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GUIDANCE FOR TRAINING PROGRAM EVALUATION

January 1984

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Memphis State University
Center for Nuclear Studies
Memphis, Tennessee

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GUIDANCE FOR TRAINING PROGRAM EVALUATION

JANUARY, 1984

PREPARED FOR

UNITED STATES DEPARTMENT OF ENERGY
ASSISTANT SECRETARY, POLICY,
SAFETY, AND ENVIRONMENT
OFFICE OF NUCLEAR SAFETY

By

CENTER FOR NUCLEAR STUDIES
MEMPHIS STATE UNIVERSITY
MEMPHIS, TENNESSEE

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CHAPTER I

INTRODUCTION AND PURPOSE

INTRODUCTION

An increased concern about the training of nuclear reactor operators resulted from the incident at TMI-2 in 1979. The reaction within the commercial power industry produced, in May 1982, a procedure published by the Institute of Nuclear Power Operations, "The Accreditation of Training in the Nuclear Power Industry."

The response to TMI-2 within the U. S. Department of Energy (DOE) included the "Action Plan in Response to March 1981 Report of the Nuclear Facilities Personnel Qualification and Training Committee." A direct consequence of that Action Plan was an increased emphasis on the quality of training programs; and DOE Order 5480.1A, which gives current training policy and requirements, was published in August 1981. It states that the requirements of American National Standard (ANS) 3.1 shall be followed to the extent they are appropriate for the operation being considered and that the operating contractor of each category-A reactor shall prepare a training plan to be approved by the DOE field office manager. The training plan describes and justifies the selective application of ANS 3.1 to the specific reactor. To continue the concentration on quality in training, this document provides guidance for reviews of training programs for operating personnel at the DOE Category-A reactors.

PURPOSE

The purpose of this guide is to provide a general framework for the systematic evaluation of training programs for DOE Category-A reactors. The primary goal of such evaluations is to promote continuing quality improvements in the selection, training and qualification programs. Evaluations should produce one of two results, either (1) assurance that the training program is achieving the training plan objectives or (2) identification of the actions needed to achieve the plan objectives. Since each DOE Category-A reactor is unique, the objectives of each component of the training program will vary according to job titles, functions, and responsibilities. Therefore, evaluations are not intended to produce identical training programs at all DOE reactors.

The process described in this guide suggests the evaluation of a particular training program in seven review areas as shown in Figure 1. These areas are detailed in Chapter IV.

FIGURE 1

AREAS FOR REVIEW, WITH MAJOR INTERACTIONS

CHAPTER II

DEFINITIONS AND ACRONYMS

DEFINITIONS

Definitions stated here indicate how the terms are used in this document. They should not be construed as requiring any contractor or field office to change its current usage.

Training section: The administrative unit containing the individuals responsible for, among other activities, construction and evaluation of certification examinations. The same unit often, but not necessarily, conducts classroom instruction. In a small operation, the training section might consist of only one individual or part-time assignments.

Operations section: The administrative unit(s) containing the individuals with line responsibility for daily operation of the reactor(s).

Training staff or trainers: Individuals whose primary tasks are in the training function. The definition includes some members of the operations section, and it is broader than that used at some sites.

Certification: Formal recognition that an individual is prepared to assume all responsibilities in a position. This requires (1) the completion of training which leads to the desired level of knowledge and skill and (2) professional judgment of physical well-being and absence of psychological maladjustment. Some sites term this recognition, "qualification." Certification for DOE reactor operators is the equivalent of licensing of operators for the reactors regulated by the Nuclear Regulatory Commission.

Requalification: Periodic, formal recognition that an individual certified for a position continues to be able to assume all of the position's responsibilities.

Reactor Operator and Senior Reactor Operator (as defined in DOE Order 5480.1A):

Reactor Operator An individual certified by contractor management to operate a Department-owned reactor.

Senior Reactor Operator An individual certified by contractor management to operate or to direct the operation of a Department-owned Category A reactor.

The titles used by the respective contractors to identify these positions vary.

Shift Supervisor: An individual certified by contractor management to have highest responsibility for the total operation of a Department-owned reactor during a given shift.

Initial Training: Training intended to lead to the trainee's initial certification as Reactor Operator, Senior Reactor Operator or Shift Supervisor.

Continuing Training: Training after certification.

ACRONYMNS

ALARA - As low as reasonably achievable

RO - Reactor operator

SRO - Senior reactor operator

SS - Shift supervisor

DOE - United States Department of Energy

CHAPTER III

EVALUATION PROCESS

The training program evaluation process recommended follows two steps. First, personnel who are part of the operation and are thereby most familiar with the training program conduct an internal self-evaluation. Second, personnel who are independent of the operation and who should be objective in an assessment conduct a review (i.e. the field office). The training program evaluations are intended to complement existing DOE requirements for annual contractor internal reviews of reactor safety programs and field office comprehensive reactor safety appraisals. To provide DOE continued emphasis on, and assurance of, quality in training, it is further recommended that training program evaluations be conducted approximately every three years if there are significant changes in training needs or longer if the needs are stable. The following sections briefly discuss both steps.

THE SELF EVALUATION

Contractor management should conduct a review of its own training program and prepare a report on that self evaluation before the field office conducts its review. The self evaluation may be conducted as part of, or separate from, the annual contractor internal review required by DOE Order 5480.1A, Chapter VI, Section 6g. The starting point for the review should be the Training Plan approved by the field office in accordance with DOE Order 5480.1A, Chapter VI, Section 6e.

The self evaluation should be comprehensive. All aspects of all the contractor's operator training programs should be examined. Not only should procedures exist, but the self evaluation should verify that procedures are in fact followed. Verification may require interviews and evaluation of tests, lesson plans, and logs. The self evaluation should reflect on the content of previous evaluations, internal audits, or external appraisals, and the response made to them by the training staff.

The self evaluation should also be analytic. It should attempt to identify the strengths and weaknesses of the various components of the training program through comparison with the good practices of Chapter IV. Specific recommendations to remedy any weaknesses identified during the self evaluation should be included in the self-evaluation report.

The self evaluation should also plan or evaluate plans for changes which will be required during the next five or six years in response to continued improvements in the training programs (such as the addition of a simulator or the acquisition of more audio-visual equipment) or in response to anticipated changes in DOE requirements or engineering changes. Staffing needs and projections should also be considered. The self-evaluation report should state the projected changes in the program, the assumptions behind the projections, and deductions from the assumptions, coordinated with overall planning for the organization.

THE FIELD OFFICE REVIEW

After completion of the contractor internal review, the DOE field office with jurisdiction over the training program should select the members of the team needed to carry out its review, using selection criteria appropriate to maximize credibility, to bring expertise to bear where needed, and to increase the likelihood of fresh solutions to problems through new perspectives. In order to find individuals with expertise in (a) nuclear operations, (b) fundamentals or classroom training, (c) on-the-job training, and (d) testing, it may be necessary or useful to use team members from outside the local field office.

The field office should conduct a review of the training program based on the approved training plan, the good practices and evaluation factors contained in Chapter IV, the contractor's self-evaluation report, and other factors considered appropriate by the local field office. The field office should provide an overall judgment of program merits and identify any areas where improvements should be made. It should follow up on the review according to existing local procedures.

The scope of subsequent field office comprehensive reactor safety appraisals could be revised to reflect the training program evaluation by addressing the following during routine appraisals.

- A. Effect of changes in the training program.
 - 1. If the training program evaluation report made recommendations or the last appraisal called for changes, what has the response been?
 - 2. Has the training program changed otherwise since the last evaluation or the last appraisal?
 - 3. Are changes large enough to require a new evaluation process?
 - 4. If changes are minor, do they maintain or enhance the program?
- B. Effect of changes in plant operation or equipment.
 - 1. Are changes large enough to require a new evaluation process?
 - 2. If changes are minor, has the training program responded properly.
- C. Analysis of events (unusual occurrences, etc.)
 - 1. Have any site events indicated training deficiencies?
 - 2. Have any industry events resulted in lessons which should be applied to training programs?

CHAPTER IV

GOOD PRACTICES AND EVALUATION FACTORS

This chapter identifies good practices and evaluation factors for use in training program evaluations. The good practices and evaluation factors were developed based on a review of existing practices at DOE Category-A reactors, related industry practices and the experience of training professionals. Because of the uniqueness of each DOE Category-A reactor, not all of the good practices may be proper for a given training program.

Section A

ORGANIZATION AND MANAGEMENT

Structure

1. The duties, responsibilities, and degree of authority of each staff member should be recorded. Those with managerial responsibilities should be clearly designated.
2. A training section should be sufficiently isolated administratively that undue pressure from the operations section can not influence the training process in the competition for the time of the employees. At reactors with small training programs, the training section may consist of only one individual or a part-time assignment. (Similarly, the training staff in the operations section may have part-time training responsibilities.) However, different individuals should be assigned to the two sections in order to satisfy the need for separate administrative units.
3. The division of assignment between the training and operations section for subject content, classroom training, on-the-job training, oral tests, written tests and practical walk-through tests should be clear. At a minimum level, the training section should be involved in the certification examinations.

4. At each reactor, responsibility for the content of the training--both on-the-job and classroom--should be assigned in order to assure that all areas of training are included. The organizational structure should assure that the responsible individuals have sufficient authority over any other members of the training staff such that the desired content is, in fact, covered. When training is a team effort, authority for carrying out portions of the program may be delegated as long as the responsibility remains with the individuals originally designated.

Functions

Training documents should show how the following functions are performed and/or set forth the responsibility for them:

- a. Establishing the goals of the training program
- b. Developing and modifying the training curricula in accordance with a training needs analysis, job performance evaluation, technological or regulatory changes, or appraisals and internal reviews
- c. Developing training materials and revising them as necessary
- d. Scheduling training activities
- e. Ensuring that new and current instructors are adequately prepared for their assigned tasks
- f. Utilizing a trainee evaluation system to ensure that trainees satisfy entrance qualification requirements and program prerequisites. (This function includes not only determination of the proper requirements but also verification that each trainee meets them.)
- g. Ensuring the proper delivery of the program and improving it if the need is indicated
- h. Evaluating the progress of trainees and counseling them as necessary
- i. Performing routine administrative and clerical chores such as recording of examination scores and filing lesson plans
- j. Auditing trainees' program participation and evaluation results.

Management

1. Management should assure satisfactory training of reactor operators through a combination of active involvement and review. This may include review of course content, examination control and management or involvement in the certification process.
2. For each position on the training staff, a position description based on considerations of job functions, responsibilities, authority, and accountability should exist. Each staff member should understand his responsibilities and how he is to be reviewed by management.
3. Management should encourage trainers to develop professionally. This implies not only providing funds for travel or course work, but also allowing time for the staff to be able to take advantage of the opportunities.

Section B

QUALIFICATIONS OF TRAINING STAFF

1. Minimum qualifications for all training staff positions should be stated which cover the following areas:
 - a. formal academic preparation
 - b. teaching experience (nuclear, non-nuclear, or combination of the two)
 - c. reactor operation experience (total or the amount at the site of employment)
 - d. current or previously held licenses or certifications.
2. If any requirement allows substitution of "equivalent" qualifications, determination of the "equivalency" for an individual should depend on the relevant competencies.
3. Documentation should indicate who verifies that trainers meet the minimum qualifications for the positions they hold. Verification may require transcripts from educational institutions or letters from other organizations.
4. Trainers should continue their professional development by such activities as attending conferences, taking additional college courses, interchanging training ideas with other training organizations, and consulting with educators. (The management role in development must be recognized, as in Section A.)
5. Procedures should exist for the evaluation of each trainer. The evaluation should be frequent enough to monitor any significant changes in the trainer's knowledge and skill.

6. Each member of the training staff should have knowledge of educational techniques sufficient for effective performance in the following:
 - a. to organize a subject
 - b. to establish training objectives
 - c. to design and plan a unit of training
 - d. to present material and otherwise "manage" the learning of trainees
 - e. to evaluate trainees' competence
 - f. to evaluate his or her own effectiveness.

Such understanding may be gained by self study, industry short courses, seminars, or regular college courses in education, such as instructional design, test design, and psychology of learning.

Section C

TRAINEE SELECTION

1. Selection criteria should be consistent with DOE Order 5480.1A, Chapter VI requirements as implemented and approved in the training plan.
2. The following list suggests additional selection considerations.
 - a. Ability to work under conditions of both high and low stress
 - b. Willingness to undergo the training and testing which the job requires
 - c. Interest in science, mathematics and mechanics
 - d. Indications of above-average mechanical ability and manual dexterity
 - e. Ability to communicate orally and in writing at the level the job requires, e.g., to write procedures or to keep logs
 - f. Indications of reliability
 - g. No indication of being accident prone (through previous work or activities)
 - h. Good judgment
 - i. Proven respect for the law.

With due recognition of the difficulty to judge these attributes, interviewers and others who evaluate candidate qualifications should assess them as objectively as possible.

Section D

TRAINING PROGRAMS: CONDUCT AND CONTENT

Training Programs in General

Operator training programs will vary according to whether a component is for initial certification or requalification as well as whether it is designed for operators or supervisors. Programs also vary according to the number of individuals being trained at one time and their previous experience. However, all operator training programs should consider the following practices.

1. The content, emphasis, and depth of coverage of specific components of the training program should be demonstrably related to the job. The complexity of some jobs will require job and task analysis for such a demonstration. Determination of proper emphasis and depth of coverage should be aided by study of procedures for normal and off-normal conditions at the reactor for which training is designated.
2. A written plan for each component of the training program which specifies goals, objectives, content and methods of delivery should exist.
3. Technical and operations staff, as well as training staff, should participate in identifying training needs, development or modification of training programs, and the conduct of training programs. Use of any staff members as instructors should be consistent with their area of expertise and instructional ability.
4. The training program for operators should include not only theory, hardware familiarity, operation, and the application of theory to plant operation, but also consequences of human error, equipment failure, and combinations of error and failure.
5. The time spent on the various subjects should depend on both the importance and the difficulty of the subject matter.

6. Training should be tailored as much as possible to individual speed of learning. Self-paced instruction may be encouraged by means of such aids as programmed texts or computer-based instruction.
7. In order to avoid trainee overload, time should be provided between sessions or modules for absorption and review.
8. A written training checklist (e.g. qualification card) should be used for each trainee, which covers all significant steps of training. The classroom training checklists need not overlap lesson plans or other documentation. On-the-job training checklists are normally more detailed to assure instruction and practice (under close supervision) on every aspect of plant operation.

Only authorized individuals should sign off each item. (Note Appendix B.) If the checklist does not require the trainee's signature for each item, the individual who signs off should inform the trainee that the item is completed; agreement by the trainee provides an internal check on completion.

9. Procedures should exist for review and revision of the training program in response to:
 - a. Engineering change notices
 - b. Reports of "events", "incidents", or "unusual occurrences" (according to site-specific terminology) at the reactor for which training is designated and other reactors
 - c. Audits, appraisals, or other reviews at the site
 - d. Employee suggestions and comments.
10. The overall training program should be periodically evaluated. The evaluation should include persons other than those directly responsible for the training. One aspect should be an evaluation of operators on the job after their certification.

11. The training program should be documented in sufficient detail to permit independent evaluation of the breadth and depth of the training program.
12. Procedures should exist for dismissing trainees or operators who clearly show the inability or unwillingness to meet and maintain minimum competency requirements.

Initial Training (for initial certification as RO, SRO, or SS)

1. As a minimum, the training program should address the following subjects:
 - a. An overview, and an indication of how each subject fits into the reactor operation and its purpose
 - b. Plant orientation, including safety awareness and general design criteria
 - c. Technical subjects:
 1. Mathematics
 2. Physics-Mechanics
 3. Reactor Theory
 4. Chemistry
 5. Reactor Heat Transfer and Fluid Flow
 6. Materials Science
 7. Electricity
 8. Instrumentation and Control
 9. Health Physics
 10. Interpretation of schematics, prints, and drawings
 - d. General reactor topics:
 1. Review of lessons learned from industry experiences (including DOE reactors)
 2. Principles of Quality Assurance, with emphasis on the requirements of the local quality assurance program
 - e. Reactor-specific topics:
 1. Reactor operation, procedures, and limitations including administrative requirements and technical specifications

2. Operator skill exercises performed in the control room or on a simulator
3. Transient prevention, mitigation, and response
- f. Any of the following topics with which the operator will be involved:
 1. Plant instrumentation and control systems
 2. Safety, fire, and emergency systems
 3. Primary and secondary mechanical/fluid systems
 4. Electrical systems
 5. Plant auxiliary and support systems
 6. Plant protection systems
 7. Fuel handling systems
 8. Waste processing systems
 9. Containment or confinement system
 10. Integrated plant operation, system interactions, and casualty response
 11. Reactor design including fuel, instrumentation, and structure.
2. The training schedule should be designed so that trainees can devote themselves fully to training. A trainee should not count in meeting requirements of minimum crew size.

At reactors which use operators who are qualified only for discrete "watch stations," not necessarily as RO's, the operator qualified for one station may contribute to requirements for staffing that station. However, at any time that individual is in training for additional watch stations, he or she should neither be responsible for operation nor be numbered among the operating crew.

3. Study outlines, texts, or lecture notes should be provided to all trainees.
4. Tests should be used to gauge the progress of trainees through initial training as well as to accustom trainees to testing. (See Section E, Examinations.)

5. Procedures should exist for trainees to evaluate classroom and on-the-job training they have received. This should include noting errors or unclear items in training manuals and other learning aids and evaluation of instructors.
6. The training program for Reactor Operators should be designed so that trainees not only learn how to perform duties as instructed but also appreciate the basis for and consequences of any actions they may perform as operators.
7. The training program for Senior Reactor Operators and Shift Supervisors should be designed so that the trainees' depth of understanding goes beyond simple comprehension of the reactor systems as measured by the ability to recall information or predict consequences of actions. They should also learn to analyze problems associated with reactor systems and operations and to develop solutions. In addition, they should be given additional training in subjects related to transients and accident assessment and control, such as reactor thermal-hydraulics, containment of radioactivity, and atmospheric dispersion of radioactivity.
8. Individuals entering positions with supervisory duties should be given additional training on a case by case basis. Topics which should be covered if the trainee does not have adequate proficiency include behavioral sciences (emphasizing supervisory techniques and performance evaluation) and effective communication. Particular skills which may be addressed are how to be aware of changes in individual behavior and how to correct departures from accepted procedures.
9. If a simulator is used, each operator trainee should practice routine manipulations and enough abnormal or emergency responses to give the trainee experience in coping with the unexpected. Selection of exercises should be based on probability of occurrence, severity of consequences, and difficulty of responding correctly, not ease of

simulation. Attention should be given to precursors of design basis accidents.

10. Trainees should receive significant portions of their training or instruction from more than one individual. Several different modes of delivery should also be utilized. A mode of delivery denotes training by video-tape, film, programmed text, simulator, or computer-assisted instruction, in addition to face-to-face training.
11. If they are indicated by a review of an individual's prior training and experience, tests should be administered which allow the entering trainee to demonstrate competence equivalent to that provided by part of the training program. The initial training should reflect the test results. Trainees should not be exempted from sections of the program without satisfactory testing, and they should not be exempted from sections on plant specifics.

If the training given an individual differs from the standard sequence, the reasons (e.g. prior education, training, experience) for modifying the program should be documented.

Training After Initial Certification

1. The requalification training program should review selected fundamental knowledge areas, reactor operations, and procedures.
2. The continuing training program should also provide for keeping the knowledge and skills of operators current with respect to:
 - a. Equipment and plant modifications
 - b. Changes in technical specifications
 - c. Changes in operating procedures
 - d. Unusual occurrences, accidents, or near misses which occurred locally, or elsewhere, if appropriate
 - e. Changing sources of radioactivity, criticality potentials, or other environmental hazards, and any changes in permissible exposures to sources
 - f. New outlooks or methods regarding ALARA concepts.

3. To the extent that any operator or supervisor positions have occasional responsibility for on-the-job training or "check off" of trainees, the continuing training program should also cover training techniques for those positions. Such instruction may be part of a "train-the-trainer" program or may be specially developed for those personnel whose primary responsibility is in operations.
4. The program and the way it is administered should be designed to motivate operators to increase their job competency, not merely maintain their current level.
5. The program should have provisions for assuring the competency of operators who have been off the job for longer than an acceptable length of time.
6. Drills on abnormal or emergency procedures should be run with reasonable frequency. Conditions of the drill should be as realistic as possible without endangering property or personal welfare. Some of the intent of this practice can be met by training on a full-scope simulator, but some of the drills should be plant based.
7. Operators and supervisors should be encouraged to describe any examples of particularly good or bad practice or particularly safe or unsafe conditions they have observed.

(One way to accomplish this is in scheduled sessions which may be held in association with other meetings. Leaders of such sessions would guide the discussion so that practices and conditions, rather than particular individuals, are discussed. They would be aware that each session serves at least two functions. (1) It is a training aid in itself as it encourages employees to be aware of good or bad practices (and what makes the difference) and to identify means of increasing safety and effectiveness. It also gives practice in thinking through and articulating improvements. (2) The session would also be an aid to training and to operation because of recommendations which may come out of it. All valuable observations and recommendations forthcoming would be conveyed to appropriate plant personnel, for review and necessary action.)

Section E

EXAMINATIONS

1. Certification as a RO or SRO requires (1) a written exam, (2) an oral exam, and (3) a plant/systems demonstration exam, sometimes called the practical exam. No examiner should be the trainee's immediate supervisor.

If a simulator is available, some of the testing for certification should take place on that simulator. (See number 14, below.)

2. Certification as a Shift Supervisor requires both a written exam and an oral exam. The exams should be of sufficient duration to demonstrate that the SS not only knows all relevant details of the operation, but also has the analytical ability to deal with new situations.
3. The certification process may require a series of steps which show the trainee's qualifications in various areas or various levels of responsibility. However, the examinations immediately preceding certification should be comprehensive, dealing with all knowledges and skills implied by the certification.
4. The unanimous approval of all examiners should be required for recommending certification; i.e., either the training section or line management may require repetition of some portion of the training process before certification is complete. The formal certification for RO or SRO should be signed by a manager who has responsibility for both training and operations sections and, for SS, by the plant manager or equivalent.
5. All written exams should be proctored.

6. Practical and oral exams should be flexible enough to allow the examiner to explore any weaknesses displayed by the trainee. The line of questioning may be expanded in order to determine the extent of explanation or retraining needed.
 - a. Practical or walk-through exams should follow an outline to assure coverage of specified areas.
 - b. Before an oral exam, not only the intended questions, but also the correct responses should be recorded to the degree necessary to provide a basic structure for the exam.

Following each exam, highlights and major deviations from the outline or the expected line of questions and responses should be recorded. In addition a brief rationale for assignment of the overall grade should be included.

7. All incorrect answers on oral or written examinations should be explored with the trainee to determine extent of misunderstanding. Further explanation and/or retraining should be given as necessary on all missed questions no matter how high the grade was. Trainees who generally perform poorly should be interviewed about their study habits and other causes of their performance.
8. The same written examination should not be given on more than one occasion. An effective way to accomplish this objective is to draw questions from a bank in order to construct each examination. A question-and-answer bank, which contains many more questions than are asked at any one time, may be stored securely in paper or computer files.
9. Question-and-answer banks, if used, should be reviewed periodically to delete obsolete questions and to add timely ones. Questions should be reviewed to assure that each training area is adequately covered and that a particular question is not repeated too frequently on different examinations.

10. Exams should be composed primarily of comprehensive essay, sketch and describe, and calculation type questions, with judicious use of fill-in-the-blank, and cautious inclusion of true/false, matching, and multiple-choice questions.
11. Examination questions should be reviewed by at least one person other than the preparer before they are given to trainees.
12. All questions should be reviewed to determine whether they relate to the knowledges and skills required by the job and whether they achieve their intended purpose. For all types of questions, validity requires clarity and lack of ambiguity. Since a trainee may be able to give the correct response to multiple-choice or true/false questions without possessing the desired knowledge, the test preparer who uses such questions should be competent on the subject of test validity.
13. In addition to any question bank, the actual questions asked on written exams should be recorded. The questions may be filed separately from the trainee's records. Graded answers should be kept in the trainee's file.
14. If a simulator is used in training, then examinations on simulator training should demonstrate the trainee's ability to manipulate the controls safely and competently, predict instrument response, use available instrumentation, follow facility procedures, understand alarms and annunciators, and respond appropriately and promptly to them.
15. Each examination should be viewed as a whole to judge the proportional emphasis given all topics. The weight given any subject on an examination should reflect the importance of the objective which underlies the subject.
16. The level of understanding expected on an examination should be consistent with the level of instruction.

Section F

SUPPORTING RESOURCES

In general, training programs should be supported through provision of adequate space for lectures, audio-visual aids, preparation of training materials, and secure storage of records. The learning environment should be conducive to concentration and as free as possible from distractions; this concern applies both to individual study and to group instruction.

The larger the number of operators trained each year, the greater the need for facilities such as classrooms, laboratories, study areas, and a simulator, and the more they can be justified in terms of expense per trainee.

The use of all materials--books, lesson plans, audio or visual aids, and computer programs--should be reviewed regularly.

Library

1. Textbooks, handbooks such as Standard Steam Tables and Table of Radio-nuclides, and reference books sufficient to support each course of study should be readily available, at all times, to trainers and trainees.
2. Trainees should have controlled access to the library used by the control room, which may hold additional documents such as operating procedures.

Lesson Plans

1. Lesson plans should exist for all courses.
2. Lesson plans should be approved by a qualified member of the training staff other than the individual who prepared the plan.

Audio-Visual Aids

1. Balanced use of audio and visual aids should be encouraged in all classroom settings as they help maintain the interest of trainees and allow the presentation of material in ways which are impossible for a "live instructor." The following guidelines are offered for obtaining the right balance, but the numbers are not intended to be strict limits:
 - a. Approximately every four hours of lecture time should be supplemented by some appropriate audio or visual aid material.
 - b. Courses of study which extend over a period in excess of about one month should be supplemented by the use of relevant films, video tapes, or computer-aided instruction.
 - c. Any course of study should have "live instructors" available to answer questions.
 - d. In the initial training program, the trainee should spend at least one third of his time with "live instructors."
 - e. In the requalification program, no more than half the review sessions should be film or tape.
2. Catalogs and film or tape listings should be reviewed on a regular basis to identify any relevant material.
3. For larger training programs (those with approximately ten or more trainees in a program at one time) the training facility should be equipped with overhead or slide projectors and screens or projecting surfaces. Film projection and sound equipment or video tape equipment should be available for occasional use. Slides should project with large enough print to be clearly read by a trainee at the farthest distance from the projecting surface.

Computer or Simulators

1. Computer programs used in academic instruction or other computer-based training and computer simulations of reactor responses should be evaluated for relevance with respect to the job.
2. Results and/or performance records of computerized instruction sessions should be kept in a confidential-security file. This file should be reviewed as soon after each training session as possible.

Section G

OPERATOR COMPETENCY CHECKS

One means of measuring the effectiveness of a training program is to evaluate indicators of operator competency. Presumably, if a training program meets its goal of making operators knowledgeable and skilled in their jobs, evaluating operator performance over a period of time will demonstrate the program's success.

Problems in operator performance suggested by the evaluation of the following factors should be analyzed to arrive at their causes. Because interpretation of the evaluation factors is complex, and not all relevant measures of operator competency now exist, the absence of problems identified by this evaluation does not necessarily imply the absence of problems in the training program. However, these factors should be evaluated in conjunction with the foregoing good practices.

Evaluation factors:

1. Interpretation of unusual occurrence reports and logs. Since the reactor's design "forgives" some human error, analysis of unusual occurrences and other events is needed in order to evaluate the appropriateness of actual operator actions.
2. Interpretation of drill critiques or other internal or external reports on operator performance under simulated or invented situations.
3. Review of training examination questions and answers.
4. Interview of operators by (a) management as a part of internal audit or self-evaluation or (b) members of a field-office team.

5. Interpretation of operator turnover, including rates and reasons, in the context of general industry conditions.
6. Comparison of operating time and safety records with similar reactors.
7. Interpretation of supervisors' performance evaluations of employees (to the extent such records are open to the evaluators).
8. Observation of operators performing normal and off-normal events (to the extent observation is possible).

APPENDIX A

ITEMS WHICH GENERALLY SHOULD BE INCLUDED IN AN ON-THE-JOB TRAINING CHECK LIST FOR A SYSTEM

1. Location, identification and purpose of all system equipment (pipes, valves, pumps, filters, checkvalves, relief valves or electrical switchgear). Trainee to trace flow of fluids or sources of electrical power.
2. Location of instrument sensors, parameters sensed, parameter of primary importance, method of transmission of information, readout locations and time constants where important.
3. Rules, limits and procedures governing system operation.
 - a. Relief valve settings
 - b. Normal and expected abnormal conditions of:
 1. flow
 2. temperature
 3. pressure
 4. vibration
 5. odor
 - c. Alarm setting and automatic action levels, including any logical conditional actions.
4. Trouble indications.
5. Consequences of operator errors.
6. Interfaces with other systems.
7. Operating experiences under supervision.
 - a. Times system placed on line
 - b. Times system shut down
8. Integration of system into the plant.
 - a. Effect of system operation on reactor
 - b. Items which influence system condition
9. Emergency procedures.
10. Hazards to operator's health.

APPENDIX B

GUIDELINE FOR GIVING SYSTEM CHECKOUTS

1. COMPONENT AND SYSTEM DESIGN

Understand the design well enough to explain operation and predict failure modes.

2. SYSTEM KNOWLEDGE

- a. Be able to draw a one line diagram or schematic of the system and discuss normal and abnormal line-ups.
- b. Know the location of components.
- c. Know how the system is controlled and what instrumentation is used on the system.
- d. Be able to explain the impact on the system of component failure and impact on the plant of system failure.

3. BASIC ENGINEERING PRINCIPLES

Demonstrate adequate knowledge of engineering principles associated with the system, such as heat transfer and fluid flow, basic electricity, and reactor theory.

4. SYSTEM OPERATION

Demonstrate adequate knowledge of all phases of system operation as follows:

- a. System startup
 1. Know what power systems are required for system startup.
 2. Be able to explain when to put system in operation during a plant startup, and how long it should take to make the system operational.

3. Know what other plant systems must be in operation before a given system can be started up and how startup of the remaining plant systems depends on the operation of the given system.
4. Thoroughly understand any administrative requirements that are placed on the system startup.
5. Demonstrate the ability to start up the system using approved procedures.
6. Be able to identify the safety hazards of the system startup.

b. Normal Operation

1. Know what parameters are expected to change during normal operation.
2. Know what parameters are not expected to change during normal operation.
3. Be able to identify any trends that could lead to out-of-spec conditions.
4. Know how to respond to out-of-spec readings, and know the possible consequences of improper response.
5. Know the capabilities and limitations of the system during normal operation.
6. Thoroughly understand any administrative requirements during normal operation.
7. Demonstrate the ability to perform all routine operations of the system using approved procedures.
8. Be able to identify the safety hazards of normal operation.

c. Shutdown

1. Explain the effects of system shutdown on other plant systems.
2. Be able to explain how to isolate and tag out a system for maintenance.

d. Abnormal and emergency procedures

1. Know the immediate actions.
2. Be able to discuss the time element involved (whether the action should be taken before notification of Shift Supervisor).
3. Understand the consequences of taking improper action and of taking no action.
4. Be able to discuss the basis of the emergency procedures (as they become available).
5. Be able to predict consequences of failures if no operator actions are taken, including pertinent times, radiation levels, heat levels, etc.

APPENDIX C

CHECK LIST OF TYPICAL MATERIALS TO BE PREPARED, COLLECTED, OR MADE AVAILABLE FOR THE FIELD OFFICE REVIEW TEAM

1. A "crosswalk" which relates names and titles of positions and other nomenclature of the particular site to the corresponding terminology of DOE Order 5480.1A, Chapter VI and ANS 3.1.
2. An organization chart showing all those with training responsibilities and the connection between training and the line organization.
3. The identification of the components of the training program, e.g., classroom instruction for initial training of reactor operators.
4. For each component, a plan showing:
 - a. goals and objectives
 - b. content (in sufficient detail to allow judgment on adequacy)
 - c. methods of delivery
 - d. assignments of members of the training staff (the last time the component was offered).
5. For each component, a list of the materials, e.g., study outlines, provided to each trainee.
6. Drill scenarios, critiques, and schedules.
7. Copies of recent written exams and the documentation on recent oral and walk-through examinations.

8. Check lists or "qual cards" for all operating positions.
9. For each member of the training staff -- both training section and operations section -- a summary of qualifications, including coursework (credit and non-credit), degrees, work experience, and certifications or other credentials.
10. For the last two years, statistics on trainees. For initial training, this should include the number of trainees beginning each program and those reaching the various levels of certification, accompanied by dates. For requalification training, statistics should include numbers of examinations given, by date, and some indications of extent of activity such as the number of lectures or drills. Additional information should be compiled as it aids interpretation of the magnitude of the training program.
11. Unusual occurrence reports.
12. Logs.
13. Safety analyses.
14. Rates of turnover for the operating staff and some interpretation of the rates.
15. Operating time and rates for the reactor(s) with reasons for down time.
16. A plant description, at a level of detail which allows a team member to learn what is relevant to training.

APPENDIX D

DISCUSSION OF GOOD PRACTICES

This appendix provides a general discussion and background information and references relative to the good practices in the following areas:

- a. Evaluating trainer effectiveness
- b. Evaluating program effectiveness
- c. Observing "depth of understanding"
- d. Applying measures of test validity.

Evaluating Trainer Effectiveness

Part of the measure of the trainer comes through evaluation of the program's effectiveness. To the extent that the contribution of individuals can be identified, program review aids in the appraisal of individual trainers. A major part of the evaluation of trainer effectiveness, however, must be directed at training competency.

A trainer's competency can be judged by whether the trainer possesses (1) the knowledge and skills which he plans to teach and (2) the basic training skills required for imparting knowledge to his students and involving them as learners. Trainers who teach plant-specific material, such as systems, can be judged to possess the relevant knowledge and skills (a) if they have been certified or licensed for reactor operation or have acquired significant operating experience, and (b) if they have maintained currency regarding the operations of the plant at which they work. Trainers who teach theoretical material, such as basic reactor physics, can be judged to possess the required knowledge if they have received appropriate classroom training and have maintained their level of knowledge. Competency in the subject area does not necessarily require an academic degree.

Teaching, as a behavioral skill, is more multifaceted than knowledge acquisition and retention. Effective classroom teaching or on-the-job

training requires several different skills. The following list gives indications of desired qualities in the trainer (most, though not all, apply to both classroom and on-the-job training):

1. Is well-prepared each time he gives a lecture, slide show, demonstration, or other presentation
2. Shows good organization by having thought through a course of study
3. Shares materials with students which help guide their thoughts and learning. The materials spell out learning objectives clearly and consistently and show good organization generally.
4. Is sensitive to the backgrounds and abilities of the trainees, and is thereby able to present material at a level which they can understand
5. Has realistic expectations of what trainees can absorb
6. Speaks clearly and distinctly and with a delivery which maintains attention
7. Understands trainees' questions, even when poorly expressed, and can either answer them clearly or lead the trainees to the correct answer
8. Maintains appropriate discipline
9. Maintains good rapport with trainees
10. Writes examinations which accurately evaluate how well trainees have mastered the learning objectives
11. Is interested in the result of his teaching.

Evaluating Program Effectiveness

Effectiveness has elements of both quality and efficiency. A first step in evaluation may be simply to ascertain the degree of satisfaction of parties affected by the training program: trainees, operators who have been trained, trainers, supervisors, and management. Any indication of lack of satisfaction should be traced to the cause, and it should be recognized that unhappiness is not necessarily the responsibility of training.

Since a major goal of training is to produce competent and effective operators, one way to check the quality of training is to evaluate its products -- the trained operators. Errors, oversights, and miscalculations of operators should be examined with the intent of discovering why the

mistakes were made. Discovery of the causes may identify weaknesses in the training programs.

Relative quality may be judged by individuals who are acquainted with more than one training program. Any review should take advantage of the presence of individuals who can compare training programs through either previous employment or other contacts.

Having decided what the program should accomplish in general terms (the goals), trainers need to specify measurable objectives. The issue then becomes whether satisfying the objectives -- a condition which can be determined -- will necessarily assure achievement of the program's goals -- which might not be directly measurable. Although it may not be possible to complete a thoroughly logical link between objectives and goals, the attempt should be made.

The attention paid to on-the-job training effectiveness should be in accord with the major importance of on-the-job training. Its complete evaluation would determine the extent to which trainees learn to use all their senses during plant operation. As much information should be derived from check lists (or qual cards) as possible. Among other efforts, check lists should be studied to see if they provide their potential benefits:

- a. Indicating the preferred sequence of training in a long, involved process
- b. Providing an easily used audit tool to assure that no significant element of training has been inadvertently omitted
- c. Providing a ready indication of the trainees' progress to certification and requalification (with regular review by management)
- d. Providing a record of who gave the training (through the trainer's signature) and the date it was completed.

Observing "Depth of Understanding"

A standard division of cognitive objectives was created by Benjamin Bloom; see Taxonomy of Educational Objectives, Handbook I: Cognitive Domain, (David McKay Company, 1956). The categories are supposed to indicate the

intended behavior of the learner, ways of thinking or acting if instruction is successful. The categories, from simplest to most complex, are knowledge, comprehension, application, analysis, synthesis, and evaluation.

The relevance of this hierarchy to the good practices appears when evaluating content of training: not only is the topic important, the intended behavior of the trainee must also be considered. Both delivery of the training and testing should be based on the "depth of understanding" expected. "Comprehension," as defined by Bloom includes the ability to give examples, to extrapolate trends, and to point out consequences. "Application" involves applying concepts in new situations. Both of these levels of understanding are generally appropriate for a reactor operator's job. However, the position of SRO most probably requires understanding at a higher level of complexity involving both "analysis" (i.e. finding assumptions and discovering relationships) and "synthesis" (i.e. requiring the combination of pieces into a structure not clearly there before). Training materials and examinations should reflect these differences.

For more information refer to NUREG/CR-1750, "Analysis, Conclusions, and Recommendations Concerning Operator Licensing" (Section 2.6, January 1981).

Applying Measures of Test Validity

A test is valid if it measures what it is supposed to measure. If training objectives are clearly specified, then the examinations are supposed to measure the extent to which trainees have mastered the stated objectives. Some instances of lack of validity are easy to check; for example, a physics-mechanics test which contained several problems on electricity would not provide a valid measure of how well a student has mastered physics-mechanics.

Ideally, trainers know the relative importance of the various facts, concepts, principles, and routines they are trying to teach. Emphasis on the various topics during the course will subsequently match the relative importance. Examination questions should then be weighted, in terms of number and difficulty, to match the degree of importance of the various training objectives.

This same principle of giving exams which are valid should be applied for all subjects -- those which are systems and operations oriented as well as fundamentals -- and for all forms of tests -- written, oral, and demonstration.

Particular care must be given to the writing of multiple-choice and true/false questions. Although some material (such as definitions and the step sequence of an operating procedure) lends itself well to testing by multiple-choice and true/false questions, guessing can distort the test score. In addition, such questions are particularly susceptible to incorrect responses because of poor wording. Some bad practices on true/false tests are (a) using words such as "only," "generally," "frequently," or "never," (b) using double negatives or unnecessarily involved statements, and (c) making true items consistently longer or shorter than false items. Some bad instances of multiple-choice questions are (a) revealing answers by the use of "a" or "an" at the end of the stem and (b) writing some choices so that they do not follow grammatically from the stem.

Some statistical tests of validity are relatively easy to apply. For one, assume that a written examination has been given. A completed examination can be divided in two, for example, by odd-numbered and even-numbered questions, and the scores on each half calculated. If the separate scores are too divergent, the exam may not be valid. For a second check on a written exam, after the usual grading the statistician can arrange the answer sheets in order by total score and separate the top third and the bottom third of the class. If any question is missed by more students in the top third than the bottom third, the question may be misleading. For more information, refer to College Teaching: A Systematic Approach by James Brown and James Thornton, Jr. (McGraw Hill, 1971) or Principles of Educational and Psychological Measurement and Evaluation by Gilbert Sax (Wadsworth Publishing Co., 1980).

APPENDIX E

TRAINING PROGRAM EVALUATION QUESTIONS

This appendix contains a series of questions that may be used as a checklist in conjunction with the good practices and evaluation factors contained in Chapter IV. The questions parallel each of the seven sections in Chapter IV.

ORGANIZATION AND MANAGEMENT

Is there any organizational chart or other documentation which clearly shows the duties and responsibilities, as well as degree of authority, of each staff member? Are individuals with managerial responsibilities clearly designated?

Does the training section exist separately from the operations section? Are the two sections sufficiently isolated administratively so that the operations section does not bring undue pressure to bear on the training in competition for employee time? Is the relationship between the training section and the line organization responsible for reactor operations clearly documented?

Which positions, sections, or offices have responsibility for subject content, classroom training, on-the-job training, oral tests, written tests, and practical walk-through tests? Does the organizational structure assure that the individuals with responsibility for the content of training -- both on-the-job and classroom -- have sufficient authority to determine that the desired content is covered?

Which training documents show how each of the following functions are performed?

- a. Establishing the goals of the training program
- b. Developing and modifying the training curricula in accordance with a training needs analysis, job performance evaluation, technological or regulatory changes, or appraisals, and internal reviews.

- c. Developing training materials and revising as necessary
- d. Scheduling training program activities
- e. Ensuring that new and current instructors are adequately prepared for their assigned training tasks
- f. Utilizing a trainee evaluation system to ensure that trainees satisfy entrance qualifications requirements and program prerequisites with respect to aptitude, knowledge, and skills (Is it always verified that new trainees do meet the requirements?)
- g. Ensuring the proper delivery of each training program and improving it if the need to do so is indicated
- h. Evaluating the progress of trainees and counseling them as necessary
- i. Performing routine administrative and clerical chores such as recording of examination scores and filing lesson plans
- j. Auditing trainees' program participation and evaluation results

How do management personnel obtain assurances of satisfactory training of reactor operators? How is management involved in training?

Is there a position description based on job functions, responsibilities, authority, and accountability, for each position on the training staff? Does each staff member understand his training responsibilities and what aspects of his work are to be reviewed by management?

How are members of the training staff encouraged to develop professionally?

QUALIFICATIONS OF TRAINING STAFF

Do training section guidelines clearly state the minimum qualifications for all training staff? How were the minima determined?

Some trainers may have acquired competence in technical subjects by job experience and self-study. Does the training section have an established procedure for judging the equivalence between such experience and formal academic training with respect to the desired technical competence?

Are established procedures, such as obtaining transcripts and letters of reference, followed to verify that trainers meet the minimum qualifications for the positions they hold.

Do trainers continue their professional development? How?

How often do training supervisors evaluate the training effectiveness of individual trainers? What areas do these evaluations check?

Are the trainers themselves trained in educational techniques? How have the trainers learned the skills necessary for training?

TRAINEE SELECTION

Do those in charge of trainee selection understand the need to recruit individuals who, because of their work histories, education, native abilities, and personalities, have a high probability of becoming successful and satisfied reactor operators?

What additional attributes are judged during trainee selection? Are they job related? How were the selection considerations developed?

TRAINING PROGRAMS: CONDUCT AND CONTENT

After identifying each component in the training program, for each component is there a written plan which specifies goals, objectives, content, methods of delivery, and training staff member assignments? Are the goals and objectives appropriate?

What procedures have been used to assure that each component and its content are related to the job? Is the content adequately related? Is the depth of coverage adequate?

How do reactor designers and the technical staff, such as health physicists and engineers, participate in the training of operators?

Do operator training programs adequately cover theory, hardware, operation, and consequences of human error and equipment failure?

What training materials, such as texts, lesson plans, and audio-visual equipment, are utilized during training? How do they contribute?

Does the amount of time spent on the various subjects reflect the importance of the underlying objectives?

Is adequate time allotted for generically different types of training, such as classroom, simulator, systems and walk-throughs? Are type of training and type of subject always consistent?

Are reasonable efforts made to tailor training to suit individual speed of learning?

Are trainees given enough time between sessions to absorb the material?

Is a written training checklist used for each trainee? Do the checklists cover all significant items on which training is given? Is each item on each checklist properly completed by an authorized individual throughout each training program?

What standard procedures assure that the content, emphasis, and depth of coverage of training topics are reviewed whenever it is necessary to respond to the following:

- a. Engineering change notices?
- b. Reports of "events," "incidents," or "unusual occurrences" (according to site-specific terminology)?
- c. Audits, appraisals, or other reviews at the site?
- d. Employee suggestions and comments?

How often are regular reviews of all training programs performed?

Whenever the training program is modified or updated, do operations, technical and training staff all play a role sufficient to ensure that the revised material is correct and maintains proper emphasis on site specifics and practical operations?

When was the last time the overall training program was evaluated?

Are all training procedures written clearly and explicitly?

What are the procedures for dismissing trainees or operators who cannot meet and maintain minimum requirements?

Can trainees devote themselves fully to their training program? What chances for distraction are there and how are these handled?

At what points are trainees tested? Is that timing adequate?

Do the evaluations which trainees make of their training reach the supervisors of the training staff? What use is made of the evaluations?

Are trainees encouraged to correct errors and to suggest improvement in the training materials?

What evidence is there for Reactor Operators to have gained an appreciation for the consequences of any actions they may perform as operators? Is an attempt made to give them that appreciation?

How does the training of SRO's and SS's differ from that of RO's in terms of level of understanding? In particular, how are they trained in areas such as accident assessment and control? What evidence is there of accomplishing the desired level?

How does the training staff determine what additional training is needed by an individual who is working toward a supervisory position? How are the topics covered?

What operational exercises, if any, are required for all trainees? How were these chosen?

In initial training, how many different individuals present material to the trainees? How many different modes of delivery are used?

Who reviews each trainee's prior background before his or her initial training begins? What determines if the trainee is tested for competence equivalent to that provided in part of the regular program? Are reasons documented for modifying the program for any given individual?

In requalification training, how are review areas selected?

How are the following fed into the requal training program:

- a. Equipment and plant modification?
- b. Changes in technical specifications?
- c. Changes in operating procedures?
- d. Unusual occurrences, accidents, or near misses which occurred locally, or elsewhere, if appropriate?
- e. Changing sources of radioactivity, criticality potentials, or other environmental hazards, and any changes in permissible exposures to source?
- f. New outlooks or methods regarding ALARA concepts?

Does requal training of operators and supervisors include a section on training of new operators?

Does requalification training motivate operators to increase their job competency?

Does the program have a provision for operators who show significant deficiencies in knowledge or skills?

Does it provide for operators who have been off the job for an excessive period? What period of time is considered excessive?

Is a simulator, if available, used in requal training?

How often does each operator participate in a drill on abnormal or emergency procedures?

What attempts are made to make requalification training palatable to operators? Are the attempts adequate?

EXAMINATIONS

For certification as RO, SRO, and SS, what examinations are utilized? How long are they? Who gives them? Are the examiners qualified? Do the certification examinations, in all, cover all relevant material in the depth and at the level required? How is it determined who passes? Is the standard adequate?

Is unanimous approval of all examiners necessary for a recommendation for certification?

Are written exams adequately proctored?

Are practical and oral exams flexible enough to allow exploration of trainee weaknesses while still following sufficient structure to assure the intended coverage? Are the exams documented with outlines of content and rationale for the grade assigned?

Is there follow-up with the trainee on all questions missed? Is generally poor performance investigated with the trainee?

How are the objectives accomplished that no written examination is given on more than one occasion and that no particular question is repeated too frequently?

How frequent is the review of questions and answers stored in a bank (if a bank is used)?

What fraction of the questions on an examination are comprehensive essay, sketch and describe, or calculations? What fraction fill-in-the-blank? Are the fractions appropriate?

Are questions reviewed by someone other than the preparer before they are given to trainees?

Have any members of the training staff who prepare examinations received training on test validity? What statistical tests have been applied to the questions given trainees? How have examinations been examined for validity?

Does the documentation on tests include all written questions asked of any operator during the training process, the answers given, and the grade assigned? Are all records secure?

In addition to comprehensive examinations for certification, are trainees tested after each segment of training?

If a simulator was used in training, are there examinations using the simulator? Does success on the exam imply, to the extent possible, that the trainee will maintain safe and competent operation?

Does the weight given any subject on the examinations reflect the importance of the objective which underlies the subject?

Is the level of understanding expected consistent with the level of instruction?

SUPPORTING RESOURCES

What facilities, library, audio-visual aids, computers, and other resources support the training program?

Considering the size and needs of the specific training program, are the supporting resources adequate?

How often are textbooks and other study materials reviewed?

Are lesson plans for all training sessions available? Is the process of their approval adequate?

Is the use of audio and visual aids balanced properly with respect to presentations by members of the training staff?

If visual aids are used, does the size of the screen or monitor relative to the number of trainees allow adequate visibility?

If computer assisted instruction is used, how is validity determined?

OPERATOR COMPETENCY CHECKS

Does study of unusual occurrence reports and logs imply any weaknesses in training?

Does analysis of drill critiques demonstrate any areas in which training should be improved?

Do answers given on examinations show any systematic gaps in the training program? Are any gaps shown through interviewing of operators?

When operators resign or when trainees drop out of the program, is there an attempt to determine the reasons? Does analysis of the reasons and the statistics of turnover provide any insight into the training program or the selection process?

Is the operating time and safety record at this site in line with similar reactors? If not, are there any implications for training?

Do supervisors' performance evaluations of operators imply that any training efforts should be improved?

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