the extent to which any of these requirements are enforced. There is also wide variation as to the degree of management involvement in the process. Many of the problems in this area have been pointed out in the Report by the President's Commission on the Accident at Three Mile Island.

Review Comments

We agree with this finding (see Section 2.4).

2. NUREG/CR-1280 Finding/Recommendation (Section V.C.2 on page 18)

> Based on a limited review of reactor operators, the most serious industry deficiency lies in the area of training -- not in the selection process. Most utilities do not have an in-house capability to conduct the required training. Consequently, it is contracted out to either the major reactor plant vendors or to companies providing training services. In doing so, the utilities have generally accepted whatever was provided with the assumption that the product they were paying for somehow met the requirements. On the other hand, the training contractors have generally taken the position, much like any educational institution, that they make the information available and it is up to the student to absorb it. They have also been content to wait for the utilities to tell them if they were producing an

acceptable product. The net result has been that responsibility for proper training has become diffuse. The only measure of success or failure of a training program has fallen on the NRC in its licensing process, i.e., did the student pass the examination? Unfortunately, the NRC licensing process has not been structured to permit the making of such judgments.

Too often the utilities fall back on the very dangerous defense that their training and qualification program must be adequate because they have not had a Three Mile Island accident.

Review Comments

As indicated in Sections 2.4 and 2.6, we found that some utilities directed their training programs toward passing the NRC operator licensing examinations and used success on these examinations as the measure of their programs. We are concerned with this practice, particularly in light of the limitations with the present operator licensing examinations identified in Section 2.6.

On the other hand, there are other utilities who have programs that significantly exceed NRC requirements. While these organizations place emphasis on their personnel passing examinations, they feel, rightfully, that their standards are well above NRC examination requirements.

3. NUREG/CR-1280 Finding/Recommendation (Section V.C.3 on page 18)

Another industry practice which, in the opinion of the reviewers, has created a degree of over-confidence in its training programs, is the use of academicians to evaluate their programs. In addition to their inability to comprehend the needs of the end product, these educationalists have introduced a plethora of new and "easy" methods of instruction, all of which sound and appear impressive, but have substantially detracted from the basic concepts of learning and understanding. For example, while the use of video-tapes for teaching may have a place, over-reliance on them, to the exclusion of qualified instructors, is dangerous. This forces the student and the training system to be geared to merely passing examinations rather than to insuring full comprehension of the multitude of complex operations and the consequences of improper actions. The proper training of reactor operators requires many hours of direct instructor-student interface wherein the instructors, who must themselves be qualified, make sure the students understand, and that classroom discussions broaden the scope of the lesson. There is no place in training reactor operators for an independent, self-pacing form of teaching.

Review Comments

The author indicates that industry practice has been to use academicians to evaluate their training programs. The authoı finds this to be a problem. Our site visits do not support this conclusion; if anything, our evaluation indicates that professional personnel with training or education in instructional methods are used too little in utility operator training programs. The training staffs of utilities are made up almost exclusively of personnel who have been operators. These personnel have been instructing based upon information that they gained through their participation as trainees in their utilities' training programs. They have been given little, if any, training in instructional methods and have infrequently been evaluated concerning their instructional methods or been given guidance on how to prepare instructional materials such as lesson plans, examinations, etc.

4. NUREG/CR-1280 Finding/Recommendation (Section V. E.1 on pages 21 and 22)

> It appears that insofar as the civilian industry and NRC are concerned, the question that needs to be addressed is: simulators being properly used to train operators? In the opinion of the reviewers, the answer is no. However, the reasons are not obvious or simple.
>
> First, recognition must be given to the comments provided in paragraphs V.C.2 and V.C.3. *(Items 2 and 3).* As long as these two conditions prevail, simulator courses, regardless of how well-structured they may be, can not perform their proper function. The student must be properly prepared ahead of time to take the simulator course. The simulator instructors must use the simulator to build on the previously learned knowledge of the student to allow him to see and understand the intricacies and interrelationships of many changing parameters of the plant. Today simulator training amounts to little more than a necessary check-off item on a list of things a student must do. Cases have been recently reported where students needed merely to be present in a simulator room during its operation to obtain the necessary credits.
>
> It is clear that the civilian industry must rely on simulators for training. However, it is not clear that industry has done what is necessary to make effective use of them.
>
> NRC should revise its training requirements to ensure that the utilities are fully responsible for all phases of their training programs. This means that even when they contract out any phase of training, they still must themselves be satisfied with the curriculum, the lesson plans, the instructors, the examining process, etc. Neither the utilities nor NRC should tacitly assume that because trainees attend a simulator course at one of the large

contractor-run training sites, it is necessarily providing the required training. For example, utility people qualified to operate their particular plants should be at the simulator and should, to the extent possible, be in charge of the training.

Each group of utility operator trainees should be accompanied to the simulator site by a qualified senior operator from the utility. He would be responsible for the performance of the trainees. He would be responsible to make the judgment that a trainee has satisfactorily completed the simulator phase of training. He would be required to sign-off this completion.

Utilities should insist that their people get sufficient time on the simulators to obtain individualized instruction on all required operations. This may mean that simulator operation be made available around the clock, seven days a week.

Review Comments

The author indicates that, in his opinion, simulators have not been properly used for training of civilian power plant operators. We agree with this conclusion. He further recommends that, for simulator training that is conducted on vendor simulators, utility licensed operators should participate in this training and make judgments on whether the trainee has satisfactorily completed the simulator evolutions. It was noted that, this practice was followed at some utilities, most commonly for situations where plant personnel were not training on a plant-specific simulator. We concur with the author's recommendation for utility personnel to participate in simulator training - at least for those facilities that do not have plant-specific simulators.

These utility operators should have responsibility not only for evaluating the trainee's performance on the simulator but also for identifying for trainees differences between the simulator response and controls and those at their plants. In this manner, simulator training on generic simulators could be made more effective.

5. NUREG/CR-1280 Finding/Recommendation (Section V.E.2 on page 23)

The proper functioning of the recently formed Institute of Nuclear Power Operations (INPO) should go a long way in resolving this problem. It is important that the relationships which will be established between NRC, INPO and the industry be such that its net result is to operate reactors safely and not one of creating another organization which could cloud the issues.

Review Comments

While we concur with this recommendation, we also feel it is important that neither the NRC nor the utilities sit back and wait for INPO to solve their problems. There are no easy solutions to the problems facing the industry. Only through a dedicated effort by all concerned will these problems be resolved.

6. NUREG/CR-1280 Finding/Recommendation (Section V.E.3 on pages 23 and 24)

> NRC should revise its requirements such that a utility company would have the prospective employee sign a waiver of the Privacy Act, thus permitting the utility to obtain information from past employees and law enforcement agencies. For licensed operators the NRC could, by changing its regulations, make it a punishable offense for an applicant to lie or withold information on his application for a license.

Review Comments

We concur and have included this recommendation in Section 2.5.1.7.

7. NUREG/CR-1280 Finding/Recommendation (Section V.E.4 on page 24)

> The Navy enforces a "no tolerance" policy on the use of illegal drugs by its operators. It is a difficult policy to enforce but it is done to their best ability. The NRC should look into the ramifications of instituting a similar policy. There are many legal and other problems in doing this. However, the NRC being silent on this issue, allows the utilities to ignore it completely. It is highly unlikely utilities will take this issue on without NRC pressure.

Review Comments

We agree that there should be policies on drug usage by operators. We do not agree that action will not occur in this area without NRC action. It is noted that at least one utility has instituted a policy of periodically taking urine samples from plant operators. Most utilities have administrative requirements that prohibit the use of alcohol or other narcotics or drugs on the utilities' premises by any personnel.

8. NUREG/CR-1280 Finding/Recommendation (Section V.E.5 on page 24)

> In its selection process for enlisted operators, the Navy uses written examinations as a means to determine acceptance into the program. These are standard Navy examinations (ARI/GCT) which test the applicant for general intelligence, basic math skills, reading ability, mechanical ability and comprehension. The scores from the two tests are totalled and a person must have a certain combined score before he can be accepted as a Nuclear Field Recruit. These types of tests have been used for over twenty-five years by the Navy and there is a good correlation between test results and nuclear training results. There is no comparable system used in the nuclear industry. In fact, because of some union arrangements, such tests are prohibited. This is something the utilities would find to their advantage once they reach the point of enforcing their training requirements. NRC does need to require such pre-employment tests. Its primary purpose is to avoid wasting time and money on people who you could predict won't make it. Here again, this is an area that INPO can assist.

Review Comments

As indicated in Section 2.5, while we concur that utilities should use valid and reliable aptitude tests for prospective operators, we do not concur that the NRC should require such tests. This is not an issue that is related to safety and therefore is not within the NRC's jurisdiction.

9. NUREG/CR-1280 Finding/Recommendation (Section V.E.6 on page 25)

> NRC should tighten up its requirements and by doing so, the utilities might follow the lead. If a person fails the licensing examination twice, that ought to be the end. No waivers should be permitted.

Review Comments

The author indicates that utilities, having once hired an individual, will generally tolerate any level of performance and that people who fail tests or courses are merely sent back to repeat them until they eventually pass. Based upon this finding, the author recommends that, "if a person fails the licensing examination twice, that ought to be the end. No waivers should be permitted." Our site visits indicated that utilities did fail personnel from their operator training courses and that only rarely did an individual take an examination more than twice. Some utilities had a policy of permitting personnel to take the examination only once -- if they failed, they were then relegated to the position of auxiliary operator for the remainder of their career. Based upon these results, we do not see a need for the NRC to require that the examinations be taken only twice. The industry appears to be satisfactorily self-policing in this area.

10. NUREG/CR-1280 Finding/Recommendation (Section VI. C.1 on pages 29 and 30)

Our recommendation is to create a new position entitled "Shift Engineer." He would be a degreed engineer who would normally function within the technical organization but is assigned to the Operations Manager to provide shift engineering coverage. This position is created for the following purposes and reasons:

a. If it is assumed that the requirements for becoming a shift supervisor (senior reactor operator) remain such that he need not be an experienced engineer (college graduate type), then there exists the need for such a person on shift who can make engineering judgments. This would be the function of the Shift Engineer.

b. The possibility exists to change the requirements for a shift supervisor such that he must be a college graduate engineer. This alternative was not selected because it would close off an advancement path for reactor operators. While some may consider this to be a minor issue, the reviewers, based on their Navy experience, do not. The civilian nuclear power industry must be able to provide an attractive career path for reactor operators or else face the prospect of heavy turnover or lower quality applicants.

c. There is also the suggestion that the position of Shift Engineer be filled only when a shift supervisor is not an engineer, or that the Shift Engineer position be an interim measure until such time as all shift supervisors meet the engineer eligibility requirements or their equivalent. We do not agree with this approach. Regardless of whether or not a shift supervisor is an engineer, there should always be present in the control room an engineer whose primary interest, background and experience is technical in nature.

d. The functions of the Shift Engineer would be as follows:

   (1) He acts as a technically qualified observer to plant operations.

(2) He has the power to order the plant put into a safe condition in the event of an emergency.

(3) He does not report to the Shift Supervisor -- he is an independent observer similar to the NRC inspector on shift. However, he has the power and responsibility to direct the Shift Supervisor in the event of an emergency or accident.

(4) He has the wherewithal to contact appropriate technical personnel to obtain technical assistance, thus allowing the Shift Supervisor to focus his attention on plant operation.

(5) If, during the course of normal operations, it is discovered that a given procedure requires modification, the Shift Engineer has the responsibility to resolve the problem, correct the procedures in accordance with approved methods, and to provide the results to the Shift Supervisor for his accomplishment.

e. The Shift Engineer would be a licensed Senior Reactor Operator and will have had operating experience as outlined in Table 2 of this report *("2 years engineering experience")*.

Review Comments

The author recommends a new position entitled "Shift Engineer." This position is the same position as the Shift Technical Advisor under current NRC requirements. The primary difference between the author's recommendation and the current NRC requirements is that he recommends that this person be assigned regardless of whether the Shift Supervisor has a degree or college-level training. He further recommends that this individual should be licensed as a senior reactor operator. While we concur that an SRO-qualified person with college-level training in the appropriate subject areas should be in a control room at all times, we see no advantage to this person's being a separate individual from that person responsible for supervising control room operations. Neither Navy nuclear nor foreign civilian nuclear power plants have such an individual in their shift organizations.

11. NUREG/CR-1280 Finding/Recommendation (Section VI. C.2 on page 30)

In the Navy, a normal watch is four hours. Depending on the size ship, number of qualified people, etc., ships will have on the average four watch sections. Thus, a man will stand a four hour watch, will be off for twelve hours and will then be back in for his four hour watch. This tends to keep the watch-stander alert during what is normally an eventless period of time. The Navy prohibits a watch longer than six hours. During his off-watch time he will carry out his divisional duties, sleep, eat, etc.

While our review did not extend into other operations, we are sure there are many other similar type jobs that have been analyzed to determine the maximum length of time one can expect a person to remain alert in situations where there is little activity or functions to be performed other than monitoring indicators.

NRC should find out what this attention span is from other sources and if it is less than eight hours, consideration should be given to establishing a maximum requirement. The fact that utilities use civilians, and civilians will normally work an eight-hour day, five days a week, should not be an argument against such a requirement. While it may take more people, there are many jobs that off-watch personnel can perform such as training, maintenance, record reviews, inspections, etc. This approach serves more than one useful purpose.

Review Comments

It is our experience that many Navy watches, particularly in the Navy nuclear submarine program, are 6 hours in length and it is also not uncommon for personnel at some watch stations to be on a "two-section" rotation (that is, 6 hours on watch and 6 hours off watch). While we do not find fault with 8-hour watches currently assigned to plant personnel at most utilities, we do not agree with the practice of some utilities that have personnel stand back-to-back 8-hour shifts when an operator from a relieving shift does not report due to sickness, etc. Utilities should have firm requirements that personnel stand no more than 12-hour shifts, and that they have at least as much time off between shifts as the length of their shifts.

12. NUREG/CR-1280 Finding/Recommendation (Section VI. C.3 on page 31)

In the Navy, watch-standers, especially EOOW's, know that they will spend only a finite period of time on shift-type duties. This time varies but it is usually not more than 3 or 4 years. One of the most often heard complaints in the Navy and in the industry is their dislike of shift-work. Generally people do not like working back-shifts. In the type operation we are concerned with, shift work is a given condition and must be dealt with. The Navy tries to handle this problem by either advancing people up to non-shift work or by rotation. NRC with INPO assistance should encourage the utilities to face up to this problem.

Review Comments

Based upon the operator comments provided in response to our satisfaction and motivation questionnaire and personal interviews, rotating shifts are a major source of operator dissatisfaction. This subject is discussed further in Section 2.9.2.

APPENDIX E

RO/SRO JOB SATISFACTION QUESTIONNAIRE

APPENDIX E
RO/SRO JOB SATISFACTION QUESTIONNAIRE

The following questionnaire was administered to RO and SRO licensed operating personnel at the reactor sites visited. A detailed evaluation of the responses to this questionnaire will be provided in the final report in Section 2.9, "Compensation, Status and Motivation."

REACTOR OPERATOR AND SENIOR REACTOR OPERATOR

JOB SATISFACTION QUESTIONNAIRE

This questionnaire will be given to a national sample of commercial nuclear power plant operators. It is designed to assess those job characteristics which may be important to operators. This information will be used to develop recommendations for improvement of job conditions for nuclear power plant operators. Your responses to these questions will be treated as confidential; your name is not required. Please answer all questions. After you have completed all the questions, place the questionnaire in the supplied envelope.

For purposes of categorization of the answers to this questionnaire, please provide the following information:

a. Title: ____________________

b. Company: ________________________

c. License Held: ____________________

d. Location: ________________________

e. Years Experience as Reactor Operator with this Utility: ___

f. Years Experience as Senior Reactor Operator (excluding Reactor Operator) with this Utility: ___

g. Total Years RO/SRO with All Utilities: ___

h. Salary: __________

1. Below are a number of job characteristics. Place a number (1-5) or a letter (X) next to each characteristic with respect to its importance to you in staying in your job up to the present and for the foreseeable future.

5 - Extremely Important

4 - Very Important

3 - Somewhat Important

2 - Not Very Important

1 - Not At All Important

X - Not Sure

_____a. the people you work with

_____b. the opportunity to do challenging work

_____c. job security

_____d. salary

_____e. recognition and reward

_____f. use of the knowledge and skills you presently have

_____g. opportunity to learn new knowledges and skills

_____h. opportunity to advance

_____i. job responsibility

_____j. good working conditions

_____k. liberal fringe benefits

_____l. work variety

_____m. geographical location

_____n. management which listens

_____o. opportunity to work with little supervision

_____p. difficult to make same salary in another field

_____q. other: ______________________________. (Please specify)

2. To what extent does your job fulfill your needs (desires, expectations)?

___	___	___	___	___
Not At All	Very Little	Somewhat	Very Much	Completely

3. Please state your reasons for entering into the commercial nuclear power field. (It is very important that you be candid.)

4. To what extent do you agree with the following: "If I could start all over, I would choose a career in the commercial nuclear power field."?

___	___	___	___	___
Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree

4a. What are the main reasons for your response in Question 4.?

5. "I feel good when I tell people what I do for a living."

___	___	___	___	___
Never	Rarely	Sometimes	Most of the Time	Always

5a. "Public opinion about nuclear power affects how I feel about my job."

___	___	___	___	___
Never	Rarely	Sometimes	Most of the Time	Always

6. Please rank the following jobs (from 1 to 10) according to the prestige (status) you feel each job has. A ten (10) should be given to the most prestigious; a one (1) to the least prestigious.

_____teacher

_____auto mechanic

_____research chemist

_____airline pilot (commercial)

_____computer programmer

_____skilled trades (electrician, machinist, etc.)

_____railroad conductor

_____architect

_____nuclear reactor operator

_____air traffic controller

7. To what extent are you involved with utility management/supervisory decisions made which are related to your work?

_____	_____	_____	_____	_____
Not At All	Rarely Consulted	Occasionally Consulted	Generally Consulted	Fully Involved

8. How much confidence does management show in operators?

_____	_____	_____	_____	_____
None	Little	Moderate	Substantial	Complete

9. Do you feel free to discuss problems concerning your job with your immediate supervisor?

_____	_____	_____	_____	_____
Never	Rarely	Sometimes	Most of the Time	Always

10. How accurate is upward communication in your organization (i.e., do communications get filtered as they go up in the organization)?

______	______	______	______
Often	Censored (only what the boss wants to hear)	Limited Accuracy	Accurate (what is intended, is received at the highest levels)

11. Is company management interested in your welfare?

______	______	______	______	______
Not At All	Very Little	Slightly	Pretty Much	Very Much So

12. What changes could be made which would make your job more enjoyable?

13. Below are 17 job characteristics. Please rank the relative importance of each to you if you had the ideal job. A seventeen (17) should be given to the most important; a one (1) should be given to the least important. Each one should receive a number.

_____a. friendly colleagues/associates

_____b. having a good boss

_____c. use of knowledge and skills

_____d. opportunity to learn new knowledges and skills

_____e. receiving recognition for contributions

_____f. good salary

_____g. opportunity for advancement

_____h. a position with responsibility

_____i. job security

_____j. good working conditions

_____k. challenging work

_____l. liberal fringe benefits

_____m. opportunity for job rotation/variety

_____n. opportunity to work independently

_____o. ability to communicate with upper management

_____p. opportunity to manage other people

_____q. recognition from the public (improved prestige)

14. Overall, how satisfied are you with your job?

_____Completely Satisfied

_____Extremely Satisfied

_____Somewhat Satisfied

_____Not Very Satisfied

_____Not At All Satisfied

15. To what extent are you satisfied with your salary for the work you perform?

____________	____________	____________	____________	____________
Extremely Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor Dissatisfied	Somewhat Satisfied	Extremely Satisfied

15a. Do you feel that your salary is adequate for the level of responsibility you have?

____________	____________	____________	____________	____________
Completely Inadequate	Somewhat Inadequate	Neither Adequate nor Inadequate	Somewhat Adequate	Completely Adequate

16. On most days of your job, how often does time seem to drag for you? (How much of the day are you bored?)

_____More Than Half the Day

_____About Half the Day or More

_____About One-Third of the Day

_____About One-Quarter of the Day

_____Time Never Seems to Drag

17. If job rotation were possible, to what degree would it be desirable?

_____ Not At All   _____ Little   _____ Somewhat   _____ Very Much

18. What ideas, concerning job rotation/variety, would you like to see?

19. How involved (dedicated/committed) do you feel in your job?

_____ Not At All

_____ Very Little Involved

_____ Slightly Involved

_____ Moderately Involved

_____ Fully Involved

19a. How often do you do some extra work for your job which isn't really required?

_____ Almost Every Day

_____ Several Times a Week

_____ About Once a Week

_____ Once Every Few Weeks

_____ About Once a Month or Less

20. With respect to supervision, is your job:

_____ Over-Supervised   _____ Under Supervised   _____ Supervised Appropriately

21. How often is your job a source of frustration for you?

_____ Never   _____ Rarely   _____ Sometimes   _____ Frequently   _____ All The Time

22. My ability to advance from an operator to a supervisor is...

___	___	___	___	___
Completely Limited	Somewhat Limited	Neither Limited nor Unlimited	Somewhat Unlimited	Completely Unlimited

22a. My ability to advance from a supervisory position to a management position is...

___	___	___	___	___	___
Completely Limited	Somewhat Limited	Neither Limited nor Unlimited	Somewhat Unlimited	Completely Unlimited	Not Sure

23. To what extent does management recognize your efforts?

___	___	___	___	___
Not At All	Rarely	Sometimes	Most of the Time	Always

23a. How often do you get credit for a job well done?

___	___	___	___	___
Not At All	Rarely	Sometimes	Frequently	Always

24. Do you get a sense of accomplishment from your job?

___	___	___	___	___
Never	Rarely	Sometimes	Often	Always

24a. Does your job allow you to see the results of your efforts?

___	___	___	___	___
Never	Rarely	Sometimes	Often	Always

25. Do you feel that your work is worthwhile?

___	___	___	___	___
Never	Rarely	Sometimes	Most of the Time	All of the Time

26. What aspects of your job do you like?

27. What, specifically, do you not like about your job?

28. Below are five (5) dimensions of a job. Please check each dimension according to your feelings about your job.

a.

_____	_____	_____	_____	_____
Boring	Somewhat Boring	Neither Boring nor Interesting	Somewhat Interesting	Interesting

b.

_____	_____	_____	_____	_____
Routine	Somewhat Routine	Neither Routine nor Varied	Somewhat Varied	Varied

c.

_____	_____	_____	_____	_____
Mechanical	Somewhat Mechanical	Neither Mechanical nor Creative	Somewhat Creative	Creative

d.

_____	_____	_____	_____	_____
Easy	Somewhat Easy	Neither Easy nor Difficult	Somewhat Difficult	Difficult

e.

_____	_____	_____	_____	_____
Non-Demanding	Somewhat Non-Demanding	Neither Non-Demanding nor Challenging	Somewhat Challenging	Challenging

f.

_____	_____	_____	_____	_____
Ambiguous (uncertain)	Somewhat Ambiguous	Neither Ambiguous nor Clear	Somewhat Clear	Clear

29. Overall, how motivated do you feel towards your job?

_____Not At All Motivated

_____Slightly Motivated

_____Moderately Motivated

_____Strongly Motivated

30. How adequately do your abilities meet the demands of your job?

________ Not At All   ________ Very Little   ________ Somewhat   ________ Extremely   ________ Totally

31. How well have you been prepared for your job?

________ Not At All   ________ Poorly   ________ Satisfactorily   ________ Extremely Well

Please feel free to make any additional comments concerning your job which you feel are important.

APPENDIX F

TASK INVENTORIES FOR NON-LICENSED PLANT PERSONNEL

APPENDIX F

TASK INVENTORIES FOR NON-LICENSED PLANT PERSONNEL

Task inventories were developed for the following non-licensed personnel:

TABLE F.1
RADIATION PROTECTION TECHNICIAN TASK INVENTORY

1. Operate and calibrate portable monitoring and sampling instruments.*
2. Dress out in anti-contamination clothing.
3. Set up and operate a radiation control zone.*
4. Prepare radiation work permits in accordance with procedures.*
5. Conduct loose contamination surveys and calculations.*
6. Conduct air sample surveys and calculations.*
7. Conduct radiation level surveys and calculations.*
8. Issue, use and control personnel dosimetry devices.*
9. Ship and receipt for radioactive material.
10. Control and leak check radioactive sources.
11. Prepare required written reports.
12. Notify appropriate personnel of survey results.
13. Use and issue personnel respirators.*
14. Operate counting room and environmental sampling equipment.*
15. Review surveys and checks for out-of-specification conditions.
16. Conduct decontamination of equipment and spaces.*
17. Serve as a member of emergency response groups, including fire brigade, search and rescue, recovery, re-entry and medical assistance teams.*
18. Provide guidance to workers to maintain radiation exposures as low as practicable.
19. Attend outage planning meetings.

*Safety-related task

TABLE F.2
ENGINEER AND TECHNICAL SUPPORT PERSONNEL TASK INVENTORY

1. Read blueprints, drawings, electrical prints, piping and instrumentation diagrams (P&IDs), and control and logic diagrams.

2. Write procedures and procedural changes.*

3. Verify initial and prerequisite conditions for tests.*

4. Schedule and coordinate tests.

5. Ensure conduct of tests is in accordance with utility and federal regulations and requirements.*

6. Identify and resolve test discrepancies.*

7. Ensure safety of personnel during tests.*

8. Ensure restoration of safety-related components or systems upon completion of tests.*

9. Analyze test data to verify acceptance criteria are met.*

10. Train less-experienced personnel.

11. Control fuel station management.*

12. Conduct reactor physics and heat transfer calculations (reactor flow, power distribution, instrumentation readings, reactivity, refueling).*

13. Prepare reports for NRC and utility management (performance, incidents, etc).

14. Conduct ESF, leak rate, valve stroke and other surveillance and performance tests.*

15. Take precision measurements.

16. Operate the station computer.

17. Maintain special nuclear materials control and accountability (fuel storage inventory, core verification, burnup calculations).*

18. Process data from in-core instrumentation.

19. Maintain records (fuel shipments and receipts, performance tests, etc).

20. Serve as a member of emergency response groups.

*Safety-related task

TABLE F.3
MAINTENANCE PERSONNEL TASK INVENTORY

1.	Prepare maintenance work requests.*
2.	Determine functional verification (that is, re-test) requirements.*
3.	Conduct functional verification (that is, re-test).*
4.	Read blueprints, drawings, electrical prints, P&IDs and procedures.
5.	Determine safety hazards associated with maintenance (radiation, chemicals, etc.).*
6.	Inspect, test, disconnect, remove, disassemble, repair, reassemble, reinstall, connect, calibrate, check and return to service plant components, including safety-related equipment.*
7.	Take precision measurements.
8.	Operate machine shop tools.
9.	Rig and handle large components.
10.	Locate and identify components.
11.	Comply with plant administrative procedures.
12.	Coordinate actions with operations personnel and support personnel.
13.	Operate hand and portable tools and test equipment.
14.	Perform in-service inspections.
15.	Conduct operational tests (hydrostatic, leak rate, etc.).*
16.	Set control and relief points of components (for example, relief valves).*
17.	Take and record readings on operating equipment.
18.	Serve as a member of emergency response groups, including recovery and re-entry teams.*

*Safety-related task.

TABLE F.4
CHEMISTRY TECHNICIAN TASK INVENTORY

1. Perform radiochemical and conventional chemical analyses to ensure that water chemistry and radioactivity content of liquids, solids and gases discharged from the plant are maintained within required limits as set forth in plant instructions or federal regulations.*

2. Collect, prepare and determine the gross radioactive content of liquid, solid and gaseous samples using alpha, beta and gamma activity counting instruments described in the plant procedures.*

3. Collect samples and make routine conventional, chemical and radiochemical analyses of reactor water, feedwater, condensate, steam and other plant water supplies.*

4. Add or give instructions to add the proper amounts of chemicals to maintain the water analysis of certain chemically treated plant systems within prescribed limits.*

5. Demonstrate proper analytical and sampling techniques to radiochemical laboratory analysts and trainees and observe the trainees' performance of analytical and radiochemical procedures and other assignments.

6. Develop and modify plant procedures.

7. Conduct maintenance and calibration of analyzers, meters and other instruments.

8. Prepare laboratory reagents, solutions and stands.

9. Maintain radiochemical logs and other written reports.

10. Serve as a member of emergency response groups, including fire brigade and medical assistance team.*

11. Clean up chemical spills in accordance with procedures.

12. Operate station chemical support systems.*

13. Report chemistry results to control room and other personnel as required.

14. Receive and store chemicals.

15. Routinely work without supervision on shift.

*Safety-related task

TABLE F.5
INSTRUMENTATION AND CONTROL TECHNICIAN TASK INVENTORY

1. Read blueprints, drawings, electrical prints, P&IDs, logic diagrams, etc.
2. Prepare maintenance work requests.*
3. Determine functional verification (that is, re-test) requirements.*
4. Conduct functional verification (that is, re-test).*
5. Determine safety hazards associated with evolutions.
6. Comply with all safety precautions.
7. Locate plant components.
8. Comply with plant administrative procedures.
9. Inspect, test, disconnect, remove, disassemble, repair, reassemble, reinstall, connect, calibrate, check and return to service instruments and controls that measure pressure, temperature, vacuum, draft, liquid level and flow and other plant parameters (including safety-related equipment, particularly the reactor protection equipment).*
10. Correct malfunctions of plant computer system.
11. Maintain plant security system.
12. Serve as a member of emergency response groups, including recovery and re-entry teams.*

*Safety-related task

TABLE F.6
QUALITY ASSURANCE AND QUALITY CONTROL PERSONNEL TASK INVENTORY

1. Review maintenance work requests.*
2. Identify "holds" on work requests.*
3. Identify nonconforming items.*
4. Read blueprints, drawings, electrical prints and P&IDs.
5. Conduct quality assurance surveillances.*
6. Conduct audits.
7. Conduct receipt inspections.
8. Verify that equipment critical to safe operation is performing as designed.*
9. Verify that personnel are following approved procedures in the operation, maintenance and engineering of equipment related to safety.*
10. Identify and maintain status of unresolved quality assurance problems.
11. Review plant instructions, procedures, records and procurements to ensure quality-related requirements are met.*
12. Review revisions to technical specifications and ensure compliance.*
13. Review plant modifications to ensure quality assurance requirements are met.*
14. Prepare reports required by technical specifications for Plant Operations Review Committee (PORC) review.
15. Ensure compliance with surveillance test schedule and conduct.
16. Perform nondestructive evaluation.

*Safety-related task

TABLE F.7
AUXILIARY OPERATOR TASK INVENTORY

1. Check status and condition of plant components including safety-related equipment.*
2. Conduct valve lineups of plant systems.*
3. Operate plant equipment not operated from the control room, including safety-related systems.*
4. Put in service and take out of service plant components.*
5. Tag-out and remove tags from plant components.
6. Operate liquid and gaseous radwaste systems.
7. Provide equipment status information to control room operator.
8. Recognize out-of-normal indications for plant parameters and components.*
9. Control system parameters (levels, pressures, etc.).*
10. Verify operation of radiation monitors.*
11. Prepare work requests for maintenance.*
12. Assist control room operator to perform routine surveillance and operating tests (leakage tests, trip tests, hydrostatic tests, maintenance re-tests, etc.).*
13. Lubricate and clean operating equipment.
14. Move fuel in spent-fuel pool.*
15. Maintain records and knowledge of individual radiation exposure.
16. Assist in transfer of radioactive material.*
17. Follow station directives and normal, abnormal and emergency operating procedures.*
18. Communicate accurately with other shift personnel.
19. Take manual and backup control of functions normally operated from the control room.*
20. Maintain logs and other routine written reports.
21. Perform tasks during emergencies as directed by RO or SRO (security force, fire brigade, search and rescue team, etc.).*
22. Make routine inspections.

*Safety-related task

TABLE F.8
SHIFT TECHNICAL ADVISOR TASK INVENTORY

1. Evaluate plant conditions and provide advice to the Shift Supervisor during plant transients and accidents.*
2. Evaluate the plant normal operations from the point of view of safety.*
3. Monitor the operating experience at other plants of similar design for information valuable to safe operation of the plant.*
*Safety-related task

TABLE F.9
MANAGER TASK INVENTORY

1. Plan, coordinate and direct the operations, maintenance, engineering and administration of the plant.*
2. Serve as a member of an Independent Review Board.*
3. During an emergency, function as emergency director, which includes:* o Recognizing accident conditions, o Identifying results of radiation surveys, o Coordinating support to operating shift personnel, o Determining additional or supporting personnel required, o Recommending actions to appropriate authorities and o Controlling off-site and on-site monitoring and reporting.
*Safety-related task

TABLE F.10
INDEPENDENT REVIEW PERSONNEL TASK INVENTORY

1. Review all procedures, except common site procedures, required by technical specifications and any other proposed procedures or changes thereto as determined by the Unit Superintendent to affect nuclear safety.*

2. Review all proposed tests and experiments that affect nuclear safety.*

3. Review all proposed changes to technical specifications.*

4. Review all proposed changes or modifications to plant systems or equipment that affect nuclear safety.*

5. Investigate all violations of the technical specifications. Prepare and forward a report covering evaluation and recommendations to prevent recurrence to the System Superintendent Nuclear Operations and to the Chairman of the Nuclear Review Board.*

6. Review events requiring 24-hour notification to the NRC.*

7. Review facility operations to detect potential safety hazards.*

8. Perform special reviews and investigations and reports thereon as requested by the Chairman of the Nuclear Review Board.*

9. Render determinations in writing with regard to whether or not items constitute an unreviewed safety question.*

10. Review plant security and emergency plans and implementation procedures.*

11. Perform special reviews, investigations and reports.*

12. Provide independent review and audit of designated activities in the areas of:*

    - Nuclear power plant operations,
    - Nuclear engineering,
    - Chemistry and radiochemistry,
    - Metallurgy,
    - Instrumentation and control,
    - Radiological safety and
    - Mechanical and electrical engineering.

*Safety-related task

APPENDIX G

FIELD SURVEY CHECKLISTS AND INTERVIEW QUESTIONS FOR REACTOR SITES

APPENDIX G

FIELD SURVEY CHECKLISTS AND INTERVIEW QUESTIONS FOR REACTOR SITES

Field survey trips to reactor sites consisted of document research and interviews conducted by survey teams of two to five people. This appendix provides a copy of the checklists used for document research and a listing of typical questions asked during interviews. Interviews at reactor sites were conducted with the following personnel:

- Control Room Operators (RO licensed)
- Supervising Control Room Operators (SRO licensed)
- Shift Supervisors
- Auxiliary Operators undergoing RO license training
- Training Department Supervisor
- Training Department Assistant Supervisor/Senior Instructor
- Training Department Instructors
- Superintendent of Operations
- Superintendents/supervisors of non-licensed maintenance and professional-technical support personnel.

G.1 FIELD SURVEY CHECKLISTS

G.1.1 Source: RO/SRO TRAINING, PERFORMANCE AND BACKGROUND RECORDS

1. Performance ranking by utility (bottom/middle/upper 1/3 or special evaluations of operators).

2. Data on predictive indices (use standard data-collection sheet) (for use in prescreening/selection).

3. Any data on psychological and attitude factors or evidence that these are periodically weighed.

4. From records of marginal performers, collect information on:

   a) indications of utility commitment to individuals
   b) any discrepancies between standard training/testing procedures and actual practice
   c) utility involvement in borderline cases
   d) utility waiving of screening criteria for a training program phase.

5. Predictive indices of performance to be applied to advancement criteria for promotion from RO to SRO (use standard data-collection sheet).

6. Evidence of any attempt to evaluate a person's managerial ability to control shift personnel activities as prerequisites for advancement to SRO. Also, any evidence of training in this area.

G.1.2 Sources: UTILITY JOB DESCRIPTIONS/JOB TASK ANALYSES FOR RO/SRO
PLANT OPERATING PROCEDURES
TECHNICAL SPECIFICATIONS
STATION ADMINISTRATIVE INSTRUCTIONS

1. Obtain copy of any existing utility job descriptions or job task analyses for RO/SROs.

2. Obtain copies of procedures for normal, abnormal and emergency evolutions selected for the RO/SRO Job Task Analysis.

3. Search through reactor operating manuals for any descriptions of general job functions/responsibilties of following personnel during normal, abnormal and emergency conditions. Copy or record these.
(NOTE: These are "functional titles" listed in ANS-3.1 and might not match the specific title at this utility.)

- Plant Manager
- Technical Manager
- Supervisors not requiring NRC license (determine who these are specifically at each site).
- Professional-Technical Groups:
  - a) Reactor Engineering
  - b) Instrumentation and Control
  - c) Chemistry and Radiochemistry
  - d) Radiation Protection
  - e) Quality Assurance
- Operator-Technician-Maintenance Personnel
  - a) Technician
  - b) Maintenance personnel
  - c) Auxiliary operator
- Engineer-in-Charge of Technical Support Personnel

4. Obtain copy of site Emergency Plan.

5. Obtain a copy of the operating instructions of general and continuing applicability to the conduct of normal operations:

   a) standing orders
   b) turnover/relief
   c) definition of general duties of operators

6. Copy selections of applicable "Technical Specifications," including Section 6.

7. Obtain copies of selected surveillance tests, functional tests and system operating procedures.

8. Copy applicable Station Administrative Procedures.

G.1.3 Source: OPERATOR TRAINING PROGRAMS

1. Obtain copies of training manual with training programs descriptions, procedures for administration of program and training policies.

2. Copy FSAR, Conduct of Operations, with training program description.

3. Obtain a copy of training organization chart.

4. Determine current corporate management level and degree of involvement in following aspects of training program:

   a) approval of training program structure
   b) approval of program composition
   c) performance of periodic audits (how often, who does them, depth of audits)
   d) approval of screening and advancement criteria and actual selec-selections
   e) approval of key utility exams
   f) certification of preparedness for NRC exam
   g) corrective action for NRC/utility audits
   h) general training program decision responsibilities.

5. Determine criteria employed and means used to certify candidates for NRC exams.

6. Determine utility procedure in case of NRC exam failure including:

   a) current procedures for re-certification
   b) policy on waiting period before re-exam.

7. Obtain copies of course outlines, syllabuses, etc. Ensure all phases of training programs are represented.

8. For each phase of training (including simulator) obtain:

a) schedule
b) lesson plans (samples)
c) all key examinations (periodic or comprehensive)
d) any list of on-the-job requirements.

9. Look for specific training given that defines basic performance expectations and responsibilities for normal, abnormal and emergency conditions for RO/SROs.

10. Look for specific training that indicates requirements for advancement from RO to SRO (technical knowledge, practical experience, previous performance in less responsible jobs, managerial ability to control shift personnel, etc.). Copy or record this specific information.

11. Ensure that materials brought away from site provide adequate information on following (for each phase):

a) training materials used (videotaped, programmed instruction, lectures, etc.) and percent of program accounted for by each technique
b) subjects and depth covered
c) time allotments
d) overall training methodology employed.

12. Collect information on techniques employed by training service contractors and consultants.

13. Determine distribution of subject areas and time allotment to simulators and actual in-plant training.

14. Obtain copy of any in-plant training/drill program. Determine utility objectives for in-plant training and rationale.

15. Obtain copies of any drill plans/scenarios for use during drills.

16. Obtain copies of AO/RO/SRO/SS qualification signoff cards in the Operations Department Instructions.

17. Obtain information on initial training program for AO from Operations Department Instructions.

18. Training Program Audits

    a) Obtain copies of any audit procedures by utility QA.
    b) Obtain copies of any actual utility audits and response to audits.
    c) Obtain copies of NRC audits/utility response.
    d) Obtain copy of any checklist used in audits.

G.1.4 Source: UTILITY SELECTION AND SCREENING PROCEDURES/POLICIES

1. Determine criteria for initial selection of applicants for Hot and Cold Programs.

2. Determine screening criteria applied to applicants prior to entry into each phase of the training program.

3. Determine current corporate management level and degree of involvement in the following:

    a) approval of screening and selection criteria
    b) approval of actual selections.

4. Obtain a copy of any established utility guidelines for operator advancement to SRO.

5. Determine current corporate management level and degree of involvement in approval of advancement criteria and <u>actual</u> selections for advancement of RO to SRO.

G.1.5 Source: OPERATOR REQUALIFICATION PROGRAM

1. Obtain copies of the requalification program description, procedures for administration of the program, and any utility guidelines, policies or directives relating to requalification.

2. For each phase of requalification obtain copies of:

   a) training schedule
   b) lesson plans (sample)
   c) simulator training conducted
   d) key examinations.

3. Determine current corporate management level and degree of involvement in following aspects of requalification program:

   a) approval of program structure
   b) approval of program composition
   c) performance of audits
   d) approval of key exams
   e) approval of recertification in case of failure of annual exam.

4. Obtain a copy of any existing record of requalification training conducted during a recent period of time (as long as reasonable based on volume) for comparison later with requalification objectives.

5. Determine typical procedures followed in case of annual requalification exam failure. Determine established procedures and copy any records showing actions taken in actual cases.

6. Requalification Program Audits

   a) Obtain copies of any audit procedures by utility QA.
   b) Obtain copies of any actual utility audits and response to audit.
   c) Obtain copies of NRC audits/utility response.
   d) Obtain copy of any checklist used in audits.

7. Ensure that the information collected on the requalification program has sufficient in-depth information that covers the following areas:

    a) subjects covered and time allotment
    b) subject depth
    c) training materials used and amount of utilization (e.g., programmed instruction, videotapes, lectures, etc.)
    d) emphasis of requalification (continuous and periodic) program
    e) methodology employed (including extent of use of outside contractors/consultants)
    f) efforts taken to ensure that safety-related tasks can be carried out effectively
    g) efforts taken to ensure that a broad and comprehensive level of understanding in fundamentals is maintained
    h) practical requalification training - composition and time allotment.

8. Determine requalification program distribution of subject areas/time allotment to simulators and in-plant training, and any rationale given behind this distribution.

9. Obtain a copy of the requalification in-plant training program. Also, obtain copy of any existing record of in-plant requalification training conducted over a reasonable period of time.

10. Obtain copies of any in-plant requalification drill plans/scenarios and drill program description.

G.1.6 Source: TRAINING INSTRUCTOR SELECTION, QUALIFICATION AND EVALUATION PROCEDURES AND POLICIES

1. Obtain copy of procedures/guidelines/policy for instructor:

a) initial selection

b) training (details, including detailed description of instructor training program)

c) qualification/certification

d) periodic evaluation.

2. Determine utility criteria for selection of instructors. (Including those contracted out to training services, companies, consultants, etc. Does utility approve any of instructors? If so, using what criteria?)

3. Determine current procedures for initial accreditation (after qualification) and follow-on evaluations of instructors.

4. Record factors considered in instructor evaluations (obtain copies of any standard evaluation forms).

5. Determine if any effort is made by utility to assess quality of instruction given by training service contractors. If so, how is it different from criteria placed on utility instructors?

6. Determine policy/procedures in case of problems with any instructor's competency.

7. Determine current instructors' backgrounds and qualifications and subject areas in which each instructs.

G.1.7 Source: OPERATOR ERROR REPORTING PROCEDURES

1. Obtain copies of procedures for operator error reporting (including "reportable occurrences").

2. Determine communications mode used to minimize delays in reporting to NRC.

3. Obtain copy of any utility guidelines for determining severity of errors and appropriate corrective action.

4. Obtain copies of personnel error related LERs and follow-up reports.

5. Obtain copies of LERs that involve unlicensed personnel.

6. Determine how LER procedure at the utility interfaces with the on-site IE representative. Also, determine if any critique prior to LER submittal includes the NRC IE representative.

G.1.8 Source: UTILITY PROCEDURES FOR PERFORMANCE EVALUATION OF RO/SRO/SHIFT SUPERVISORS

1. Obtain copies of any formal procedures/standard forms for:

   a) periodic RO/SRO/SS performance evaluation
   b) recording of operator performance during drills or evolutions.

2. Obtain copy of any policy statements or procedures concerning corrective action for repeated operator errors or handling operators who are marginal performers.

G.1.9 Source: UTILITY PROCEDURES FOR FEEDBACK OF INFORMATION ON PROBLEMS TO OPERATORS/TRAINEES

1. Obtain a copy of utility procedure for feeding back information on operator errors, design problems and equipment failures to operating/trainee personnel. Procedures should provide the following information (If they do not, ask for any documents that do provide these answers):

   a) subjects covered and depth
   b) expediency requirements of feedback process

c) methodology for factoring this information into initial training and requalification programs - including utility guidelines for determining which information is appropriate for each area of training.
d) provisions for ensuring that safety-related problems receive priority exposure
e) administrative procedures to document feedback process and degree of exposure to operators. [This includes how the lessons learned from publications/reports (e.g., IE bulletins, LERs, etc.) are handled.]
f) functions of the utility "Operating Experience Evaluation Group"
g) techniques employed to convey information on operator errors to operators and trainees.

G.1.10 Source: NON-LICENSED PERSONNEL JOB DESCRIPTIONS AND TRAINING

1. Obtain copies of any detailed job descriptions that will permit determination of job functions and responsibilities during normal, abnormal and emergency conditions. (These are listed by "functional title" in ANS-3.1 and will require correlation to actual utility title.)

- Plant Manager
- Maintenance Manager
- Technical Manager
- Supervisors not requiring NRC License (determine specifically who these are at each site)
- Professional-Technical Groups
  a) Reactor Engineering
  b) Instrumentation and Control
  c) Chemistry and Radiochemistry
  d) Radiation Protection
  e) Quality Assurance

- Operator-Technician-Maintenance Personnel
  - a) Technician
  - b) Maintenance personnel
  - c) Auxiliary operator
- Engineer-in-Charge of Technical Support Personnel

2. Obtain copy of any existing job task anlayses of any of these personnel.

3. Obtain a detailed description of training programs and certification received by these personnel, including any on-the-job training requirements.

4. For Maintenance and Professional-Technical Groups, obtain representative copies of:

   a) surveillance procedures
   b) functional test procedures
   c) preventive maintenance procedures
   d) repair procedures.

G.1.11 Source: EXAMINATIONS

1. Get copies of utility exams given to certify candidates ready for NRC exams.

2. Obtain copies of annual requalification exams for comparison with NRC exams and requalification program criteria. If the annual exam is given in segments, obtain a copy of all parts.

3. Get copies of any exams administered to certify passing each phase of training (i.e., used as screening device for the next phase).

4. Obtain copies of any exam waiver requests, including NRC response.

G.1.12 Source: MISCELLANEOUS INFORMATION

1. Collect any information from incentive programs of any utility incentives for superior trainee performance or operator performance.

2. Obtain a copy of utility procedures for implementing regulatory changes.

3. Obtain a copy of the power plant organization diagram.

G.2 INTERVIEW QUESTIONS

G.2.1 LICENSED ROs and SROs

1. What measures are taken typically during each phase of the initial training program to assist trainees who are having difficulties completing the curriculum (e.g., extra instruction, regulated study time, additional testing, etc.)? Do you feel these measures were sufficient and appropriate? Did you find the program easy or difficult? Does utility management get involved in boderline cases; if so, how?

2. What incentives exist to encourage superior trainee performance during the training program? After completion of licensing, what incentives exist to encourage superior operator performance?

3. While on shift as a reactor operator or senior operator, how do you interface with maintenance/support personnel performing work in the plant? What are your responsibilities for the actions of these people? What are their responsibilities to you? Do you provide direction to them: if so, how and when?

(FOR SROs ONLY)

4. One of the objectives of this study is to collect information on the duties and responsibilities that distinguish the SRO from the RO. To approach this subject, we would like to discuss the differences between the principal DUTIES (or FUNCTIONS) that SROs perform that are in addition to those that the ROs perform. In addition, we would like to identify the TASKS performed in support of these DUTIES.

   a) During NORMAL plant operating conditions, what are your principal duties above those of an RO?
   b) During ABNORMAL plant conditions, what additional duties do you perform? (Abnormal conditions include shutdowns for unscheduled maintenance, startups, significant power manipulation, etc.)
   c) Under EMERGENCY plant conditions, what are your duties?
   d) For each of these duties you have mentioned, what are the tasks you do in support of those duties?

5. What are the objectives of each phase of the training program as you see them?

6. During your initial training period at this facility, which phase of the program, do you feel, did the least to adequately prepare you for your responsibilities as RO/SRO? Why? Were you interested in these areas?

7. Which phase of the program do you feel was most effective in preparing you to be a RO/SRO? Why?

8. What are the requirements that must be met for advancement from operator to senior operator? Do you agree or disagree with them? (If you disagree, then what do you think the requirements should be?) Why?

9. Describe the written and oral NRC licensing examination given to you (for operators licensed within the last 2 years).

10. How difficult is it for an operator to move from one unit to another when licensed on more than one unit?

11. What is your opinion of the simulator for training you have received? What problems reduce its effectiveness?

12. What would you like to see done to improve your satisfaction with your job? What motivators and demotivators exist on your job?

13. One area that our research will look into is the screening of applicants prior to their entry into each phase of the training program. Please describe the phases of training in the program you completed and give your opinion of the factors that should be considered (i.e., what screening should be done) prior to permitting a candidate to enter each phase of training.

14. What opportunities do you have for advancement?

G.2.2 SHIFT SUPERVISORS

1. During a shift, how do reactor operators and senior operators interface with maintenance/support personnel performing work in the plant? What are the RO/SRO responsibilities for the actions of these people? What is the shift supervisor's responsibility? What are the responsibilites of these maintenance/support personnel to the RO/SRO? Do RO/SROs provide direction to them? If so, how and when?

2. Please describe your involvement in the formal evaluation of the performance and competency of ROs and SROs for:

   a) periodic evaluations
   b) evaluation of actions taken or to be taken during actual or simulated abnormal and emergency conditions.

What factors do you consider in evaluating both ROs and SROs? (Distinguish between the two.)

3. What corrective action or special personnel procedures are taken for the case of an operator who repeatedly makes errors or is generally considered to be a poorer quality operator?

4. Considering the duties and tasks of the SRO and RO, what are the principal duties of an SRO in addition to those of an RO during NORMAL operating conditions? What additional duties does he gain during ABNORMAL conditions? EMERGENCY conditions? What tasks are performed by the SRO in support of those duties?

5. Consider ROs who have been advanced to SRO. From your experience what do you consider to be the best predictors of excellent and poor performance as SROs? Do you feel that current advancement prerequisites are satisfactory or need improvement? How?

6. What problems currently exist in operator motivation? How do you think motivation can be improved?

7. For operators (RO or SRO) who have left this utility, what is your recollection of their general complaints about their jobs? How many different operators are you talking about and over what period of time?

8. What is your opinion of the feasibility of creating a job rotation system for operators to add job variety?

9. What opportunities do you have for advancement?

10. What is your opinion of the practice of granting NRC licenses on multiple units? What problems do operators have when they move from one unit to another?

11. What is your opinion of the simulator training you have received? Is there any need to place more emphasis on team training at the simulator? What improvements would you like to see in simulator training?

12. What is your opinion of the STA requirements?

G.2.3 AUXILIARY OPERATOR UNDERGOING RO LICENSE TRAINING

1. What measures are taken typically during each phase of the initial training program to assist trainees who are having difficulty?

2. During the training problem:

   a) Are there any mandatory study requirements?
   b) Are there any efforts to provide additional instructor assistance for weak students?
   c) Do utility management personnel get involved in borderline cases? If so, how?
   d) Do company management personnel participate in training sessions? How often?

3. What incentives exist to encourage superior trainee performance during the training program?

4. Are your instructors utility personnel, contractors or a mixture of both? What mixture? How knowledgeable are your instructors (both groups)?

G.2.4 TRAINING DEPARTMENT SUPERVISOR

1. These questions concern utility commitment to individuals during and after training.

a) What level of utility management becomes involved in cases of borderline trainees and what is the degree of this involvement? How about cases oi marginal operator performance?

b) What special procedures are followed in the case of a marginal trainee?

c) What special procedures are followed in the case of a poorly performing operator?

d) What incentives currently exist to promote superior trainee/operator performance?

e) What has been the drop-out/failure rate of hot/cold applicants in the past 3 years?

2. What criteria are applied to the selection of instructors? What is the rationale behind these criteria?

3. Have you ever had any problems with instructor competency? If so, what actions were taken to correct this situation?

4. For the following areas, what level of corporate management gets involved and what is the degree of involvement in the training and certification process?

   a) approval of training program structure
   b) approval of program composition
   c) performance of periodic utility audits (how often, who does them, depth of audits)
   d) approval of prescreening and advancement criteria and actual selections
   e) approval of key utility exams
   f) certification of preparedness for NRC exam
   g) corrective action for NRC/utility audits
   h) general training program decision responsibilities.

5. Concerning the corporate management personnel discussed in Question 4, what technical knowledge, experience levels and training have these personnel had to prepare them for operator certification responsibilities? Is there any program for this?

6. Concerning the distribution of practical training subject areas and time allotment to simulators versus actual in-plant training (hot or cold programs), what is the rationale behind the current program distribution?

7. From your viewpoint, what are the simulator organizations' training responsibilities to you, both for initial training programs and requalifications training?

8. The following questions concern your in-plant training program:

   a) What are the objectives of the program - both initial training and requalification training?
   b) What are the practical scheduling limitations of in-plant training?
   c) What advantages do you see for using reactor time for conducting periodic drills? Disadvantages?
   d) What percentage of your program results in actual plant manipulation versus walk-through only?
   e) If faced with a specific NRC requirement to conduct periodic drills requiring plant manipulation, how would you schedule them?
   f) What is the feasibility of conducting drills during startup/shutdown periods?

9. For in-plant training and drills that are conducted:

   a) Who is involved in the planning of the drills and to what degree?
   b) Who grants permission/authorizes the training to be conducted?
   c) Who monitors the training?
   d) Who reviews the results of training conducted?

10. What are the NRC practices that you have observed for implementing training requirements? What are your opinions (pro and con) of these implementation practices? What are the utility's practices for implementing regulatory requirements in the training area?

11. What are your opinions (pro and con) on current NRC training audit practices (enforcement)? How much preparation is required for these audits?

12. What formal or informal methods exist for:

    a) evaluating the effectiveness of courses
    b) evaluating currency and accuracy of materials
    c) updating materials
    d) evaluating courses for providing operators information related to the skills and knowledges required to meet their job requirements?

13. What are your opinions of the advantages/disadvantages of generic and plant-specific simulator training?

14. Is current emphasis on individual training versus team training appropriate? If not, what should it be?

15. What do you view as INPO's role in the industry?

16. Considering the three areas of training, operations and regulation, what significant improvement do you feel is needed on an industry-wide basis?

17. What types of skills are taught to your operators during simulator training and percentage of emphasis on each? Do you feel it is appropriate? What improvements in simulator training would you like to see?

18. How does the cold license program concept compare to the hot license program for adequately preparing operators for their jobs?

19. Please comment on the following changes in requirements, identified in NUREG 660 NRC Action Plan:

a) Vice President of Operations certifying fitness of candidates for the NRC examination
b) one year of experience as RO required prior to SRO licensing
c) three months of control room training as an extra person on shift required for RO/SRO candidates
d) review of training programs to assure that safety-related functions, including job task analysis can be carried out effectively
e) emphasis of the team aspect of training, particulary during simulator training and requalification and plant drills
f) plant drills - normal and offnormal operating maneuvers to be simulated for walk-through drills; test adequacy of reactor and plant operating procedures; what drills should include actual maneuvers of the plant; desirability of initiation of drills by NRC inspectors
g) NRC Operating Tests to be conducted on simulators
h) requalification exams to be administered by the NRC
i) new staffing requirements for control rooms
j) new NRC exam requirements: (1) thermodynamics and fluid flow category, (2) time limit, (3) new pass/fail criteria, and (4) SRO candidates to take an oral exam.

G.2.5 TRAINING DEPARTMENT ASSISTANT SUPERVISOR

1. Part of our study involves evaluating NRC audit practices. Please describe what actual NRC training program audit practices are in at least the following areas:

a) frequency of audits
b) subject areas of audits
c) length of audits
d) distribution of administrative audits versus personnel evaluations or training practices evaluations.

What are your opinions of the weaknesses in the current NRC audit program?

2. What fraction of the training program is conducted by training service contractors? In what areas? Why are these personel or organizations used?

3. What formal effort is made by the utility to assess the quality of instruction given by training service contractors? Does the utility have any say in the instructors used?

4. What are the various training techniques/methods used in your initial training programs (e.g., individual study, programmed instruction, video tapes, lectures, etc.)? What is the degree of utilization of each? What is the rationale behind this breakdown?

5. For the training services contractors/consultants used, what training methods are used and to what degree?

6. What are the training technique/methods used as part of the continuing and periodic requalification program? What is the degree of utilization of each?

7. To what extent are outside contractors/consultants used during the continuing and periodic requalification program? What is the rationale for their use?

8. Concerning practical requalification training, both continuous and periodic - what are the goals and composition of the programs and what amount of time is allotted to this effort? What is the designed emphasis of these programs?

9. Have you had any cases where operators have failed their annual requalification exams? For these cases, what corrective action was taken?

How is this action typically determined (rationale)? Are there any established criteria?

10. Concerning the criteria used to certify candidates for NRC exams:

    a) What criteria are used for this certification?
    b) Are the certification criteria tailored to NRC evaluation criteria? (Why or why not?)
    c) Are all NRC exam subject areas independently evaluated?
    d) What are the utility techniques for evaluating operator ability/willingness to accept the responsibilities of an operator?
    e) At what levels and to what degree do utility management personnel get involved in this certification process?

11. Have you had any cases where operators have failed their NRC exam? For these cases, what corrective action was taken? How is this action typically determined (rationale)? Are there any established criteria?

12. Describe the utility procedures for feeding back information on operator errors, design problems and equipment failures to operating personnel and instructors and trainees, including:

    a) subjects covered and depth
    b) expediency requirements of feedback process
    c) methodology for factoring this information into initial training and requalification programs
    d) provisions for ensuring that safety-related problems receive priority exposure
    e) administrative procedures to document feedback process and degree of exposure to operators. (This includes how lessons learned from publications, e.g., IE bulletins, LERs, etc., are handled.)
    f) functions of the utility "Operating Experience Evaluation Group"
    g) guidelines for determining which information is appropriate for each area of training.

13. What is the rationale behind the selection criteria applied to applicants for the reactor operator training program?

14. How are trainees screened prior to entry into each phase of training program? What are the criteria applied to each phase? What is the rationale for these criteria?

15. In your opinion, what are the best indicators during training of how good an operator will become after licensing?

16. During the training program, how is a student's progress tracked? What action is taken in case of marginal performance?

17. Please summarize the following concerning the instructors used in your programs:

   a) selection procedures and criteria
   b) qualification procedure
   c) procedure for initial accreditation
   d) follow-on evaluations including factors considered in the evaluations.

18. During simulator training, what percent of the time is spent on:

   a) demonstrations
   b) practices
   c) performance evaluation for normal, abnormal and emergency conditions?

G.2.6 TRAINING DEPARTMENT INSTRUCTORS

1. What is your experience background in nuclear power? Would you classify your background as theory or operations oriented?

2. What formal education have you received? What training did you receive to prepare you to be an instructor? Why did you become an instructor?

3. What are your specific responsibilities for teaching? (What phases of training/requalification subject areas, courses to you teach?) Are there any limitations placed on which courses you are qualified to teach in the initial training and requalification programs? Are other instructors limited in their teaching scope?

4. What type of guidance do you receive on how you instruct (directives, etc.)? From whom? What types of instructional methods do you use - lecture, discussion or seminar, practice (percent of time of each)?

5. What types of materials do you use (e.g., programmed instructions films, slides, guides, etc.) and to what degree of each? Why do you use these rather than 100 percent lecturing?

6. Do you develop your own tests? If not, who does? What are typical pass/fail ratios for your tests? What types of tests are they - short answer, true/false, multiple choice, discussion? How frequently do you administer tests?

7. How is student progress tracked? How do you handle poor learners? Do you provide extra individual instruction? What other techniques are used to assist these people? How involved does utility management get with marginal trainees? Do you feel that the overall effort to assist these people is adequate? Is it appropriate in all cases? If not adequate/ appropriate, why not?

8. Does company management ever sit in on classes? How often? What level of management? Do they participate?

9. Do NRC personnel ever observe classes in progress? How often? What do they do? Do NRC personnel conduct any other types of audits that affect you?

10. In what phases of training do training services contractors or consultants provide instruction? To what extent? What type of supervision and auditing do they receive by the utility? What techniques do they use? What is your opinion of the caliber of instruction they provide?

11. Do you become involved in the continuing requalification program? Please describe its:

    a) emphasis
    b) goals
    c) composition
    d) time allotment.

12. Of what does practical requalification training consist? Is it adequate in your opinion? Why?

13. What are the best predictors in the training program of an operator's performance after completing certification?

14. What incentives exist to leave operations and join the training department?

15. Are instructors regularly sent with trainees to license training conducted at simulator facilities? If so, what functions do they perform? What advantages/disadvantages exist in this policy?

G.2.7 SUPERINTENDENT OF OPERATIONS

1. Would you please describe your own background and experience?

2. Concerning advancement from operator to senior operator:

    a) Who makes the final decision to advance an operator?
    b) What is the chain or recommendations to this individual for making the final decision?

c) What are the most important factors considered prior to recommending advancement? Are these your own personal criteria or are company criteria firmly established for this?

d) For the factors considered prior to advancement, what are the measurement techniques?

3. What is the highest level of corporate management responsible for plant operation? What is his degree of involvement in the performance of operators? Is there anyone else between yourself and this person who gets involved? To what degree?

4. Concerning the training of new operators and certification of them for the NRC exam:

   a) What is your involvement?
   b) Do the personnel listed in Question 3 get involved? To what degree?
   c) What technical knowledge, experience levels and training have these personnel had to prepare them for participation in the certification process?

5. What is done typically for the cases of marginal operator performance (operators who frequently make errors, are obviously poorly motivated, etc.)? What is done to attempt to improve performance? For operators who seem to have a lack of adequate knowledge, is any effort taken to give them refresher training (classroom, or simulators)? Could you give some specific examples of cases you remember?

6. Would you consider your current RO/SRO operating staff as "lean," "just right," or "fat" in regards to number of licensed operators needed? If "lean," what problems does this impose?

7. What level of difficulty for you do management-labor (union) relationships pose with respect to:

   a) normal plant operation
   b) dealing with marginal/poorly performing operators
   c) allotment of time to training?

8. Based on your experience, what do you feel are the best indicators in a trainee's training record of how well he will perform as a licensed operator? After he is licensed, what do you feel are the best predictors of his performance as an SRO?

9. How are operator errors investigated and reported? How involved does the resident IE representative get in the process? What advantages/disadvantages exist in identifying individuals by license number or social security number on these reports?

10. What problems exist in the current methods for providing information to utilities and the NRC on operating errors (e.g., LER system)?

11. What is your opinion of the use of generic versus plant-specific simulators? Do you see a need for more team training on simulators? How big a scheduling problem would this be for you?

12. Should different licensing programs exist for professional/engineering personnel than for operators?

13. What role do you see INPO playing in future?

14. What is your opinion of the adequacy of the current NRC examination process?

G.2.8 SUPERINTENDENTS/SUPERVISORS OF NON-LICENSED MAINTENANCE AND PROFESSIONAL-TECHNICAL SUPPORT PERSONNEL

Note: Supervisory personnel in the following functional areas were interviewed:

a) Reactor Engineering
b) Instrumentation and Control Maintenance
c) Chemistry/Radiochemistry
d) Radiation Protection/Health Physics
e) Quality Control/Quality Assurance
f) Mechanical Maintenance.

The following questions were tvpical of those asked of these individuals.

1. What are the duties, responsibilities and tasks performed by personnel in your group at the levels of Manager, Supervisor and Technician?

2. Of the personnel discussed above, which people perform work that could impact on plant safety and public safety?

3. What qualitv control currently exists for the performance of these personnel? In what areas do you feel this quality control should be improved and what ideas do you have for improvement?

4. How do these maintenance personnel at the supervisor level and technician level interface with the RO/SRO on shift? Who provides direction to them, and how are the responsibilities shared between these personnel and the RO/SRO?

5. Which functions performed by these personnel require the use of procedures? Which do not?

6. What training and certification do these personnel receive? Do you feel that current practice is adequate? What improvements would you like to see in the training area?

7. What is your opinion of the need for an industry-wide training standard and/or certification of these personnel? Who should provide this certification? What involvement should the NRC have?

APPENDIX H

FIELD SURVEY CHECKLISTS AND
INTERVIEW QUESTIONS FOR TRAINING CENTERS

APPENDIX H

FIELD SURVEY CHECKLISTS AND
INTERVIEW QUESTIONS FOR TRAINING CENTERS

Field survey trips to training centers consisted of document research and interviews. This appendix provides a copy of the checklists used for document research and a listing of typical questions asked during interviews. Interviews at training centers were conducted with the following personnel:

- Training Department Supervisor
- Training Department Assistant Supervisor/Senior Instructor
- Instructors.

H.1 FIELD SURVEY CHECKLISTS

H.1.1 OPERATOR TRAINING PROGRAMS

1. Obtain copies of initial training program descriptions and administrative procedures/policies (hot and cold).

2. Determine the process used for certifying trainees as satisfactory operators. What are the criteria for passing this certification?

3. Obtain a copy of simulator training organization chart.

4. Determine criteria employed and means used to certify that candidates are ready for the NRC exam.

5. Ascertain percentage of program designed and administered by utility/ reactor vendor/training service company.

6. Look for general differences between utility-run and contractor-run programs. Comment on any obvious ones.

7. Look for differences in programs provided to on-site operators versus operators from other utilities.

8. Obtain a copy of any existing records of training conducted during a recent period of time (as long as reasonable, based on volume) for comparison with program objectives later. (This might include any certification letters sent to utility by simulator that describes the training given to operators X, Y and Z while at the site.)

9. Obtain copies of procedures for audits (internal or external). Obtain copies of actual audits conducted, if possible.

10. Determine simulator availability for initial training and requalification. Determine the training program capabilities for the number of operators that can be trained. Obtain any copy available of a typical schedule of simulator operations.

11. Obtain list of plants/utilities serviced by the simulator.

12. Determine if any simulator program exists for personnel who fail the NRC exam.

13. Obtain a copy of simulator training organizational diagram.

14. Obtain a copy of any detailed curriculum description that has been previously submitted to NRC (hot and cold).

15. Obtain copies of syllabuses, outlines, training plans, etc. Ensure all phases of simulator training programs are represented.

16. Look for specific training given that defines basic performance expectations and responsibilities for normal, abnormal and emergency conditions for RO/SRO. (This is needed as part of Job Task Analysis.) Copy or record this specific information/outline if not able to bring it away from site.

17. Look for specific training that indicates requirements for advancement from RO to SRO (technical knowledge, practical experience, managerial ability to control shift personnel, etc.). Copy or record this specific information.

18. Ensure that materials brought away from site will provide adequate information on following:

    a) training materials used and percent of program accounted for by each technique
    b) subjects and depth covered
    c) time allotments
    d) overall training methodology employed.

19. Obtain some samples of lecture outlines drill outlines, and evolution outlines actually used.

20. Determine emphasis of training program as a result of simulator's design.

21. Observe some training conducted and make comments on advantages/disadvantages.

22. Collect copies of any major written, oral or operational examinations conducted during the initial training programs (hot and cold).

H.1.2 OPERATOR REQUALIFICATION PROGRAMS

1. Obtain copies of requalification program descriptions and administrative procedures/policies.

2. Obtain a copy of any existing records of actual requalification training conducted (as much as reasonable, based on volume) for comparison later with requalification objectives. (This might include any certification letters sent to utilities by the simulator that describe the specific requalification training given to operators X, Y and Z while at the site.)

3. Determine if any simulator program exists for personnel who fail annual requalification exams. If so, what is it? Also, determine any upgrading program for operators who have had difficulty as reactor operators (marginal performers). Collect specific details on training given for actual cases falling in these categories.

4. Obtain copies of any audit procedures/programs. Obtain copies of any actual audits conducted.

5. Determine percent of simulator time devoted to requalification.

6. Look for differences in requalification programs provided to on-site operators versus operators from other utilities.

7. Determine certification criteria for passing a simulator requalification program.

8. Obtain a copy of the requalification program curriculum with sufficient in-depth information that covers the following areas:

    a) subjects and depth covered
    b) time allotment
    c) training materials used and amount of utilization
    d) emphasis of requalification program

e) methodology employed

f) efforts taken to ensure that safety-related tasks can be carried out effectively

g) efforts taken to ensure that a broad and comprehensive level of understanding in fundamentals is maintained.

10. Obtain copies of outlines/lesson plans/drill plans/scenarios/schedules used.

11. Obtain copies of any final exams/drill scenarios used for certification of satisfactory completion of course.

12. Obtain a list of simulator malfunctions.

H.1.3 INSTRUCTOR SELECTION, QUALIFICATION AND EVALUATION PROCEDURES AND POLICIES

1. Obtain copy of procedures/guidelines/policy within the training center organization for:

   a) initial instructor selection

   b) instructor training (including detailed description of instructor training program)

   c) instructor qualification/certification

   d) instructor periodic evaluation.

2. Determine the criteria used for selection of instructors.

3. Determine the simulator facility procedure/requirements for instructor qualification.

4. Determine current procedures for initial accreditation (after qualification) and follow-on evaluations of instructors.

5. Record factors considered in instructor evaluations. (Obtain copies of any standard evaluation forms.)

6. Determine if customers have any input into the instructors used at simulator facilities.

7. Determine policy/procedure in case of problems with any instructor's competency.

8. Obtain a copy of any incentive policies for instructor qualification or performance.

H.2 INTERVIEW QUESTIONS

H.2.1 TRAINING DEPARTMENT SUPERVISOR

1. From your viewpoint, what are your responsibilities to customer utilities for the initial training and requalification training administered to their personnel?

2. What are the criteria applied to the selection of instructors? What is the rationale behind these criteria?

3. Have you ever had any problems with instructor competency? If so, what actions were taken to correct this situation?

4. What factors do you consider in evaluating your instructors?

5. This question applies to simulators run by utilities:

   For the following areas, what level of corporate management gets involved and what is the degree of involvement in the training and certification process?

a) approval of training program structure
b) approval of program composition
c) performance of periodic utility audits (how often, who does them, depth of audits)
d) approval of key exams
e) certification of preparedness for NRC exam
f) corrective action for NRC/utility audits
g) general training program decision responsibilities.

6. Have you ever had any cases of trainees who failed the simulator course? What action was taken? What procedures are followed in the case of a poorly performing trainee?

7. What are your opinions (pro and con) of NRC practices for implementing training requirements? What are your opinions on NRC enforcement (audit) practices?

8. What is your facility's involvement with utilities that lease time on the simulator and conduct their own training?

9. Have you ever refused simulator time to utilities due to excess demand on simulator time?

10. What are the minimum requirements specified by the NRC for your programs?

11. Do your simulators meet the requirements of ANS-3.5? If not, in what areas are they deficient?

12. Based on the training that you have provided in cold or hot initial training, what casualties do you feel that a graduating team could handle on their own after licensing? What are your obligations to the utility for casualty training?

13. What training do you provide to STA personnel?

14. What improvements in your simulators' capabilities do you see are needed?

15. What is your opinion of the advantages/disadvantages of generic versus plant-specific simulators?

16. Based on the utility personnel you have observed, do you feel that greater emphasis needs to be placed on team training? How might this be accomplished?

17. What are suitable criteria for deciding which simulators are suitable training devices for which plants?

18. What is your opinion of the NRC practice of requiring only a reactor startup for certification on the simulator?

19. What auditing of your training services is done by outside sources and the NRC?

20. What do you think INPO's role should be?

21. On an industry-wide level, what improvements do you feel are necessary in the training, operations and regulatory areas?

H.2.2 TRAINING DEPARTMENT ASSISTANT SUPERVISOR/SENIOR INSTRUCTOR

1. Has your simulator ever been used specifically to help improve the performance of a marginal operator? If so, how is his simulator program different from the standard requalification program provided? How about operators who have failed an annual requalification exam or any NRC exam?

2. Part of our study involves evaluating NRC audit practices. Please describe actual NRC training program audit practices in at least the following areas:

   a) frequency of audits
   b) subject areas of audits
   c) length of audits
   d) distribution of administrative audits versus personnel evaluations or training practices evaluations.

3. What are your opinions of the weaknesses in the current NRC audit program?

4. Please summarize the following concerning the instructors used in your programs:

   a) selection procedures and criteria
   b) qualification procedure
   c) procedure for initial accreditation
   d) follow-on evaluations including factors considered in the evaluations.

5. Describe the procedures for feeding back information on operator errors, design problems and equipment failures to instructors and trainees.

6. What are the various training techniques/methods used in your initial training programs (e.g., individual study, programmed instruction, video tapes, lectures, etc.)? What is the degree of utilization of each? What is the rationale behind this breakdown?

7. During the training program, how is a student's progress tracked? What action is taken in the case of marginal performance?

8. Do you provide any certification that an applicant is ready for his NRC Operating Test?

9. Concerning the criteria used to certify candidates ready for NRC examinations:

   a) What criteria are used for this certification?
   b) Are the certification criteria tailored to NRC evaluation criteria? Why or why not?
   c) Are all NRC exam subject areas independently evaluated?
   d) At what levels and to what degree do utility management personnel get involved in this certification process?

10. Have you ever had any cases of trainees who failed the hot or cold program course? What action was taken? What procedures are followed in the case of a poorly performing trainee?

11. What are your obligations to the utility for casualty training? How adequately prepared do you feel students graduating from your hot or cold initial training programs are for handling casualties?

12. Do you provide simulator training on compound casualties? What limitations do you have in providing training in this area?

13. What methods are used for your simulator modeling? What training problems have you observed as a result of the simulator model?

14. What training is provided to Shift Technical Advisors?

15. During simulator training, what percent of time is spent on:

   a) demonstrations
   b) practice
   c) performance evaluation?

16. How much emphasis is placed on development of diagnostic skills, procedural skills and control skills during initial training and requalification training?

H.2.3 INSTRUCTORS

1. What is your experience background in nuclear power? Would you classify your background as theory or operations oriented?

2. What formal education have you received? What training did you receive to prepare you to be an instructor? Why did you become an instructor?

3. What are your specific responsibilities for teaching? (What phases of training/requalification, subject areas, courses do you teach?) Are there any limitations placed on which courses you are qualified to teach in the initial training and requalification programs? Are other instructors limited in their teaching scope?

4. What is your estimate of the extent to which the simulator provides totally realistic experience?

5. Please describe the simulator's capabilities, including limitations.

6. Based on this simulator's design, what are its areas of training emphasis?

7. What are the current differences between this simulator and the plant after which it was designed? What efforts are made to keep the simulator up with the actual plant design? How successful have these efforts been?

8. From which plants do your typical trainees come and what are the differences between this simulator and those plants? How much of a problem do these differences pose for operators?

9. (This question applied to simulators on reactor sites.) What differences exist in initial training and requalification programs provided to on-site operators versus operators from other utilities?

10. When other utilities send trainees here for initial training or send operators back for requalification training, what do you consider to be your training responsibility to the parent utility?

11. Do you develop your own tests? If not, who does? What are typical pass/fail ratios for your tests? What types are they? How frequently do you administer tests?

12. How is student progress tracked? How do you handle poor learners? Do you provide extra individual instruction? What other techniques are used to assist these people? How involved does utility management get with marginal trainees? Do you feel that the overall effort to assist these people is adequate? Is it appropriate in all cases? If not adequate/appropriate, why not?

13. Do NRC personnel ever observe instruction in progress? Do NRC personnel conduct any other types of audits that affect you?

14. For the requalification program administered:

    a) What areas are emphasized?
    b) What subjects are covered? Mention depth and time allotment.

15. How do you conduct casualty training on the simulator?

16. What improvements in the simulator capabilities do you see are needed?

17. For initial training classes where the utility sends an instructor along with the class, what advantages/disadvantages has this practice presented?

18. What do you think of method used by some utilities where time is leased on the simulator and all the training is done by utility instructors? What training do these instructors get on the operation of the simulator?

GLOSSARY

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AEC	Atomic Energy Commission
ANS	American Nuclear Society
ANSI	American National Standards Institute
AO	auxiliary operator
BWR	boiling water reactor
CFR	Code of Federal Regulations
CRO	control room operator
EPRI	Electric Power Research Institute
ESF	engineered safety features
FSAR	Final Safety Analysis Report
GED	General Education Development Program
I&C	instrumentation and control
IE	Office of Inspection and Enforcement
INPO	Institute of Nuclear Power Operations
LER	Licensee Event Report
MIPA	NRC's Office of Management Information and Program Analysis
NPRDS	Nuclear Plant Reliability Data System
NRC	U.S. Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
NSAC	Nuclear Safety Analysis Center
NSSS	nuclear steam supply system
NUREG	NRC document
OLB	Operator Licensing Branch
P&ID	piping and instrumentation diagram
PORC	Plant Operations Review Committee
PORV	power-operated relief valve
PWR	pressurized water reactor
QA	quality assurance
QC	quality control
RO	reactor operator
RPM	Radiation Protection Manager
SAR	Safety Analysis Report
SCO	supervising control room operator
SRO	senior reactor operator

SRP	Standard Review Plan
SS	shift supervisor
STA	shift technical advisor
TMI	Three Mile Island

NRC FORM 335 (7-77)

U.S. NUCLEAR REGULATORY COMMISSION

BIBLIOGRAPHIC DATA SHEET

1. REPORT NUMBER *(Assigned by DDC)*
NUREG/CR-1750

2. *(Leave blank)*

4. TITLE AND SUBTITLE *(Add Volume No., if appropriate)*
Analysis, Conclusions, and Recommendations Concerning Operator Licensing

3. RECIPIENT'S ACCESSION NO.

7. AUTHOR(S)
L. T. Davis, T. J. Mazour, R. Zaret

5. DATE REPORT COMPLETED

MONTH	YEAR
November	1980

9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS *(Include Zip Code)*
Analysis & Technology, Inc.
Technology Park, P.O. Box 220
North Stonington, CT 06359

DATE REPORT ISSUED

MONTH	YEAR
January	1981

6. *(Leave blank)*

8. *(Leave blank)*

12. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS *(Include Zip Code)*
Division of Human Factors Safety
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

10. PROJECT/TASK/WORK UNIT NO.

11. CONTRACT NO.
FIN B6871

13. TYPE OF REPORT
NUREG/CR

PERIOD COVERED *(Inclusive dates)*

15. SUPPLEMENTARY NOTES

14. *(Leave blank)*

16. ABSTRACT *(200 words or less)*

This report provides an independent perspective to the U. S. Nuclear Regulatory Commission regarding the requirements and practices for control room operator licensing. Analysis conclusions and recommendations are provided in the following areas:

- Selection, training and certification of control room operators,
- Effectiveness of the NRC operator licensing program,
- Methods to assure continued competence of operators,
- Methods for maintaining a highly motivated and dedicated operator work force,
- Upgrading of presently licensed operators to meet proposed requirements,
- Training and qualification of non-licensed operating, maintenance and technical support personnel,
- Qualifications of Operator Licensing Branch (OLB) examiners and
- Organization of the OLB.

17. KEY WORDS AND DOCUMENT ANALYSIS

17a. DESCRIPTORS

17b. IDENTIFIERS/OPEN-ENDED TERMS

18. AVAILABILITY STATEMENT
Unlimited

19. SECURITY CLASS *(This report)*
Unclassified

21. NO. OF PAGES

20. SECURITY CLASS *(This page)*
Unclassified

22. PRICE
$

NRC FORM 335 (7-77)