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Power Plant Staffing

Prepared by W. Wegner

Basic Energy Technology Associates, Inc.

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POWER PLANT STAFFING

I. PREFACE

The U.S. Nuclear Regulatory Commission (NRC) is currently reassessing its requirements regarding the selection, training and licensing of all categories of personnel involved in the operation and maintenance of licensed nuclear power plants. Part of this reassessment includes considering the applicability of experience and practices associated with non-licensed nuclear power plants and other complex industrial activities that may involve considerations similar to nuclear power plants. This report outlines the results of a comparative review of current NRC requirements, licensed nuclear power plant practices and the Naval Nuclear Propulsion Program procedures for the selection, training and qualification of personnel involved in nuclear plant operation and maintenance.

The basis used for the comparison, insofar as the Naval program is concerned was the "Statement of Admiral H.G. Rickover, USN, Director, Naval Nuclear Propulsion Program Before the Subcommittee on Energy Research and Production of the Committee on Science and Technology, U.S. House of Representatives, May 24, 1979."

The basis used for the comparison involving current civilian nuclear power plant practices were source documents from three nuclear utility companies and the reviewer's background knowledge of such practices. No visits to civilian nuclear power plants were authorized for this review, and no such visits were made. Therefore, recognition should be given to the limited coverage of this aspect of the review along with the knowledge that wide variation of current civilian nuclear power plant practices exist.

Recognition should also be given to the rapidly changing requirements and practices as a result of the accident at Three Mile Island (TMI). This review considered only existing requirements and practices now in use, not those being contemplated such as proposed revisions to ANS 3.1.

II. INTRODUCTION

This report discusses the results of a comparative review of the selection, training, qualification and requalification of:

1. Maintenance personnel

2. Operators

3. Shift supervisors

4. Senior onsite managers

involved in the operation and/or maintenance of nuclear power plants. It also contains recommendations to improve the NRC requirements and civilian practices.

III. BACKGROUND

Before discussing the results of a comparison between the selection, training and qualification of operators, supervisors and maintenance personnel as practiced at NRC licensed plants and those of the naval program, it is essential to understand some of the differences which exist between the two insofar as personnel functions and responsibilities are concerned. These differences make it difficult to present a simple one for one comparison. However, knowing what these differences are and understanding why they exist, makes the comparison performed more meaningful. Some of these differences are:

1. The Navy, being a military organization, operates with officers and enlisted personnel. This line of demarcation does not have a direct counterpart in civilian nuclear plants, such as between union and non-union, white collar and blue collar, or between supervisory and non-supervisory. Background, education, training and career patterns can be markedly different between these two Navy groups.

2. All naval personnel who are involved with the start-up, operation, and maintenance (as used in this report) of the Navy's nuclear plants are "nuclear trained" and are "nuclear qualified". This means they have successfully completed the 6 months Nuclear Power School course and the 6 months prototype training program. Some large percentage of them will have "qualified" on specific watch stations aboard their ship. This applies not only to the enlisted personnel but also to the officers who stand watches involving operation of the plant.

3. Typical in any navy shipboard organization each person, officer or enlisted, has two functions or assignments. One is his departmental or division responsibility, while the other is his watch assignment. Thus, an officer may be the Main Propulsion Assistant, the Electrical Division Officer or the Reactor Controls Division Officer. In addition he will have a watch assignment such as Engineer Officer of the Watch.

The divisional responsibility includes maintenance, repair, training, etc., whereas the watch responsibility involves the direct on-watch operation of the plant. In civilian plants these two functions are normally carried out by two separate groups of people.

4. Another significant difference between naval and civilian practices is in maintenance philosophy. In the naval program, because of its very nature, the assigned crew must be capable of performing at-sea maintenance and

repair to that degree necessary to keep the plant operating. Thus the crew is trained and qualified to perform extensive repairs at sea without assistance from any outside source. In addition to this capability, the Navy maintains an effective tender or base repair capability for those ships at their homeports using naval personnel. Major repairs, overhauls, and refuelings are performed by shipyards, both private and government owned.

5. There are fundamental differences which exist between how the Navy acquires its personnel and how civlian organizations acquire theirs. In the nuclear Navy, enlisted personnel are recruited from civilian life predominantly at the high school graduate level. They are enlisted for a 6 year term by way of a Nuclear Field Recruit Program and are brought into the Navy in three basic rates:

a. Machinist Mates (MM's)

b. Electronic Technicians (ET's)

c. Electrician Mates (EM's) and (IC's)

There are no "nuclear" rates in the Navy. After they reach a particular point in their training and qualification they are given a nuclear designation, but they continue to hold their basic rates in the three categories listed above. This procedure is followed for good reason in that it allows the Navy to reassign its people throughout the fleet as the needs exist. However, it is from these three basic rates that nuclear qualified personnel are drawn.

Essentially all officers used in the nuclear program are brought in at the point of graduation from college, rather than at higher nuclear experience levels.

6. Another difference which bears on the comparison between the NRC's senior operators vs the Navy's (Engineering Officer of the Watch) is the amount and degree of supervision each one receives. On a ship, the EOOW is the senior person on watch who has direct responsibility for the operation of the reactor. However, there is always, whenever the reactor is operating, at least one more senior officer with nuclear experience onboard and within immediate call in case the EOOW requires assistance. For example, the Commanding Officer, the Executive Officer and the Engineer Officer ar persons who usually possess years of naval nuclear operating experience. While the ship is underway all of these are onboard and are on immediate (within seconds) call of the EOOW if he requires assistance. In case of a reactor plant casualty aboard ship, the word is immediately passed over the ship's announcing system, and depending upon the tactical situation faced by the ship, one or more of these senior people will immediately proceed to the control room to either advise or take control.

This situation is in contrast to the civilian nuclear plant case where there may be times when the senior operator may be the only senior licensed operator at the site and the only immediate assistance he can obtain is by telephone.

This difference is significant and would indicate that greater reliance is being placed on the civilian senior operator.

IV. MAINTENANCE PERSONNEL

For the purposes of this review the term "maintenance" personnel means those personnel assigned to a nuclear power plant for conducting normal maintenance of the plant and its equipment. It will not include personnel especially brought onto the site for major overhauls, refuelings, conversions, modifications, new construction, or decommissioning. For shipboard application, the term "maintenance personnel" refers to those naval personnel permanently assigned to the ship's force in the engineering department of a nuclear powered ship.

A. Types of Maintenance Personnel Considered

1. Electronics Technicians
2. Radiation Technicians
3. Chemistry Technicians
4. Test Technicians
5. QC Inspectors
6. Machinists
7. Electricians
8. Welders
9. Pipefitters
10. Grinders
11. Carpenters
12. Lead Burners
13. Riggers
14. Sheet Metal Workers
15. Pipe Coverers
16. Painters
17. Cleaners
18. Burners/Chippers
19. Helpers

NOTE: The job titles listed above are typical. Specific titles and job categories may vary at different sites.

B. NRC Requirements Relating to Maintenance Personnel

1. Eligibility Requirements

There are no eligibility requirements issued by the NRC covering the previously listed maintenance trades and professions with the exception of those covered under "Qualification" requirements discussed below.

2. Training Requirements

NRC training requirements for maintenance personnel is broadly outlined in ANSI 18.1 1971 as follows:

> "5.1 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."
>
> "5.3 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."

"5.3.4 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."

"5.4 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."

3. Qualification Requirements

NRC qualification requirements for maintenance personnel is contained in ANSI 18.1 1971 as follows:

"4.1 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."

"4.5.2 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."

"4.5.3 Repairmen

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."

4. Requalification Requirements

There are no NRC requirements for requalification of maintenance personnel other than the following ANSI 18.1 1971 statement:

> "5.5 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 programs for appropriate evaluation of its effectiveness."

C. Industry Practice for Maintenance Personnel

There are wide varieties of industry practices in handling the selection, training, and qualification of maintenance personnel at nuclear utility plants, depending on the number of plants at the site, the size of the utility company, the degree of work subcontracted out, and the degree of union involvement with the company.

During construction and where industry/code qualification requirements exists for trades, they are generally followed. This includes welders, QC inspectors, electricians, machinists, etc. In many cases the people are hired by the utility on the basis that they already possess a "license"; for example, the hiring of a state-licensed electrician. In other cases, the utility will hire nonlicensed mechanics, such as helpers, and will provide necessary on-the-job training to allow advancement into journeyman status.

In those cases where the utility company subcontracts its labor force, or portions of it, the utility may specify the degree of competence or license desired.

Most utilities have attempted to develop a maintenance force of their own employees after the heavy labor-intensive construction period. This works to their advantage, since work force stability and dependability is much better than with subcontracted labor. However, for economic reasons, utilities try to hold that maintenance force to a minimum level commensurate with the normal expected maintenance work load. During extended shutdowns when the maintenance work load is usually high, they may be forced to hire subcontracted labor or temporary employees. As a consequence, permanent utility maintenance employees are likely to be more qualified to do nuclear repair work than are the subcontracted types or the temporaries.

The permanent maintenance work force does not have all of the nineteen crafts/professions previously listed. For example, most utilities will not attempt to maintain on their permanent staff, craftsmen who are qualified lead burners because there is usually little need for them except on special occasions. Also, in an attempt to keep the number of permanent employees to a minimum, many utilities, to the maximum extent possible, will try to combine trade cognizance across several lines; i.e., welders will do their own grinding, other mechanics will function as machinists, etc. The degree to which this is done is, in many cases, dependent on existing union contracts.

Another variable is the degree to which the individual utilities interpret the coverage of Section 4 of ANSI N18.1 1971 insofar as who are considered "Maintenance Personnel" and what work constitutes maintenance. For example, individuals in training or apprentice positions must be permitted to perform work in order to obtain the required experience to become journeyman level.

There are many maintenance operations where there is little doubt or argument by management as to the need for strict interpretation. However, where this falters is at the working level. When there are many jobs that need to be done and there is pressure to get the plant back to power, people are assigned to do jobs because their supervisors "feel" they are qualified to do them, rather than strictly following the qualification requirements. Procedures do not usually specify the work that must be performed by a person having a particular qualification. There are no posted lists which specify which craftsman has a particular qualification to do specific work on the plant. These decisions are generally left up to the foreman or the maintenance group manager.

Each utility company has a training program for its maintenance personnel. The scope, depth, and duration of it varies widely between the different companies and between the various crafts at a site. The common base, or least amount of training, consists of a two or three day site orientation course which covers security, quality control and general work/employee practices. In addition, the company will provide a two or three day indoctrination course in radiation control. Beyond that, the training responsibility is usually handed over to the maintenance trade shops where, depending on the trade skill involved, on-the-job training starts. In some cases fairly extensive classroom training takes place such as in the case of electronics technicians who will eventually work on reactor I&C equipment.

Very little if any requalification takes place except where a person leaves the site or job area for an extended period of time and returns, or when a person's job performance degrades such as to warrant additional training and requalification.

D. Major Differences and Recommendations for Maintenance Personnel

1. Difference:

In naval plants all personnel who perform maintenance are nuclear trained and in addition to their maintenance responsibilities they have responsibility to operate the systems they are maintaining. As a result they have achieved some level of watch-standing qualification aboard the ship to which they are assigned. The Navy does not differentiate between its operators and maintenance personnel. By virtue of their training, these Navy maintenance personnel have a background in the fundamentals of reactor design, operation and safety in addition to the craft training they have received. They are examined on this and other aspects of their duties every year.

Recommendations:

Personnel who conduct maintenance on any reactor system should be qualified and licensed by the NRC. To this end 10 CFR 55 should be revised to create a new category entitled "reactor technician". A reactor technician would be any person who conducts or oversees maintenance, repair, test or overhaul of any equipment or system in the primary reactor plant on systems which have a direct bearing on reactor safety or the release of radioactivity to the environment.

The NRC license for a reactor technician should be based on a formal affidavit submitted by the utility company attesting to the fact that the individual has met the following requirements:

a. Attended and successfully completed a classroom course of instruction lasting at least 12 weeks covering:

Basic principles of reactor operation
Basic principles of reactor safety
Reactor Systems
Steam systems
Electrical systems
Quality Assurance
Radiation Protection
Site emergency systems
Industrial Safety

b. Has demonstrated to the satisfaction of the appropriate Group Leader or Manager that he or she possesses the necessary trade skill to perform the intended work.

c. Has had at least three years of experience in the trade skill involved.

d. Has met the qualification requirements as specified in applicable codes, i.e., welding, radiography, etc.

e. Is a high school graduate or has met the GED equivalency requirements.

f. Has been employed by the utility company and has worked in the plant as a helper, apprentice, or assistant technician for at least six months.

The NRC license for the reactor technician would be valid for three years and would be renewable upon resubmittal and updating of the above affidavit and confirmation that the individual has performed satisfactorily in the job. Periodic examinations should be conducted to assure the technician has retained the basic information covered in the classroom lessons. Refresher courses should be given if necessary. NRC inspectors and on-site representatives would audit compliance with these requirements.

The utility company should be required to post in the control room a list of currently licensed reactor technicians. All reactor plant work requests/authorizations should be required to specify whether or not a licensed reactor technician is to be used. The completed work document would be signed by the licensed reactor technician performing the work along with the expiration date of his license.

Under these rules, all radiation technicians would be licensed reactor technicians.

The following category of individuals while needing to be qualified in other respects, would not need to be licensed reactor technicians:

- cleaners
- painters
- insulation craft
- carpenters
- on-site crafts who work only in shops such as the machine shop
- quality control inspectors

Persons acting as direct line supervisors of licensed reactor technicians would be required to meet at least one of the following:

a. Be a licensed reactor technician, or

b. Be a licensed reactor operator or senior operator

2. Difference:

All maintenance on naval reactor plants and their associated equipment is performed in strict accordance with written procedures or technical manuals issued and approved by headquarters. Shipboard personnel are not authorized to change or to deviate from these instructions without headquarters written approval, except in emergency situations and then only with the approval of the Commanding Officer.

Recommendations:

Amend 10 CFR 50.34 to include a requirement that the applicant have, and submit for NRC review, a procedure which covers the performance of normal and preventive maintenance of reactor plant and other safety related systems. This procedure should require verbatim compliance with other approved procedures covering all aspects of the job. This overall maintenance procedure should cover the approvals required to change, alter, or omit any of the procedural steps included in the specific maintenance procedure.

3. Difference:

Normal and preventive maintenance practices and the performance of the maintenance personnel both overall and individually are reviewed and audited yearly by the Fleet Examining Board, and more frequently by the Type Commander and headquarters.

Recommendations:

10 CFR 50 Appendix BI already requires the applicant to verify by audits the effectiveness of his quality assurance programs, including maintenance. NRC should periodically check the applicant to determine if he is, in fact, conducting these audits and how effective they are in finding and resolving deficiencies in the maintenance program. These audits should also include periodic tests to determine that the individuals have retained their proficiency in all areas of importance.

4. Difference:

In naval plants there is no person whose sole job is maintenance. Maintenance is considered an essential element of operation. The Engineer Officer and his Division Officers are responsible for maintenance in the same manner as they are for operation, training, etc.

Recommendations:

No change is recommended on the basis of this difference except that maintenance should be covered in the applicant's training program for operators and senior operators. In addition, NRC should include questions on maintenance in their written and oral examinations for operator and senior operator licensees. In this manner an awareness of the importance of maintenance and the special considerations involved can be further developed.

5. Difference:

Whenever a situation develops aboard ship such that the issued procedures either to not cover the required maintenance or the scope of the maintenance is considered to be beyond the capability of the shipboard personnel, headquarters dispatches to the ship either an approved procedure for performing the maintenance or sufficient technical personnel from outside sources such as:

a. the reactor plant contractor
b. vendor
c. headquarters
d. shipyard

The procedures which these technical personnel will use are also approved by headquarters.

Recommendations:

If item 2, above, is carried out, the utility company will be forced to develop a system to handle this situation. It will be up to NRC to ensure that utility company procedures require technical judgments of this nature to be made at an appropriate level within the organization and with sufficient technical review. Also see item 6. below.

6. Difference:

For naval plants the reactor plant contractor is required to maintain within its organization a group of technically qualified people who are responsible for the operation and maintenance of the reactor plant throughout the entire life of the plant. They are cognizant of the specific construction details of the plant and all of its equipment on each ship such that if a problem develops they understand the system design basis, they have the correct up-to-date plans, a record of tests previously performed on that component, and knowledge of the past operating history. These people are on call 24 hours a day, seven days a week. In addition, because there are more than one plant of a given design, they have the reports of the operating history from the other plants.

Recommendations:

This difference is a major area of concern and a difficult one to correct. While it is not specifically tied to selection, training, and qualification of maintenance personnel, it has a direct bearing on it. The level of qualification of an individual who is going to do work on a reactor plant is dependent on the degree of verbatim compliance required, the completeness and accuracy of the procedure and the extent of technical back-up talent available to help if the need arises. Utilities have varying amounts of in-house technical capability. However, none have the depth of experience, background material or the know-how that exists in the major reactor plant contractor organizations. It is here where the reactors were designed and all of the nuclear safety analyses were performed. Consequently there should be a requirement that for as long as a particular reactor exists, there must be a technical responsibility link between the reactor plant contractor and the owner. There is no likelihood that nuclear utility companies, even if they wanted to, could ever achieve such a technical capability. Therefore the reactor plant contractors must perform that function, which they are not doing today.

There is an additional consideration which appears to need clarification and that is the continuing role and active participation of the architect-engineers once the plant construction is completed. Today it is usual practice for a utility company to contract with an architect-engineer for specific jobs i.. the post-construction period. It may or may not be the same architect-engineer who was involved in the construction. The degree of coordination between the architect-engineer and the reactor plant contractor varies considerably. In some cases the reactor plant contractor has no knowledge whatsoever of design or equipment changes which have been made. It is also noted that, because of the looseness of the control exercised by the utility companies, architect-engineers and reactor plant contractors in the conduct of reactor plant maintenance, it is not likely that accurate records are readily available that would tell a person precisely what the true "as-built" condition is.

It is recognized that to achieve correction of these problems will require substantial contractural changes in existing arrangements between utilities, reactor plant contractors, and architect-engineering firms. Perhaps this is a problem better solved by the industry with NRC merely insisting that they arrive at some solution.

7. Difference:

Each shipboard reactor plant has an assigned shipyard whose function is to maintain an accurate up-to-date set of as-built plans for that specific plant. The shipyard maintains close liaison with the reactor plant contractor and is also on call 24 hours a day. Thus there are at least two locations where accurate technical information resides.

Recommendations:

This item has many of the same features as item 6. above. The essential element in both items 6. and 7. is that there needs to be one central repository other than the utility, where not only all the detailed technical information resides, but where there is technical control and the qualified people necessary to make the technical decisions.

For example, a qualified reactor technician is directed to conduct a routine rod alignment check in accordance with an approved procedure. In doing so he notes that one of the required meter indications is out of tolerance. After advising the Senior Operator, he performs the called-for adjustments and still the indication is out of tolerance. He reports this to the Senior Operator who must decide whether or not a reactor safety issue is involved. He will make that decision then and there but will still be faced with correcting the problem. It is not clear today, just how long it would take for a competent person to confirm that a reactor safety problem does or does not exist, or if such a confirmation ever takes place at all. It is also not clear that such a malfunction would ever be reported through the "unusual occurrence" reporting system.

8. Difference:

There is a reporting system which requires the ship to promptly document any instance of equipment or system failure or maloperation and the action taken to correct the problem. This report is transmitted to headquarters where it is catalogued, reviewed, and corrective action is taken if required. These reports are used to correct designs, methods of operating, training, repair parts, etc. In particular, this system provides an excellent basis to evaluate the performance of the personnel associated with the maintenance and operation of the plant.

Recommendations:

Current requirements contained in ANSI N18.7 1976, paragraphs 4.3.4, 5.2.7 and 5.2.12, if properly interpreted and enforced, would correct this difference. However, these requirements are being interpreted very loosely and in such a way that most "minor" repairs, adjustments and replacements are not being reported far enough into the system to have any effect. It is recommended that this standard be revised to make it useful for determining trends in the performance of personnel, systems, or components and permit evaluation of the need for design changes, replacement of components, training improvements, or procedure revision.

9. Difference:

Only those repair parts which are specifically authorized by the component technical manuals are permitted to be used in conducting maintenance or repair of reactor plant equipment. Exceptions, if any, must be authorized by headquarters.

Recommendations:

This can be corrected by amending ANSI N18.7 1976, to require the utility to have a system which places tight controls on who can authorize substitutions of specified parts.

10. Difference:

A major tenet of naval reactor philosophy is plant cleanliness. All plants are continually inspected for this at all levels of management. It is believed that this emphasis on cleanliness reflects back to the plant operating and maintenance personnel attitudes. It shows the owner's concern about the plant and a strong desire that its overall condition not be allowed to deteriorate. In such an environment, maintenance personnel would be expected to perform with greater care and attention to detail.

V. OPERATORS

A. Definitions

For the purposes of this comparative review, the term "operators" will consist of the two following categories:

1. Licensed reactor operators as defined in 10 CFR 55.4(d), namely an:

"Operator" is any individual who manipulates a control of a facility. An individual is deemed to manipulate a control if he directs another to manipulate a control."

This definition, as it has been applied by the industry and NRC, generally covers only those persons in the control room who actually operate the reactor plant console, i.e., those controls which have direct bearing on the status of the reactor.

2. Other operators which include auxiliary operators, station attendants, etc., but do not include maintenance technicians. These "other operators" include personnel who are in training for licensed reactor operator. This category consists of personnel who are on shift and may be directed by a licensed reactor operator or senior reactor operator to manipulate some piece of reactor plant equipment such as valve positioning, electrical switching, or the like.

B. NRC Requirements for Operators

1. In the case of licensed reactor operators, the eligibility, training, qualification and requalification requirements are delineated in ANSI Standard N18.1 1971 and NUREG-0094. These requirements are summarized in Tables 1 and 2.

2. NRC requirements for "other operators" are delineated in ANSI Standard N18.1 1971, and are summarized in Table 1.

C. Industry Practices for Operators

1. 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.

2. 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.

3. 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.

D. Navy Operators

Before a Navy enlisted man can qualify as an "operator" on a nuclear ship he will have met the following requirements:

1. Enlisted in the Navy as a Nuclear Field Recruit (NFR) for a period no less than six years. Entry into the NFR

program is voluntary. Normal Navy enlistment is four years. Will have met certain requirements to enlist in the nuclear program, namely:

a. Age requirements (17-26).

b. Physically qualified - not only meeting normal Navy requirements, but also radiation physical standards.

c. Be a high school graduate or equivalent (GED).

d. Taken a series of written examinations (ARI/GCT) and oral interviews.

e. Successfully answered, in writing, a questionnaire relating to moral turpitude, i.e., drug usage, police record, etc.

f. Selected one of four Navy rating programs: Machinist's mate (MM), electricians mate (EM), electronics technician (ET) or interior communications electrician (IC). Only ET's are permitted to achieve qualification as a reactor plant control panel operator. Other rates are used for other watch stations throughout the plant.

2. Prior to entry into the nuclear program, and after enlistment, he will have successfully passed through the following training programs:

a. Recruit training.

b. Class "A" School in the rate of his selection. Duration varies depending on the rate:

MM - 9 weeks (approximately)

EM - 14 weeks (approximately)

ET - 30 weeks (approximately)

IC - 16 weeks (approximately)

Class "A" schools teach basic theory and some practical application in the specific rate. Nuclear Field Recruits (NFR) attend Class "A" school along with rest of Navy's input (nonnuclear). In some of the rates, during about the last 1/3 of the course, NFR's are separated and given instruction unique to nuclear plants but still within the rate.

c. Depending on convening dates of Nuclear Power School (NPS), some graduates of the "A" school may:

(1) Go directly to NPS to start a 6 months course.

(2) Go to sea on a nonnuclear ship awaiting start of NPS.

(3) Go to NPS but enroll in a pre-Nuclear Power School. Length of attendance at the pre-Nuclear Power School, which is located at the NPS, depends on results of the following:

(a) ARI/GCT tests.

(b) "A" school performance.

(c) Results of NPS diagnostic test given at end of "A" school.

3. Will have successfully passed the 6 months NPS course for enlisted students. NPS course teaches basic theory relating to nuclear power. All instruction is conducted in the classroom.

4. Will have successfully passed a 6 months practical course of instruction at a naval prototype plant. There are 8 such plants located at 3 sites. Student will have actually "qualified" on the plant. Those selected to be qualified as engineering lab technicians (ELT's) will remain at the site for an additional 3 months for extra training in radiation control and water chemistry.

5. Will have been assigned to a nuclear powered ship, taken a series of specified training programs conducted by the ship, and will have passed a series of written and oral examinations conducted by the ship. The ship's training programs include:

a. A basic engineering qualification (BEQ) course which, in addition to being a review of course material covered at NPS, covers basic reactor plant theory applicable to the specific plant installed on his ship.

b. A watch qualification program involving standing watches under instruction throughout the plant. Specific watches will depend on the ultimate qualification he is attempting to obtain.

c. The watch qualification program also involves completion of each item of a watch qualification guide by obtaining signatures, usually several hundred, that he has demonstrated, through discussion, actual practice, or written tests, his knowledge and abilities.

d. He will be given a final comprehensive written examination and a series of oral examinations. The scope of these examinations will depend on the watch station for which he is striving to obtain qualification. For example, the Commanding Officer of the ship is required to conduct personally an oral examination prior to qualifying the prospective watchstander as "reactor operator", i.e., the reactor plant control panel operator.

6. The shipboard qualification program described in paragraph 5. above, varies in length depending on the individual ship, the ability of the person qualifying, and other factors, but usually takes 6 to 9 months.

7. Once qualified on the ship, he is then allowed to stand his watch in the plant. However, during the first several months he is watched closely by more senior and experienced personnel until a degree of confidence in his capabilities has built up.

8. At this point while maintaining qualification for his watch station, the process of training continues and the individual begins the qualifying process for an advanced watch station.

9. In summary, he will have spent approximately two years in formal Navy schooling prior to his arrival at the ship and he will have spent 6 to 9 months on the ship before standing his first watch as a qualified operator.

E. Differences and Recommendations

There are so many differences which exist between how the Navy selects, trains and qualifies its operators in comparison to industry practices, it is impractical to attempt to list them. Previous sections in this report point out how these two programs operate. Therefore, only those differences which indicate a needed change in industry/NRC practices will be outlined.

1. Difference:

Obviously, one major difference between civilian and Navy practice is in the use of simulators. The Navy does not use simulators and Admiral Rickover has presented the reasons in his May 24th testimony previously mentioned. The civilian nuclear industry relies heavily on the use of simulators in its training programs. The NRC recognizes and gives credit for the use of simulators. In the case of simulators, it is not a question of who is right or wrong because the circumstances which lead to their use or lack of use are entirely different. Thus, in this case, a comparison of differences does not produce a clear direction.

Recommendations:

It appears that insofar as the civilian industry and NRC are concerned, the question that needs to be addressed is: are 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. 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 inter-relationships 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.

2. Difference:

The people in the Navy who are auditing and evaluating the effectiveness of a ship's training and qualification program have a responsibility to the Navy to make sure the ship is operable. This may appear to be a conflict of interest but in reality it is not. Audit teams are chartered not only to evaluate and to criticize, but to provide assistance where weaknesses are noted. For example, if the Nuclear Propulsion Examining Board (NPEB) examines a ship and finds serious problems, the ship and senior officers up the chain of command are immediately notified. People from these higher commands are dispatched to the ship right away, and in some cases, the members of the NPEB will remain with the ship, while corrective action is undertaken. In other words, all the people who are involved; the ship, the NPEB, the fleet, etc., are brought to bear to fix the problem. It is essential that the Navy have an operating fleet of nuclear ships. Great effort is expended to erase any attitude of "we" and "they".

In the civilian nuclear power industry this is not the case. The NRC has become and is tending to become even more so, an adversary to industry and vice versa. There may be good justification for this to have occurred. It is recognized that NRC is in a regulatory role and can not cross over into one of advocacy. However, it does appear that some correction of this problem is needed on both sides of the argument.

Recommendations:

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.

3. Difference:

The Navy places great significance on a person's moral and life-style habits prior to entry into the nuclear program. This involves his prior arrest record, his prior use of unlawful drugs and his past performances. He is required to sign certain statements relating to these issues. If he refuses to divulge such information, he is not accepted. If he refuses to allow the Navy to probe into these areas (Privacy Act) he is not accepted. He is interviewed, not by a psychiatrist, but by a nuclear trained experienced person whose function is to make a judgment as to whether or not the individual is suited for the intended job.

While utilities do some of this, to varying degrees, this review indicates several deficient areas. For example, utilities make use of ex-Navy nuclear trained personnel. In many cases, the mere fact that they are from the Navy's program is accepted as sufficient. The Navy is not permitted to release performance information on an individual without that person's written consent. Thus, it is possible for a nuclear trained navy person to be disqualified from the nuclear program for any number of reasons, get out of the Navy, and apply for a job at a nuclear utility. In his job application he need not disclose his disqualification. If the utility attempted to obtain that information, the Navy would not be permitted to release it. This same situation could occur with job applicants from prior positions other than the Navy.

Recommendations:

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 withhold information on his application for a license.

4. Difference:

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.

Recommendations:

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.

5. Difference:

In its selection process for enlisted operators, the Navy use written examinations as a means to determine acceptance into the program. These are standard Navy examinations (ARI/GCT) which tests 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 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.

Recommendations:

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.

6. Difference:

Throughout the nuclear training program the Navy adheres to a very strict policy on performance. Students are given clear directions as to what is expected, what is passing or failing, and what it takes to be disenrolled. These procedures are faithfully followed and as a result about one-third of those who start do not finish. As previously pointed out, this method of operating is just one more segment of the philosophy of the entire program. From the very beginning when a young person comes in the program, he is repeatedly faced with the concept of being told what the requirements are and what will happen if they are not carried out. He soon learns that people are checking upon him and that if he fails to perform, he will be brought to task.

In the civilian nuclear industry this philosophy is not carried out. Specifically in the case of training, utilities, once they have hired an individual, will generally tolerate any level of performance. People that fail tests or courses are merely sent back to do them again until they eventually pass. 10 CFR 55 permits a person to retake the license examination an unlimited number of times with the passage of sufficient time. Such procedures engender loose adherence to requirements.

Recommendations:

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.

VI. SHIFT SUPERVISORS

A. Definitions

In the context of this review, shift supervisors will be considered licensed senior reactor operators (SRO's) and will be compared with Engineering Officers of the Watch (EOOW's).

An Engineering Officer of the Watch (EOOW), insofar as a nuclear ship is concerned, is an officer who has been selected, trained, qualified, and designated as a nuclear trained officer. He has been qualified as an EOOW in his ship by his Commanding Officer. He is the senior officer on watch in the engineering plant of the ship. All persons on watch in the engineering plant report to him. He is responsible for the operation of the plant, its safety, emergency action and anything going on in the plant. He directs all operations.

B. NRC Requirements for Shift Supervisors

NRC requirements for eligibility, training, qualification and requalification of shift supervisors are contained in ANSI N18.1 1971 and NUREG-0094. These requirements are summarized in Table 1 of this report.

C. Industry Practices for Shift Supervisors

As in the case of operators, civilian industry practices generally follow the NRC requirements. However, as previously indicated, ANS 3.1 1978 and proposed Revision 2 to Regulatory Guide 1.8 are used even though not required. All of the comments made in Section V.B of this report concerning industry problems with operators equally apply to the case of shift supervisors.

D. Navy Practices

Before a naval officer can qualify as an Engineering Officer of the Watch (first-line operating supervisor) on a nuclear ship he will have met the following requirements:

1. He will have entered into the Navy's nuclear power program by applying (volunteering) and meeting the following requirements:

a. Age requirements: no older than 27 years of age.

b. College graduate (4 year curriculum) having successfully completed one year of calculus through differential and integral calculus, and one year of calculus-based physics.

c. Physically qualified.

d. Meet requirements of moral turpitude sufficient to be granted an appropriate security clearance.

e. Have been interviewed in Washington, D. C. headquarters of the Department of Energy's Deputy Assistant Secretary for Naval Reactors. These interviews consist of at least three individual interviews by senior technical staff personnel and the Deputy Assistant Secetary himself. In about two-thirds of the cases, written examinations in math and physics are administered during this interview period.

2. The Navy acquires its officers for the nuclear program through three sources: U.S. Naval Academy, NROTC colleges, Nuclear Power Officer Candidate (NUPOC) program. Officers selected for the nuclear program from the NUPOC program must attend the Navy's Officer Candidate School (OCS) for 16 weeks.

3. Successful completion of the Navy's 6 months Nuclear Power School (NPS). This course teaches basic theory relating to nuclear power at a higher level than that taught to enlisted personnel. All instruction is conducted in the classroom.

4. Successful completion of a 6 months practical course of instruction at one of the Navy's 8 nuclear prototype plants. Students will have actually "qualified" on the plant. During this phase, the officer will qualify on all enlisted watch stations in addition to qualifying as an EOOW.

5. Will have been assigned to a nuclear powered ship and will have "qualified" on that ship's plant. This takes about 9 months and involves the following:

a. A basic engineering qualification (BEQ) course which, in addition to being a review of course material covered at NPS, covers basic reactor plant theory and application to the specific plant installed on his ship.

b. A watch qualification program involving standing watches under instruction throughout the plant.

c. The watch qualification program also involves completion of each item of a watch qualification guide by obtaining signatures, usually several hundred, that he has demonstrated, through discussion, actual practice, or written tests his knowledge and ability.

d. He will be given a final comprehensive written examination and a series of oral examinations. He must be given his final oral examination by the ship's Commanding Officer.

6. This entire program, from the time he enters the Navy as an officer until he stands his first EOOW as a qualified watch stander is about 2 years.

E. Differences and Recommendations for Shift Supervisors

1. Difference:

EOOW's are naval officers selected into the program through a tough but well-defined system. Quality input is maintained even to the sacrifice of quantity. High standards of performance are instilled from the first moment of selection and are emphasized throughout the training program. Each candidate knows he has a 5 year commitment. He may fail, but he can not quit. The training program is structured so that all students must work hard to succeed. No one, regardless of his background or intelligence, can just breeze through. Standards for passing or failing the courses are clearly defined and enforced without waivers. There is every incentive to finish the courses and finish them well. There is no incentive to "drift along". He is constantly examined as to his understanding and retention of knowledge. His examinations are orals or essay written. There are no true or false or multiple choice examinations. There is no self-pace teaching. His training is competitive and he knows it. The higher his relative standing, the better chance he has of selecting his duty station. His prototype instructors are qualified and experienced operators, many of whom are sea-returnees. His rewards are ample:

a. Recognition in the form of special bonuses which are substantial.

b. Pride in being part of a small, elite group of officers who have successfully passed through the most difficult program the Navy has to offer.

c. A sure path to future, better-than-average promotion if he continues satisfactory performance.

d. The prospect of a select civilian career if he elects to resign at the end of his commitment.

e. Knowledge that he is an integral part of the nation's number one major deterrent to war.

In the civilian nuclear industry a shift supervisor comes from two sources. He can either be promoted up from the ranks of an operator, or he can be brought in directly from outside and made a shift supervisor without passing through the job as operator. In either case, his selection, training and qualification generally follows that of an operator but with greater experience required. All of the comments provided in Section V of this report relating to differences and recommendations have direct applicability to shift supervisors.

However, there are two additional differences that should be highlighted which are unique to the shift supervisor and the EOOW's.

The one difference has been discussed in the various reports and studies emanating from the Three Mile Island accident and has to do with the proper manning of the control room. NRC has already issued interim requirements on the stationing of a Shift Technical Advisor in the control room.

Recommendations:

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. Difference:

The other difference which we believe has a bearing on long term safe operation has to do with the time spent on watch and the total time a person spends in shift-type operations.

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.

Recommendations:

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.

3. Difference:

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 complaint 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.

Recommendations:

NRC with INPO assistance should encourage the utilities to face up to this problem.

VII. SENIOR ONSITE MANAGERS

A. Definitions

For the purposes of this review Senior Onsite Managers are Plant Managers, Plant Superintendents, Site Managers or any other title used to designate that individual who is the senior utility manager at the reactor site in charge of the safe operation and maintenance of the plant. This corresponds to the definition contained in ANSI N18.1 1971, which states:

> "3.2.1 Managers
>
> Positions at the functional level of manager are those to which are assigned broad responsibilities for direction of major aspects of a nuclear power plant. This functional level generally includes the plant manager (plant superintendent, or other title), his line assistants, if any, and the principal members of the operating organization reporting directly to the plant manager and having overall responsibility for operation of the plant or for its maintenance or technical service activities."

In the Navy, the corresponding position would be the ship's Commanding Officer. However, to some extent, the duties of the Engineer Officer would also be included in this definition.

The Commanding Officer of a ship is that person assigned by the Navy to be fully and totally responsible for safety of the ship, its people and its equipment. Obviously, there are many additional duties of a Commanding Officer relating to his ship's wartime mission. However, for the purposes of this review, his position of total responsibility is sufficient.

Depending on the size of the ship, he will have had at least 14 years of experience in the Navy prior to command. He will be a college graduate. Prior to taking command of his first nuclear powered ship he will have met other requirements which are discussed later in this report.

B. NRC Requirements for Senior Onsite Managers

The eligibility, training, qualification and requalification requirements for Senior Onsite Managers are delineated in ANSI N18.1 1971 and are summarized in Table 1.

C. Industry Practices

Industry practices relating to the selection, training and qualification of Senior Onsite Managers is generally consistent with NRC requirements.

D. Differences and Recommendations for Senior Onsite Managers

1. Difference:

As previously noted, the Senior Onsite Manager corresponds to both the Commanding Officer and the Engineer Officer of a nuclear ship. He is responsible for the safe operation of the plant and to ensure that it is operated in accordance with officially approved procedures and by properly qualified people.

In the Navy, the Commanding Officer of a nuclear ship must have had previous experience and a record to warrant the Navy's confidence in his ability to assume the responsibility for the safe operation of the plant(s). Having reached that point he will then attend a special 3 months course of reactor plant instruction given by and at headquarters and must pass a series of very difficult written and oral examinations. If he fails the course he cannot repeat it.

The 3 months course, although highly technical in nature, stresses all areas relating to command responsibility of the reactor plant. The course is managed at the highest levels within the headquarters organization and the final decision rests with the Director. Passing or failing ultimately is a judgment, not a grade.

Commands are assumed to be for at least three years duration.

Except in certain isolated cases, Commanding Officers of nuclear ships must have qualified as Engineer Officers and must have served as an Executive Officer of a nuclear ship.

In order to qualify as an Engineer Officer of a nuclear ship, a candidate must pass a two day series of written and oral examinations at headquarters.

The major difference however, is in the degree of responsibility placed on the Commanding Officer in contrast to that placed on the Plant Manager. As previously pointed out, when the ship is operating, the Commanding Officer is on the ship. Thus, he is in a position, twenty-four hours a day, seven days a week to exercise his full responsibility for the safe operation of the plant. The requirements are clear that there are certain decisions relating to the reactor that he and only he can make--they cannot be delegated. He is always just moments away from the control room and he is always in easy and direct communication. This is not the case with civilian nuclear plants.

Recommendations:

Senior Onsite Managers should be required either to be or have been licensed senior reactor operators. They should have a college degree in engineering or some related science major. They should have served for at least 2 years as the Operations Manager on that or a similar plant. They should be required to pass the training course given by the utility for its licensed senior operators just prior to assuming the position as Senior Onsite Manager if they are not currently licensed as such on that plant.

2. Difference:

In the Navy, while the Commanding Officer has full authority on his ship, he does not have authority, except in emergency situations, to deviate or change any officially transmitted requirement or procedure relating to the operation or maintenance of the reactor plant. This is not the case in civilian nuclear plants. Our review noted that in most utility companies, especially those with more than one reactor plant site, the Senior Onsite Manager tended to be autonomous. He is given the authority to change the plant design or an operating procedure if he himself is satisfied that it is technically correct. At his election, he could refer it back to his headquarters organization. In most cases he would eventually inform his headquarters of what he had done, but even this was not a hard requirement.

Recommendations:

We feel this practice is wrong and should be corrected. The entire issue of who, in the utility organization, is authorized to approve changes to the design or procedures needs to be clarified and spelled out. Except under emergency conditions, appropriate technical review and approval, external to the Senior Onsite Manager should be required.

VIII. GENERAL COMMENTS

As a result of this review, a number of observations can be made which relate peripherally to the issue of selection, training and qualification of personnel, but which have a bearing on the overall effectiveness of a reactor's operation. These general comments are provided below.

A. In reviewing the differences between the naval and civilian nuclear programs one important observation becomes evident. The written requirements issued in the two programs are not that far apart. What is different is the degree of enforcement. Over the years the Navy has developed, through the efforts of its Director, an effective system of checks and counterchecks such that the participants in the program, from the day they enter it, know that strict compliance with the requirements is expected and enforced. This philosophy permeates the program. Requirements are never looked upon as goals but rather as the starting point. People who disregard the requirements are dealt with harshly and this fact is well-known and appreciated.

While this review contains certain recommended changes to the NRC rules and regulations, it should be recognized that enforcement of the existing rules would probably correct the vast majority of problems highlighted as a result of the Three Mile Island accident.

B. It is noted that many of the various recommendations coming out of the Three Mile Island studies, have the NRC performing more audits, examinations, licensing, monitoring, surveillance checks, inspections, etc. There are also many studies underway which, if carried out, would add new systems, requirements, etc. The Navy faced a somewhat similar situation in the early 1960's, when the number of nuclear ships was rapidly expanding as a result of the POLARIS program. Coincident with this, the THRESHER was lost at sea for reasons unknown. However, this caused many studies to be undertaken, each one coming up with lists of corrections, changes and improvements.

At the time, Admiral Rickover wisely recognized that in the rush to achieve absolute safety, many of the recommended changes, taken in totality would actually result in a less safe condition. He provided the steadying hand of conservatism and simplicity.

For example, Admiral Rickover did not accept the proposition that he would massively increase the size of his headquarters organization in order to perform more inspections and audits. He, instead, turned to the fleet, using the qualified assets available in that sector, rather than weaken his own highly trained headquarters organization. He knew from his own experiences that any organization that expands rapidly will not only weaken the organization but will produce less or poorer work.

There are obviously many improvements that need to be made as a result of the lessons learned from the Three Mile Island accident. However, the possibility of an ever-increasing workload on NRC at a rate faster than can be effectively assimilated should be a matter of concern. As much as possible of the new inspections, audits, and monitoring should be put at the utility level with NRC being the watchdog.

C. In the area of training and qualification of operators and senior operators, it is our opinion that too much of a distinction is being made between a "cold" operator and a "hot" operator. 10 CFR 55 provides sufficient leeway to handle the problem of granting interim licenses prior to criticality. What has happened is that from this given leeway, training, examinations, etc., have created a wide gap between the two conditions. There should be one set of requirements for qualifying an operator with merely a provision to recognize that under certain circumstances it will not be possible for an individual to have actual operating experience on a given plant.

D. A review was made of the fifty findings contained in the "Technical Staff Analysis Report on Selection, Training, Qualification and Licensing of Three Mile Island Reactor Operating Personnel" as conducted by the President's Commission on the Accident at Three Mile Island. Each of the fifty items listed was analyzed in our comparative review to determine how that particular item is handled in the naval program and whether or not comments contained elsewhere in this report address the finding as it would apply to generalized civilian nuclear plants, not just Three Mile Island. Listed below are the fifty findings and a brief statement relative to Navy practice.

1. There is no regulation concerning the minimum eligibility requirements for either reactor operators or senior reactor operators.

    - The Navy issues such requirements.

2. The NRC has not prescribed any training requirements for the qualification of operators.

    - The Navy prescribes detailed requirements for training.

3. The NRC has not prescribed any requirements concerning the education, experience, reliability, skill, stress fitness, psychological fitness, or criminal records of managers, supervisors, operators, technicians or repair personnel of nuclear power plants.

- The Navy does this not only as a selection criteria but on a continuing basis. All of these attributes are periodically reviewed.

4. The NRC has not prescribed any requirements concerning the experience levels of operators prior to their being licensed.

- While there are no prescribed requirements the training pipe-line assures the person has the necessary experience level.

5. An operator of a nuclear power plant need not be a high school graduate.

- Navy uses high school graduate or GED equivalent.

6. No management personnel other than the operations manager require operator's licenses.

- The Navy does. This subject addressed in detail in the report.

7. The minimum required shift composition for operation of TMI-2 while the reactor is at power is one senior operator, two operators, and two non-licensed operators. Only one operator need be in the control room.

- The Navy requires a full watch section which is a minimum of eleven for a submarine and can go as high as 48 for multiple reactor large ships.

8. The examining and licensing of operators is solely the responsibility of the chief of the Operator Licensing Branch of the NRC.

- There is no direct applicability in the Navy to this comment. How this is done in the Navy is discussed in detail in the report.

9. Regulations do not require a comprehensive level of knowledge of reactor operators or senior reactor operators.

- The Navy does.

10. A candidate for an operator's license need not actually conduct a reactor startup and shutdown to obtain the license. He need not demonstrate the ability to respond to emergency situations.

- The Navy does require this not only at the prototype but onboard ship.

11. The program for training and qualification of auxiliary operators at TMI is not defined formally.

    - In the naval program it is not only formally defined, it is a requirement.

12. There is no formal program at TMI for training shift foremen or shift supervisors.

    - This is also spelled out as a requirement in the Navy.

13. The Babçock & Wilcox Training Department does not have a formal program.

    - The two DOE laboratories that provide training for naval personnel operate under the same requirements issued by headquarters that cover the entire training program.

14. The NRC has no requirements concerning the qualifications of engineers and managers.

    - Discussed in detail in the report.

15. Auxiliary operators who can affect reactor power level and who handle radioactive material are not subject to any regulatory requirements.

    - All naval operators are qualified.

16. The regulations do not address any aspects of the licensing process other than a written examination and operating test.

    - Previously addressed.

17. The NRC licensing process institutionalizes a shallow level of operator knowledge.

    - Previously addressed.

18. The NRC conducts a paper review of licensee training programs and a one-time-only review of simulator training programs.

    - Headquarters and headquarters site representatives continuously monitor training programs.

19. The NRC has no formal criteria concerning licensee or B&W instructor qualifications.

    - Headquarters issues formal requirements for instructor qualifications.

20. The NRC does not conduct in-depth reviews of licensee or simulator training programs.

- Covered in item 18. above.

21. The NRC has no objection to the licensee or B&W teaching the NRC licensing exam; 'mock' exams are encouraged.

- This practice is also followed in the Navy. However, no two examinations are the same and the bank of questions is in the thousands. Furthermore, all questions are essay type.

22. Most examiners who prepare and administer operator license examinations do not themselves have reactor operating experience.

- In the naval program, while many questions may not be prepared by qualified operators (some prepared by design engineers), all questions and approved answers are reviewed and approved by a person who is qualified.

23. A person can fail several categories of the NRC operator licensing exam and still pass overall.

- Failure of any one section in the naval program constitutes an overall failure.

24. No candidate for a reactor operator license at TMI since 1974 has failed an NRC licensing examination; 88 percent of senior reactor operator candidates have passed on the first attempt.

- This item is discussed in the report.

25. The Operator Licensing Branch of the NRC is not audited by other parts of the NRC.

- Previously discussed.

26. Once a person is licensed by the NRC he will not, except in rare cases, be again examined by the NRC as long as he participates in a company-administered requalification program.

- All nuclear trained personnel are examined once a year and must requalify every two years.

27. The Operator Licensing Branch of the NRC is understaffed and overworked and has not been given the attention that is merited.

- Not applicable.

28. Babcock & Wilcox performs a crucial role in training operators for utilities which do not have a simulator.

- Not applicable.

29. B&W instructors are not required to requalify as operators.

- Bettis and KAPL operators are qualified.

30. The B&W Training Service section has functioned almost independently of both the B&W management and engineering as far as course content and conduct are concerned.

- Bettis and KAPL training staff are an integral part of the laboratory management.

31. There is a lack of interaction between plant designers and training personnel at B&W.

- Laboratory training personnel work with (required) design personnel. Planned movement of people from design to operations, to training and back to design is maintained.

32. Few senior engineers at B&W have any first-hand experience with nuclear reactor operations.

- All senior managers at the laboratories have had some involvement with reactor operations.

33. Met Ed management had not observed training of their operators at B&W.

- Previously discussed.

34. Many deficiencies exist in the administration of courses at B&W such as not factoring into the program transients from operating plants, lack of syllabi, and lack of training manuals.

- Constant crosschecking and monitoring of training program by independent groups tends to correct this problem.

35. The B&W simulator was unable to reproduce the TMI-2 accident sequence prior to March 28, 1979.

- Use of simulators covered in report.

36. Evaluations and drills conducted on the simulator at B&W have not trained operators to cope with major casualties.

- Use of simulators covered in report.

37. Trainees' performance on the B&W simulator was not evaluated although this is the only opportunity available to determine if an operator is competent to function during an emergency.

    • Use of simulators covered in report.

38. Training at B&W did not instruct operators on how to deal with a small-break LOCA in the steam space of a pressurizer. This was the TMI-2 accident cause and had been the subject of much concern among B&W engineers following a similar transient at Davis-Besse 1 in Toledo, Ohio.

    • No direct applicability. However, previous experience from fleet is fed back into the training programs.

39. Babcok & Wilcox did not instruct trainees one way or another about allowing the pressurizer to go solid when the reactor is shut down.

    • Same as above.

40. Training which operators received at Three Mile Island did not prepare them to cope with the accident on March 28, 1979.

    • Same as above.

41. The TMI Training Department is understaffed in terms of quality and quantity. The supervisor of training has been unable to obtain an operator license in over 5 years of trying.

    • Not applicable.

42. Management at Three Mile Island has not been involved in, nor has it considered itself responsible for, training of operators.

    • Ship Commanding Officer is held personally responsible for training of his people. He must interview reactor operators and EOOW's himself.

43. The Training Department reports to Met Ed headquarters in Reading, Pa., not to site management.

    • Not applicable.

44. There have been many changes of head of training.

    • Not applicable.

45. Shift foremen who are responsible for operator training are unable to give adequate attention to this task.

- In the Navy, "shift foremen" are nuclear qualified and they conduct the training.

46. Auxiliary operator training is sporadic and ill-defined, and does not cover material needed by these persons to carry out their jobs.

- All operators in the Navy are qualified.

47. Only about 30 percent of the time allotted to training weeks is used for training of auxiliary operators.

- Training is an integral part of daily routine for naval personnel.

48. Replacement operator training is not formally approved and is done on a self-study basis.

- All training and qualification is done by requirements. Navy does not use self-study as a basis for training even though some self-study is used.

49. The Three Mile Island operator requalification program is of low quality; the material covered is shallow, does not include topics required by 10 CFR 55, and is not related principally to ensuring safe reactor operation. Absenteeism is high.

- Requalification is the same as qualification. Absenteeism is not a problem.

50. The TMI-2 training program did not teach operators about:

a. pressurizer level versus reactor coolant system pressure;

b. recognition of saturation conditions;

c. recognition of the need to remove decay heat and how to do it;

d. recognition of the significance of high radiation levels; or

d. recognition of a loss-of-coolant accident.

- These subjects are covered in the naval program.

EXISTING ELIGIBILITY RE

	PLANT MANAGER	OPERATIONS MANAGER	MAINTENANCE MANAGER	TECHNICAL MANAGER	RADIATION PROTECTION MANAGER	SHI SUPERVIS (SENIO OPERATOR
MINIMUM POWER PLANT EXPERIENCE	10 YEARS	8 YEARS	7 YEARS POWER PLANT OR INDUSTRIAL	8 YEARS	3 YEARS RADIATION PROTECTION IN NUCLEAR FACILITY	4 YEARS
MINIMUM NUCLEAR POWER PLANT EXPERIENCE	3 YEARS	3 YEARS	1 YEAR	1 YEAR		1 YEAR
MINIMUM EDUCATION	• BACHELOR'S DEGREE IN ENGINEERING OR SCIENCE • NOT REQUIRED IF ALTERNATE PLANT MANAGER HAS DEGREE				BACHELOR'S DEGREE IN ENGINEERING OR SCIENCE AND FORMAL TRAINING IN RADIATION PROTECTION	HIGH SCHOOL DIPLOMA OR EQUIVALENT
MAXIMUM SUBSTITUTION OF ADVANCED EDUCATION FOR POWER PLANT EXPERIENCE	4 YEARS ENGINEERING OR SCIENCE EDUCATION ASSOCIATED WITH POWER PLANTS	2 YEARS ACADEMIC OR TECHNICAL TRAINING	2 YEARS ACADEMIC OR TECHNICAL TRAINING	4 YEARS	• MASTER'S DEGREE FOR 1 YEAR PROFESSIONAL EXPERIENCE • DOCTOR'S DEGREE FOR 2 YEARS PROFESSIONAL EXPERIENCE	2 YEARS
SPECIAL CONDITIONS	EXPERIENCE AND TRAINING TO BE ELIGIBLE FOR SENIOR OPERATOR'S LICENSE	SHALL HOLD SENIOR REACTOR OPERATOR'S LICENSE AT APPOINTMENT	KNOWLEDGE OF NONDESTRUCTIVE TESTING, CRAFTS AND CODES			
MEDICAL REQUIREMENTS		AT APPOINTMENT • 10 CFR 55 • FORM NRC-396				• 10 CFR 55 • FORM NRC-396
QUALIFICATION REQUIREMENTS		• SATISFACTORY COMPLETION OF TRAINING • LICENSED BY NRC AS A SENIOR OPERATOR				• SATISFACT COMPLETION OF TRAINING • LICENSED B NRC AS A SENIOR OPER
REQUALIFICATION REQUIREMENTS						• EVERY 2 YE • IN THE EVE MINIMUM W REQUIREM ARE NOT M

REMENTS FOR PERSONNEL AT LICENSED NUCLEAR POWER REACTORS

JANUARY 18, 1980

OTHER SUPERVISORS	GROUP LEADER REACTOR ENGINEERING AND PHYSICS	GROUP LEADER INSTRUMENTATION AND CONTROL	GROUP LEADER RADIOCHEMISTRY	REACTOR OPERATOR	OTHER OPERATORS	TECHNICIANS	REPAIRMEN	ENGINEER IN CHARGE	STAFF SPECIALISTS
4 YEARS CRAFT EXPERIENCE		3 YEARS INSTRUMENTATION AND CONTROL	3 YEARS CHEMISTRY (MINIMUM 1 YEAR OF WHICH IS RADIOCHEMISTRY)	2 YEARS		2 YEARS EXPERIENCE IN SPECIALITY	3 YEARS EXPERIENCE IN CRAFT		
	2 YEARS ENGINEERING OR PHYSICS			1 YEAR				3 YEARS PROFESSIONAL NUCLEAR EXPERIENCE	
HIGH SCHOOL DIPLOMA OR EQUIVALENT	BACHELOR'S DEGREE IN ENGINEERING OR SCIENCE	2 YEARS TECHNICAL TRAINING	2 YEARS TECHNICAL TRAINING	HIGH SCHOOL DIPLOMA OR EQUIVALENT	HIGH SCHOOL DIPLOMA OR EQUIVALENT	1 YEAR TECHNICAL TRAINING		BACHELOR'S DEGREE IN ENGINEERING OR THE PHYSICAL SCIENCES	
		2 YEARS	2 YEARS						
				• MANUAL DEXTERITY • MATURE JUDGMENT • SELECTION INTERVIEWS AND EXAMINATIONS	• MANUAL DEXTERITY • MATURE JUDGMENT • SELECTION INTERVIEWS AND EXAMINATIONS		• MANUAL DEXTERITY • CAPABLE OF LEARNING AND APPLYING BASIC SKILLS		COMPETENT IN TECHNICAL MATTERS
				• 10 CFR 55 • FORM NRC-396					
				• SATISFACTORY COMPLETION OF TRAINING • LICENSED BY NRC AS A OPERATOR					
				• EVERY 2 YEARS • IN THE EVENT MINIMUM WATCH REQUIREMENTS ARE NOT MET					

TABLE 1

PROPOSED ELIGIBILITY REQUIREMENTS FOR PER

	PLANT MANAGER	OPERATIONS MANAGER	MAINTENANCE MANAGER	TECHNICAL MANAGER	RADIATION(BIT) PROTECTION MANAGER	TRAINING MANAGER	QUALITY ASSURANCE MANAGER	SHIFT SUPERVISOR (SENIOR OPERATOR)	TRADE SUPERVISOR (NOT REACTOR OPERATOR)	TECHNICAL GROUP LEADER	MAINTENANCE GROUP LEADER
MINIMUM TOTAL EXPERIENCE	7 YEARS OPERATIONAL OR ENGINEERING EXPERIENCE WITH COMPLEX ENGINEERING INSTALLATIONS		7 YEARS OPERATIONAL EXPERIENCE AT COMPLEX ENGINEERING INSTALLATIONS		3 YEARS EXPERIENCE IN RADIATION PROTECTION AND MONITORING		5 YEARS ENGINEERING EXPERIENCE AND 1 YEAR QA EXPERIENCE		4 YEARS CRAFT EXPERIENCE	4 YEARS ENGINEERING EXPERIENCE	3 YEARS IN SPECIALITY AT COMPLEX ENGINEERING INSTALLATIONS
MINIMUM REACTOR EXPERIENCE	4 YEARS OPERATIONAL OR ENGINEERING EXPERIENCE	7 YEARS OPERATIONAL OR ENGINEERING EXPERIENCE AT A REACTOR	3 YEARS OPERATIONAL EXPERIENCE	5 YEARS OPERTIONAL OR ENGINEERING EXPERIENCE		3 YEARS	1 YEAR ENGINEERING OR QA EXPERIENCE	1 YEARS AS REACTOR OPERATOR AT THIS OR SIMILAR REACTOR	1 YEAR	2 YEARS IN ENGINEERING SPECIALITY	1 YEAR IN SPECIALITY
MINIMUM EDUCATION	BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCES(2)	HIGH SCHOOL DIPLOMA OR EQUIVALENT(1)	HIGH SCHOOL DIPLOMA OR EQUIVALENT(1)	BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCES	• BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCES AND • 2 YEARS TRAINING	BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCES	BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCES	HIGH SCHOOL DIPLOMA OR EQUIVALENT(1)	HIGH SCHOOL DIPLOMA OR EQUIVALENT(1)	BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCES	2 YEARS TECHNICAL TRAINING
MAXIMUM SUBSTITUTION OF ADVANCED EDUCATION FOR EXPERIENCE	NONE	4 YEARS						BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCE SUBSTITUTES FOR 2 YEAR REQUIREMENT		GRADUATE DEGREE OR SPECIAL TRAINING PROG MAY BE EQUIVALENT TO 1 YEAR REACTOR EXPERIENCE	2 YEARS OF MINIMUM TOTAL EXPERIENCE
SPECIAL REQUIREMENTS	IS OR WAS QUALIFIED AS SENIOR OPERATOR FOR THIS OR SIMILAR REACTOR	IS OR WAS QUALIFIED AS SENIOR OPERATOR FOR THIS OR SIMILAR REACTOR			ON SITE POSITION	EXPERIENCE IN TRAINING					
MEDICAL(3) REQUIREMENTS								• 10 CFR 55 • FORM NRC 396			
ADDITIONAL REQUIREMENTS IF RESPONSIBLE FOR PREPARATION SUPERVISION OR EVALUATION OF TESTS OR PROCEDURES	INDIVIDUALS THAT DIRECT OR SUPERVISE THE CONDUCT OF REACTOR TESTS OR REFUELING SHALL HAVE A BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCE AND 3 YEARS OF ENGINEERING EXPERIENCE AT COMPLEX ENGINEERING INSTALLATIONS 2 YEARS OF WHICH SHALL BE REACTOR EXPERIENCE, AND SHALL HAVE SUCCESSFULLY PASSED A WRITTEN AND ORAL EXAMINATION TO QUALIFY AS A REACTOR PLANT TEST ENGINEER							INDIVIDUALS RESPONSIBLE FOR APPROVAL OF REACTOR PLANT PROCEDURES (MAINTENANCE OPERATING, TEST OR REFUELING) SHALL HAVE A BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCE AND 4 YEARS ENGINEERING EXPERIENCE WITH COMPLEX ENGINEERING INSTALLATIONS 2 YEARS OF WHICH BE ON THIS REACTOR			
QUALIFICATION REQUIREMENTS								• SATISFACTORY COMPLETION OF TRAINING • LICENSED BY NRC AS A SENIOR OPERATOR			
REQUALIFICATION REQUIREMENTS								• EVERY TWO YEARS • IN THE EVENT MINIMUM WATCH REQUIREMENTS ARE NOT MET			
SECURITY CLEARANCE REQUIRED	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

POOR ORIGINAL

...ONNEL AT LICENSED NUCLEAR POWER REACTORS

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SHIFT ENGINEER	REACTOR OPERATOR	AUXILIARY OPERATOR	REACTOR TECHNICIAN (2)	RADIATION TECHNICIAN	OTHER MAINTENANCE PERSONNEL(4)	QUALITY ASSURANCE PERSONNEL	INSTRUCTOR	SECURITY FORCE	INDEPENDENT REVIEW SUPERVISOR	INDEPENDENT REVIEW PERSONNEL	ENGINEER IN CHARGE OF TECHNICAL SUPPORT
			2 YEARS CRAFT EXPERIENCE		3 YEARS CRAFT EXPERIENCE	ANSI/ASME N45.2.6 1978 ASNT NO. SNT-TC-1A	SHALL HAVE EXPERIENCE AND TRAINING IN THE AREA OF RESPONSIBILITY	10CFR73 APPENDIX B	10 YEARS ENGINEERING EXPERIENCE	5 YEARS IN ENGINEERING SPECIALTY	
2 YEARS ENGINEERING EXPERIENCE	1 YEAR AT THIS OR SIMILAR REACTOR		6 MONTHS AT THIS REACTOR (TRAINING)	1 YEAR TRAINING AND EXPERIENCE	6 MONTHS	↓	↓	↓	3 YEARS ENGINEERING EXPERIENCE		3 YEARS OPERATIONAL OR ENGINEERING EXPERIENCE
BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCES	HIGH SCHOOL DIPLOMA OR EQUIVALENT[1]	HIGH SCHOOL DIPLOMA OR EQUIVALENT[1]	• HIGH SCHOOL DIPLOMA OR EQUIVALENT[1] • 1 YEAR TECHNICAL TRAINING	HIGH SCHOOL DIPLOMA OR EQUIVALENT[1]	HIGH SCHOOL DIPLOMA OR EQUIVALENT[1]	↓	↓	↓	HIGH SCHOOL DIPLOMA OR EQUIVALENT[1]	• BACHELOR'S DEG. IN ENGINEERING OR PHYSICAL SCIENCE • IN CERTAIN CASES 3 YEARS ADDT'N'L EXPERIENCE CAN SUBSTITUTE FOR BACHELOR'S DEG.	BACHELOR'S DEGREE IN ENGINEERING OR PHYSICAL SCIENCES
						↓	↓	↓	4 YEARS OF MINIMUM TOTAL EXPERIENCE	2 YEARS	
	PASS AN ACCEPTANCE EXAMINATION PRIOR TO TRAINING	PASS AN ACCEPTANCE EXAMINATION PRIOR TO TRAINING	MANUAL DEXTERITY	• MANUAL DEXTERITY • PASS AN ACCEPTANCE EXAMINATION WITH EMPHASIS ON HIGH SCHOOL MATH AND SCIENCE	MANUAL DEXTERITY	↓		↓	OFF-SITE POSITION	OFF-SITE POSITION	OFF-SITE POSITION
	• 10 CFR 55 • FORM NRC 398					↓		↓			
						↓		↓			
AME AS ENIOR PERATOR	• SATISFACTORY COMPLETION OF TRAINING • LICENSED BY NRC AS A OPERATOR	• SATISFACTORY COMPLETION OF TRAINING • LICENSED BY NRC AS A REACTOR TECHNICIAN	• SATISFACTORY COMPLETION OF TRAINING • LICENSED BY NRC AS A REACTOR TECHNICIAN	• SATISFACTORY COMPLETION OF TRAINING • LICENSED BY NRC AS A REACTOR TECHNICIAN	AS REQUIRED BY CODES	↓	AS REQUIRED BY SITE PREPA… INSTRUCTOR QUALIFICA… REQUIREME…	↓			
AME AS ENIOR PERATOR	• EVERY TWO YEARS • IN THE EVENT MINIMUM WATCH REQUIREMENTS ARE NOT MET	EVERY TWO YEARS	EVERY TWO YEARS	EVERY TWO YEARS		↓	SAME AS ABOVE	↓			
S	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	NO

TABLE 2

FOOTNOTES FOR TABLE 2

"Proposed Eligibility Requirements for Personnel at Licensed Nuclear Power Reactors"

1. High School Diploma Equivalence. Successful completion of the General Education Development (GED) test is the only acceptable equivalence.

2. Education. A Bachelor's Degree in a non-engineering or scientific field combined with two years experience as an Engineering Officer of the Watch in the Navy's nuclear power program can be substituted for the requirements for a Bachelor's Degree in Engineering or Physical Science.

3. Reactor Technicians. These are individuals who are authorized to perform work on reactor plant systems which may affect plant safety or lead to the possible release of radioactivity to the environment. Trades involved include the following:

    a. Electronics Technicians

    b. Radiation Technicians

    c. Chemistry Technicians

    d. Test Technicians

    e. Machinists

    f. Electricians

    g. Welders

    h. Pipefitters

    i. Grinders

    j. Riggers/weight handlers

4. Other Maintenance Personnel. This category of trades need not be licensed as reactor technicians and includes crafts such as:

    a. Cleaners

    b. Painters

    c. Laggers

d. Carpenters

e. QC Inspectors

f. Burners (cutters)

g. Lead Burners

h. Sheetmetal workers

i. Helpers

5. Medical. All personnel that could potentially be exposed to radiation must have a physical examination every three years or anytime it is reasonable to expect an over exposure.

6. A Certified Power Reactor Health Physicist is considered to meet the requirements for the Radiation Protection Manager.

7. In the event the Radiation Protection Manager is not a Certified Power Reactor Health Physicist, arrangements should be made to have one available on short notice.

TYPICAL REACTOR PLANT SITE ORGANIZATION - 1/18/80

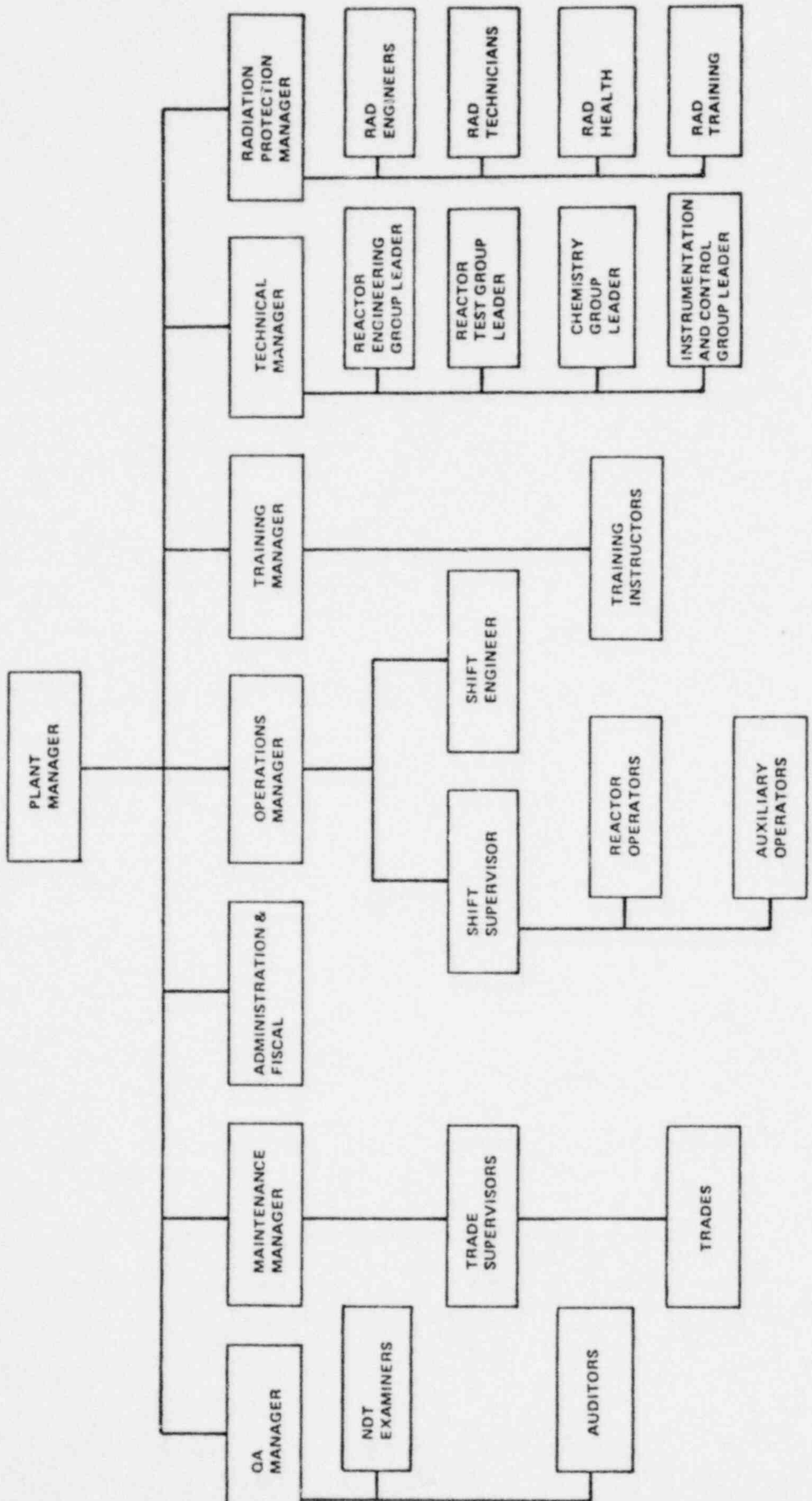

TABLE 3

NRC FORM 335 (7-77) U.S. NUCLEAR REGULATORY COMMISSION **BIBLIOGRAPHIC DATA SHEET**		1. REPORT NUMBER (Assigned by DDC) NUREG/CR-1280	
4. TITLE AND SUBTITLE (Add Volume No., if appropriate) POWER PLANT STAFFING		2. (Leave blank)	
		3. RECIPIENT'S ACCESSION NO. BETA-103	
7. AUTHOR(S) W. WEGNER		5. DATE REPORT COMPLETED MONTH JAN	YEAR 1980
9. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code) BASIC ENERGY TECHNOLOGY ASSOCIATES, INC. 1700 N. MOORE STREET ARLINGTON, VIRGINIA 22209		DATE REPORT ISSUED MONTH JAN	YEAR 1980
		6. (Leave blank)	
		8. (Leave blank)	
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		11. CONTRACT NO. NRC-03-80-116	
13. TYPE OF REPORT FINAL	PERIOD COVERED (Inclusive dates) DEC 1979 - JAN 1980		
15. SUPPLEMENTARY NOTES		14. (Leave blank)	

16. ABSTRACT (200 words or less)

This report outlines the results of a comparative review of current NRC requirements, licensed nuclear power plant practices and the Naval Nuclear Propulsion Program procedures for the selection, training and qualification of personnel involved in nuclear plant operation and maintenance. It also contains recommendations to improve the NRC requirements and civilian practices.

17 KEY WORDS AND DOCUMENT ANALYSIS

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17b. IDENTIFIERS/OPEN-ENDED TERMS

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