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NUCLEAR REGULATORY COMMISSION
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INFORMATION REPORT

July 5, 1979 SECY 79-330D

For: The Commissioners

From: Harold R. Denton, Director
Office of Nuclear Reactor Regulation

Thru: Executive Director for Operations

Subject: COMPARISON OF THE NAVY AND NRC/INDUSTRY TRAINING AND REQUALIFICATION PROGRAMS

Purpose: To provide the Commission with information on the Navy's nuclear training and requalification program and a comparison of the NRC license program to that of the Navy.

Introduction: In a memorandum from Samuel J. Chilk to Lee V. Gossick dated April 30, 1979, NRR was requested to inform the Commission regarding seven items relating to the procedures for qualifying reactor operators.

Item 6 of the memorandum requested that we obtain information from the Navy on their training and requalification program and compare the NRC licensing program to that of the Navy.

A summary comparison is given below. Enclosure 1 provides a more detailed description of commercial power reactor training programs regulated by the NRC. Enclosure 2 provides a more detailed description of the Navy Nuclear Propulsion Training Program.[1]

Summary: A comparison of the Navy and the NRC/commercial programs indicate the following points:

(1) Selection of Personnel

Commercial - Applicants for reactor operator and senior operator licenses hired by the utility come from (1) conventional plants throughout the utility, (2) government operated nuclear reactors, and (3) new hires off-the-street. Both the operator and senior

1/ Navy program as described in a statement of Admiral H. G. Rickover, USN, Naval Nuclear Propulsion Training Program Before The Committee on Science And Technology-United States House Of Representatives, May 24, 1979.

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operator must be high-school graduates or equivalent. Many utilities employ preselection screening using tests designed to determine an individual's suitability for nuclear training.

Navy - Officers are selected from (1) shipboard experienced personnel, (2) the Naval Academy, (3) NROTC Colleges, and (4) the Navy's Officer Candidate School. In 1969, the Nuclear Power Officers Candidate Program was added where top graduates of all colleges are given the opportunity to apply for nuclear training. Further, officer candidates are brought to Washington, D.C., where they are interviewed by Admiral Rickover. Enlisted men are involved in nuclear propulsion training through a program of recruiting promising young high-school graduates throughout the country. Enlisted applicants must be high-school graduates who have completed one year of algebra and must have high academic ability in areas of math and science, as measured by the Armed Services Vocational Aptitude Battery Test and Nuclear Field Qualification Test.

The difference in the selection of personnel between the NRC and the Navy is that the NRC is not directly involved, but only offers guidance in the selection of personnel. The Navy, on the other hand, has direct control of the selection and screening of personnel for the Navy Nuclear program.

(2) Initial Training of Personnel

NRC - The NRC requires two types of training programs. The "cold" program provides the necessary training for personnel who will sit for NRC license examinations prior to initial fuel loading. The "hot" program is for applicants who will sit for license examinations following criticality of the reactor.

The NRC required training for cold applicants usually starts two years before fuel loading. Applicants who have previous nuclear experience are phased in at proper times in accordance with their experience. Applicants with no experience complete the following program: Phase 1 - Basic courses which normally last 12 weeks are conducted at the nuclear training centers or universities. Phase 2 - Design lecture series takes six weeks and familiarizes the trainees with the features of his plant. Phase 3 - Observation training is conducted at both the simulator and on an operating nuclear power plant. The training requires

four months and consists of observation of day-to-day operation at an operating plant and "hands on" training on a simulator. Phase 4 - is onsite training and takes approximately one year.

The hot licensing program follows the same material outlined under the cold licensing program. The training is conducted onsite and requires six months to complete. The training program requires a minimum of 500 hours of lectures and three months of observation and "hands-on" manipulation of power plant controls, on a day-to-day basis. Training includes one week of simulator operation which involves observing reactor transients and coping with accident conditions.

Navy - The Navy Nuclear Training Program centers around (1) pre-nuclear training, (2) formal academic instruction and operational training at the DOE land naval reactor prototypes. Officer training throughout the Navy is at a higher level than that of the enlisted men.

Initial pre-nuclear training for the enlisted personnel is conducted at several training sites throughout the country. During basic training, the candidates are screened and classified into one of the program ratings. The trainee attends appropriate Navy Class "A" school which varies in length from two to five months. The curricula are basic to the ratings and are not specialized to nuclear power. Nuclear program trainees successfully completing Class "A" school training will normally be ordered directly to the Nuclear Power School located at Orlando, Florida.

The Nuclear Power School provides instruction to both officers and enlisted men in the principles of science and engineering fundamentals necessary for the understanding of the operation of Naval propulsion plants. The course at the Nuclear Power School lasts six months and consists of approximately 700 hours of classroom instruction. The curriculum includes math, physics, heat transfer, fluid flow and radiological fundamentals.

Operational training is conducted at eight land based Naval Reactor prototypes. Instruction is provided by Naval personnel and civilian personnel from the Naval Reactor Laboratories. The Navy personnel receive lectures and on-the-job training in the practical aspects of reactor plant operation.

The NRC col licensing training program is similar to that of the Navy. However, the operator replacement program is different from that of the Navy in that the utility hot licensing program is conducted at the facility site. Another significant difference is that all enlisted men aboard ship have been qualified on their rating. On the commercial plant only, the control operators and supervisor are licensed. The balance of plant personnel complete a training program, but are not licensed.

(3) Qualification and Requalification Program

NRC - At the completion of the training program, operators and senior operators are certified by utility management and are then examined by NRC licensing examiners. If they successfully pass the written and oral examinations, they are issued a license to operate the plant. The written examination for the operator consists of seven categories and generally takes eight hours to complete. The senior operator written examination consists of the same seven categories plus an additional five. Approximately six hours are required to complete the examination. The written examinations are followed by an operating test conducted by an NRC examiner. A typical operating test takes from four to six hours and consists of a one-on-one oral examination, which tests the applicant's knowledge of the plant operations and procedures.

The NRC aporoved requalification program requires that each licensed individual demonstrate his competency over a two year period to renew his license. The program requirements include preplanned lectures and on-the-job training, including control reactivity manipulations, understanding of systems, procedures, design changes, changes to facility license and the emergency procedures.

Navy - Upon completion of the academic training program, both officers and enlisted students are required to pass a four hour written examination prior to graduation from the Nuclear Power School. Following the prototype, training officers qualify as Engineering Officer of the Watch. This means that they must qualify to operate all the equipment associated with the plant, as well as direct operations. Enlisted men must qualify as operators of equipment connected with their particular rating. This qualification consists of demonstrating general knowledge

of all reactor plant systems and detailed knowledge associated with their own rating. Students must stand a specified minimum number of satisfactory watches to qualify and must receive a final evaluation watch to qualify. This qualification is an evaluation by a three man board, one from the local Naval Reactors field office, a senior representative of the plant management, and a staff engineering officer instructor. The students must also pass a final comprehensive written examination of about four hours duration before leaving the prototypes. Officers and enlisted men reporting to the fleet go through a shipboard watch qualification. The mechanics of the shipboard watch qualification are similar to that in use at the prototypes. A continuous shipboard training program is a high priority program referred to as "Recurring Training." The program requires the complete requalification of all watch standers every two years. Recurring training includes lectures, drills and comprehensive examinations.

A significant difference exists in the NRC and Navy qualification of personnel. The NRC licenses both the operator and supervision to operate all systems in the nuclear power plant. However, in the Navy program only the officer is qualified on all watches of the plant while the enlisted men are qualified with a general knowledge of all stations, but detailed knowledge of their single rating.

(4) Practice of Casualty Drills and Plant Evaluations

NRC - The utility requalification program provides training and evaluation of the performance of abnormal and emergency procedures. This is accomplished by a training supervisor, reviewing step-by-step, the procedure with the licensed operator or supervisor at the operating control board. Casualty training and evaluation on a reactor simulator is an integral part of many of the plant requalification programs. On the simulator, the student observes the symptoms and performs the immediate actions required to cope with the accident condition.

Navy - Casualty drills are a part of the recurring training program. Approved drill guides are maintained for recurring use. The drills are carried out under the guidance of drill monitors and safety observers and consist of part walk-through and part actual operation. The drills may, or may not, be announced prior to their conduct.

Both the NRC and Navy requirements are similar as they relate to casualty drills. The NRC requires the licensed personnel to discuss step-by-step the emergency procedures on the control boards. Many of the utility training programs include training on simulators when the licensee analyzes and copes with the accident condition. The Navy requires actual drills on shipboard, which includes discussion and actual operation as far as practical on the casualty.

(5) Continued Review of Personnel Performance and Removal From the Program of Those Who Do Not Meet Standards

NRC - The utility requalification program provides an ongoing review of personnel performance through preplanned lectures, control manipulations, review of abnormal and emergency procedures and annual written and oral examinations. A grade of less than 80% on any category of the written examination requires attendance of the lecture on that category material. A grade of less than 70% overall on the annual written examination requires mandatory participation in an accelerated requalification program. The individual is removed from his licensed duties until he has successfully completed the accelerated program and scored not less than 70% on a re-examination.

Further, if a licensee has not been actively performing the functions of an operator or senior operator for a period of four months, he must demonstrate to the NRC his understanding of facility operation before he is permitted to resume his licensed duties.

Navy - Watch standing proficiency is maintained on board. An operator can be considered proficient on a given watch station only if he stands watch at a prescribed frequency on that watch station. The engineering officer of the watch must stand at least two four hour watches each month to maintain proficiency. If a watch stander does not meet these requirements, his name is removed from the list of qualified watch standers. He is required to complete special training specified by the ships Engineering Officer before his name can be returned to the list of qualified watch standers.

The NRC and Navy both require continued demonstrated proficiency. Both require requalification every two years and if a failure to meet requirements exists, the individual is removed from his regular duties, retrained and examined prior to resumption of his duties.

(6) Inspections of the Plants and Plant Operations With Systematic Follow-Up on Deficiencies

NRC - The Office of Inspection and Enforcement, NRC, conducts inspections of the utility's plant and operations. It also investigates any deficiencies found and provides feedback into the regulatory process. Further, it ascertains compliance with Federal Regulations and takes the necessary enforcement action. Periodic audits of the approved personnel training and requalification program are conducted by IE. Operator Licensing Branch conducts audits on the requalification examinations administered by the utility.

Feedback on incidents in the plants, that are reported by IE, are reviewed and Licensee Event Reports are prepared and distributed throughout the agency and to the nuclear plants.

Navy - Feedback of problems, both ship and prototype are fed directly to the Office of Naval Reactors in Washington, D.C. The ship Commanding Officers and Prototype Managers report directly on any equipment malfunction, operational difficulty, or deviation from prescribed procedures. Lessons learned from these reports are periodically promulgated to the fleet and changes are made to design and to the overall training program, as needed. The Navy conducts an annual safeguard examination, which is conducted by a Nuclear Propulsion Examining Board and last from two to five days. The board reviews every aspect of the nuclear propulsion plant, radiological support, administration and training. Casualty drills and evolutions are conducted for the board to evaluate. Operators are interviewed by Board members to determine their level of knowledge. The Operational Reactor Safeguard Examination Report provides the individual ship immediate feedback that can be used for training and operation.

Both the NRC and the Navy are similar in that both have mechanisms established to feed back information which is reviewed and fed back to the operating plants. The NRC conducts periodic inspections, which parallels the Navy's safeguard examinations, except actual plant casualty drills and evaluations are not conducted for NRC evaluation.

Coordination: This paper has been reviewed by the Office of the Executive Legal Director, which has no legal objection.

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Office of Nuclear Reactor Regulation

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ENCLOSURE 1
COMMERCIAL POWER REACTOR
TRAINING PROGRAMS REVIEWED BY THE NRC

Enclosure 1

Commercial Power Reactor

Training Programs Reviewed by the NRC

The following outlines the training program as set forth in the NRC Regulatory Guide 1.8, "Personnel Selection and Training" that endorses, in part, ANSI N18.1-1971, "Selection and Training of Nuclear Power Plant Personnel."

In accordance with 10 CFR Part 55, the NRC issues two types of licenses. In general, anyone who manipulates reactor controls must be licensed as an operator, and those who direct the activities of licensed operators must be licensed as senior operators. In practice, the control room operators at a power station will be the licensed operators and their immediate supervisor will normally be the senior operator.

Cold Training Programs

Cold training programs provide the necessary training for personnel who will sit for the NRC license examination prior to the initial fuel loading of the nuclear plant. Since it is impossible to perform plant operations at that time, these examinations are referred to as cold examinations.

Applicants for reactor operator and senior reactor operator licenses have come from the following sources: (1) conventional plants throughout a utilities system, (2) government-operated nuclear reactors, and (3) new hires. A few power-plant applicants have come from research and test reactors at various universities. However, the majority have come from the first group. Over one-half of the operators have little, if any, nuclear experience at the time they are selected for training.

Many utilities employ a preselection screening process using tests designed to determine an individual's suitability for nuclear training. Because many of those selected for training have been out of school for a number of years, some companies have found it advantageous to first conduct a review of basic mathematics and physics for the candidate. Generally these reviews last four weeks.

Training programs, together with the training schedule prior to fuel loading, are submitted to the NRC for approval. Usually the training program for applicants with no previous nuclear experience starts two years before fuel loading. Applicants who have previous nuclear experience are phased in at the proper times in accordance with their experience.

Applicants with no previous experience are required to complete the entire training program outlined below. The programs outlined below are minimal programs. Applicants must be highly motivated and dedicated to successfully complete these programs. Many applicants will require additional tutoring and time to become competent operators.

Phase 1: Basic Courses

Basic courses, which normally last 12 weeks, are usually presented at nuclear training centers or universities. The courses include approximately ten weeks of basic study, which includes nuclear physics, health physics, chemistry, and plant technology. The study program is followed by two weeks of practical operational training on a nuclear training or research reactor, where the applicants participate in fuel-loading experiments and coefficient measurement experiments, perform reactivity calculations, and manipulate the controls during ten reactor startups.

Phase II: Design Lecture Series

This phase of the training consists of a lecture series to familiarize the trainee with the design features of his plant. This phase normally takes six weeks. Lectures can be devoted completely to the individual's plant and can be given after Phase II, or some of the lectures can be given prior to Phase III and some of them after Phase II. When the course is split in this manner, the trainee will be taught the general design characteristics during the first session and his plant's special characteristics during the second session.

Phase IV: On-Site Testing

The applicant for a cold examination must successfully complete an approved on-site training program that covers information on the plant for which he

will seek a license. In addition to classroom training, the applicant will engage in the day-to-day plant activities, such as procedure writing, construction check-out, and preoperational testing, for a period of approximately one year prior to fuel loading. The time spent in this phase varies according to the experience of the applicant; however, the minimum required time is six months.

Phase III: Observation and Simulatory Training

Observation training involves the day-to-day operation of a nuclear power plant. This training is conducted in conjunction with the plant operating organization. During the observation training, the trainee observes various operations, surveillance testing, and the practical aspects of the radiation protection program. All training must be documented and must be supervised by knowledgeable individuals. The training period varies from one to three months. In conjunction with the plant observation, the trainee receives training on a power-plant simulator.

Simulator training varies from two to three months. While at the simulator training center, the applicant observes and participates in all phases of power-plant operations (e.g., reactor and plant startups, loading the turbine generator, and power-level changes) and learns to use normal procedures and other procedures to cope with abnormal and emergency conditions. The simulator must be similar to the facility for which the trainee will seek a license.

The observation and simulator training must be under the administration of the same organization. The minimum time required for Phase II is 4 months of combined power-plant observation and simulator training.

HOT TRAINING PROGRAMS

Hot training programs provide the necessary training for applicants who will sit for the NRC license examination following criticality of the reactor.

Training for hot licensing begins by selecting candidates from among plant auxiliary operators who normally have had 1.5 to two years of operating experience at that facility and placing them in a formal training program.

Applicants for hot examinations must complete the same technical training that is required for applicants for cold examinations. Applicants will also participate in a program of on-the-job training which involves manipulations of controls during five reactivity changes and at least two training startups of the reactor. Their training usually includes self-study programs and tutoring by more experienced personnel on plant operating characteristics, plant system performance characteristics, and the use of normal, abnormal, and emergency operating procedures. An appropriate nuclear power-plant simulator can be used in the training in lieu of two training startups on the reactor.

The first group of hot license applicants must participate in reactor and plant operations during the commissioning phase of the facility until the facility has been operated at a power level of at least 20% prior to taking the examination. This is done to give the applicants actual hands-on experience in operating the reactor and to give the NRC assurance that they have participated in integrated plant operations. The training program follows the material outlined under the cold licensing program and covers a period of six to eight months.

Energy (DOE) primarily to provide research and test facilities for the DOE naval reactor laboratories. Instruction is provided by naval personnel and by civilian personnel from the Naval Reactors laboratories. The Navy provides some of the classroom and administrative facilities together with most of the operating crew for the prototype plant. The DOE in turn, makes the plant available for training when it is not otherwise required for developmental testing.

At these prototypes, the Navy personnel in training receive lectures and on-the-job instruction in the practical aspects of reactor plant operation. They operate all of the equipment associated with the reactor plant under the supervision of qualified instructors. Officers qualify as Engineering Officer of the Watch. They must demonstrate a thorough knowledge of all the reactor plant and steam plant systems, as well as the detailed operating criteria and procedures, and demonstrate the ability to perform operations on all watch stations in the prototype plant; they must demonstrate that they can take charge of the plant and put it through normal and casualty maneuvers.

Enlisted men qualify as operators of equipment connected with their particular rating. This qualification consists of demonstrating general knowledge of all reactor plant systems and detailed knowledge of those associated with their own rating. They must qualify on the watch stations they would normally stand aboard ship, and they must be able to handle normal maintenance problems on their equipment.

Training at any one of the eight prototypes is conducted the same way, and is based on a four-phase program covering a 26-week training period. A Classroom

The written examination for senior reactor operators (Section 55.22) consists of the same seven categories above plus an additional five. Approximately four to six hour are required to complete the five senior categories, which are:

H. Reactor Theory.

I. Radioactive Materials Handling, Disposal, and Hazards.

J. Specific Operating Characteristics.

K. Fuel Handling and Core Parameters.

L. Administrative Procedures, Controls, and Limitations.

Operating Tests

The purpose of the operating test (Section 55.23) is to determine the following for each applicant:

A. Ability to read and interpret the control instrumentation of the facility.

B. Ability to manipulate the control equipment in a safe and competent manner.

C. Knowledge of how to operate the facility, including operating under emergency conditions.

D. Knowledge of radiological safety practices and the purpose and function of radiation monitoring equipment.

A typical operating test takes from four to six hours and proceeds as follows. In the privacy of an office or conference room, the examiner explores the

applicant's knowledge of reactivity effects, theory of operation, and radiation protection practices and procedures.

The major portion of the operating test is conducted in the control room. The applicant's ability to read and interpret the control instrumentation is determined by discussing both normal and off-normal operation. The applicant points out on the operating board the controls used and explains the instrumentation involved in accordance with the facility procedures.

If the applicant was previously certified on reactor startup on an approved simulator, actual startup of the reactor is waived. At a minimum the examiner will have the applicant talk through the startup, indicating controls and instrumentation used in taking the reactor to criticality. The examiner determines the applicant's knowledge of subcritical multiplication and delayed-neutron effects, his understanding of when the reactor is subcritical or supercritical, and his knowledge of the effects of coefficients on the startup of the reactor.

The applicant's ability to operate equipment in a safe manner is determined by discussing such operating situations as load changes, equipment operation, and off-normal operation. The applicant must demonstrate his knowledge of the actions to take and indicate to the examiner the controls he will manipulate and the instrumentation he will observe.

The examiner also determines the applicant's knowledge of how to operate the facility under emergency conditions. This is accomplished by postulating symptoms of an incident to the applicant. From the symptoms, the applicant

must determine the immediate actions required by procedure. He must demonstrate a knowledge of the emergency systems and be able to evaluate instrument readings to know that the emergency systems are operating in the manner in which they were designed to operate. He must also demonstrate what actions he would take if any part of the system fails to operate properly by mock manipulation of the controls.

The proper use of normal, abnormal, and emergency procedures are evaluated throughout the control-room exercise. The applicant's knowledge and understanding of the Technical Specifications, administrative procedures, emergency plans, operating curves, and data are explored.

The final phase of the operating test is touring the plant with the applicant. Here the applicant's knowledge of the radiological practices and monitoring equipment is evaluated. The applicant must demonstrate the use of portable radiation monitoring instruments, how to properly enter and exit a controlled area, and how to use the facility radiation procedures. During the plant tour, the applicant must review local procedures and demonstrate his knowledge and understanding of local plant operations. Typical systems explored include electrical control centers, diesel generators, engineered safety feature, plant instrument air systems, and selected operating equipment.

Examination Evaluation

After the examination, the applicant's knowledge and understanding are evaluated by the examiner and reviewed by senior examiners and/or the Chief of the Operating License Branch. On the basis of the results of the evaluations and review, the applicant receives a license or his application is denied.

If an individual has his senior operation application denied, an evaluation is made to determine if he should be licensed as an operator. If he passed the operator's written examination and demonstrated sufficient knowledge and understanding at an operator level during the operating test, he is issued an operator's license.

Requalification Program

Periodic requalification for all operators and senior operators is necessary to maintain their continued competence. The following is an outline of the NRC requalification requirements.

1. Schedule. The requalification program shall be conducted for a continuous period not to exceed two years, and upon conclusion shall be promptly followed, pursuant to a continuous schedule, by successive requalification programs.

2. Lectures. The requalification program shall include preplanned lectures on a regular and continuing basis throughout the license period in those areas where annual operator and senior operator written examinations indicate that emphasis in scope and depth of coverage is needed in the following subjects:

   a. Theory and principles of operation.
   b. General and specific plant operating characteristics.
   c. Plant instrumentation and control systems.

d. Plant protection systems.

e. Engineered safety systems.

f. Normal, abnormal, and emergency operating procedures.

g. Radiation control and safety.

h. Technical specifications.

i. Applicable portions of Title 10, Chapter I Code of Federal Regulations.

Other training techniques including films, videotapes and other effective training aids may also be used.

Individual study on the part of each operator shall be encouraged. However, a requalification program based solely upon the use of films, videotapes and/or individual study is not an acceptable substitute for a lecture series.

3. On-the-job training. The requalification program shall include on-the-job training so that:

a. Each licensed operator of a production or utilization facility manipulates the plant controls and each licensed senior operator either manipulates the controls or directs the activities of individuals during plant control manipulations during the term of their licenses. For reactor operators and senior operators, these manipulations shall consist of at least 10 reactivity control manipulations in any combination of reactor startups, reactor shutdowns or other control manipulations which demonstrate skill and/or familiarity with reactivity control systems.

b. Each licensed operator and senior operator has demonstrated satisfactory understanding of the operation of all apparatus and mechanisms and knows the operating procedures in each area for which he is licensed.

c. Each licensed operator and senior operator is cognizant of facility design changes, procedure changes, and facility license changes.

d. Each licensed operator and senior operator reviews the contents of all abnormal and emergency procedures on a regularly scheduled basis.

e. A simulator may be used in meeting the requirements of paragraphs 3a and 3b if the simulator reproduces the general operating characteristics of the facility involved, and the arrangement of the instrumentation and controls of the simulator is similar to that of the facility involved.

4. Evaluation. The requalification program shall include:

a. Annual written examinations which determine areas in which retraining is needed to upgrade licensed operator and senior operator knowledge.

b. Written examinations which determine licensed operators' and senior operators' knowledge of subjects covered in the requalification program and provide a basis for evaluating their knowledge of abnormal and emergency procedures.

c. Systematic observation and evaluation of the performance and competency of licensed operators and senior operators by supervisors and/or training staff members including evaluation of actions taken or to be taken during actual or simulated abnormal and emergency conditions.

d. Simulation of emergency or abnormal conditions that may be accomplished by using the control panel of the facility involved or by using a simulator. Where the control panel of the facility is used for simulation, the actions taken or to be taken for the emergency or abnormal condition shall be discussed; actual manipulation of the plant controls is not required. If a simulator is used in meeting the requirements of paragraph 4c, the simulator shall accurately reproduce the operating characteristics of the facility involved and the arrangement of the instrumentation and controls of the simulator shall closely parallel that of the facility involved.

e. Provisions for each licensed operator and senior operator to participate in an accelerated requalification program where performance evaluations conducted pursuant to paragraphs 4a through 4d clearly indicate the need.

ENCLOSURE 2

THE NAVY NUCLEAR PROPULSION TRAINING PROGRAMS

Enclosure 2

The Navy Nuclear Propulsion Training Programs

The following outlines the Navy's Nuclear Program:

Screening of Candidates

The responsibilities involved in operating naval nuclear powered ships and the requirements of the nuclear plants themselves make it essential that individuals in the program have a high degree of intelligence and capacity to learn. Early in the program, it was recognized that normal procedures of personnel selection and assignment used by the Navy could not be counted on to provide this program with the proper type of individual. In order to select candidates of the necessary intellectual capacity and motivation, a number of special measures had to be taken. Typical civilian procedures could not be followed. Recognition had to be given to the fact that the Navy was dealing with a body of military people. This meant they would be faced with the inevitable high turnover rate; the problems typical of young, inexperienced enlisted men, and the antiquated Navy training methods.

Officers for assignment to the engineering crews of the first nuclear-powered ships were, by necessity, drawn from those having had previous shipboard experience. Experienced officers ultimately became insufficient to support the needs. Therefore, beginning in 1960, a number of top ranking students

graduating from the Naval Academy, NROTC Colleges, and from the Navy's Officer Candidate School were selected to enter nuclear power training following graduation. In 1969 the Nuclear Power Officer Candidate Program was added through which top graduates of all colleges are given the opportunity to apply for nuclear power training. Today, these programs which take officers directly from the Naval Academy or civilian colleges account for more than 95% of the officers entering the nuclear training program. To date, some 7,000 officers have been trained in the nuclear power program.

Officers who apply for nuclear training must be college graduates meeting minimum requirements for courses in mathematics and science. The college records are screened to determine scholastic aptitude, and performance. For those officers with sea experience, naval records are also reviewed to determine effectiveness as naval officers, experience level (particularly in engineering), and their commanding officer's evaluation of them as candidates for the nuclear program. This screening is performed by the Bureau of Naval Personnel with the advice and assistance of Naval Reactors personnel.

In order to further ensure that only officers with the necessary potential and motivation are selected for the naval nuclear propulsion program, the candidates are each called to Washington and interviewed by several senior members of the Naval Reactor staff and finally by Admiral Rickover, USN. In addition to providing information over and above that available in an officer's service record on his intelligence and ability, these interviews are useful in determining the willingness of the officer to undertake the difficult training program for nuclear propulsion assignment and his interest in professional advancement as evidenced by his work and study habits.

As in the case of officers, in the early years of the nuclear program enlisted candidates, came from the fleet and had snipboard engineering experience. Those who applied were interviewed and screened by their commanding officers before being recommended as candidates. Eligibility criteria were established by the Chief of Naval Personnel with the advice and assistance of Naval Reactors. Assignment to the nuclear program was made by the Bureau of Naval Personnel from among those recommended.

The manning requirements for the expanding nuclear submarine program and the nuclear surface ship program required a new source of people for training. In 1957 direct input of enlisted men for nuclear propulsion training was provided by a program of recruiting promising young high school graduates into the Navy, specifically for ultimate duty in nuclear ship engineering departments. Today this program is the primary source of enlisted personnel for nuclear power training. Approximately 40,000 enlisted operators have completed the naval nuclear propulsion training program to date.

Training, Qualification and Recurring Programs

The Navy nuclear training program is centered around five major phases: (1) Pre-nuclear training program, (2) formal academic instruction, (3) operational training at the DOE land naval reactor prototypes, (4) training and qualification as a watchstander aboard an operating Naval nuclear-powered ship, and (5) recurring training.

Phase 1: The initial training of enlisted personnel selected for nuclear training is conducted at several training sites throughout the country.

During basic recruit training, the candidate is screened and classified into one of the program ratings: (Machinist's Mate, Electrician's Mate, Interior Communications, or Electronics Technician) according to his capabilities and the needs of the program. The trainee then attends appropriate Navy Class "A" school training, which varies in length from two to five months. The curricula are basic to the ratings and are not "specialized for nuclear power." These Class "A" schools are operated by the Chief of Naval Education and Training, and are not controlled by Naval Reactors. Nuclear program trainees completing Class "A" school training will normally be ordered directly to Nuclear Power School at Orlando, Florida.

Phase 2: The Nuclear Power School curriculum is prepared under the direction of the Naval Reactors staff in Washington. The assistance of the Naval Reactors Laboratories is utilized in developing the curriculum. The course at Nuclear Power School lasts six months and consists of approximately 700 hours of classroom instruction.

The officer student curriculum includes: mathematics, physics, heat transfer and fluid flow, electrical engineering, reactor dynamics, chemistry, aspects of reactor plant operations, materials, radiological fundamentals, core characteristics and reactor plant systems, which is an overview of all mechanical and electrical systems. Officers receive instruction up to and including the graduate level.

The enlisted curriculum includes: reactor plant systems, mathematics, physics, heat transfer and fluid flow, reactor principles, chemistry, radiological fund- 's, materials, specialized in-rate instruction on plant

systems and reactor plant operations. Enlisted personnel receive instruction at the undergraduate level.

In the school, the instructor is required to take the subject he will teach. He will give practice lectures and become familiar with the related Nuclear Power School subjects. The new instructor must pass oral boards on the technical content of the course, and present a certification lecture for the division director, the department head, and the commanding officer. After qualification, the training continues so that the instructor will remain current and knowledgeable. An annual written examination is administered to all instructors to determine any weak areas. The instructor's classroom presentation is audited at least twice during each period he teaches a subject. The commanding officer, the executive officer and the department heads are required to audit one instructor each week. Also, Bettis Technical Consultants randomly monitor the instructors. Evaluation reports are filled out by the auditors and discussed with the instructor. These reports are forwarded up the chain of command and filed in the instructor training folder after any necessary corrective action has been taken.

Both officer and enlisted students are required to pass a four-hour written comprehensive examination prior to graduation. In addition, there are weekly quizzes and a two-hour examination about every ten days.

Phase 3: Prototype operational training is conducted at eight land-based Naval Reactor prototypes. Three are located at the Naval Reactors Facility, Idaho Falls, Idaho; four at West Milton, New York; and one at Windsor, Connecticut. These prototypes are owned and operated by the Department of

LICENSE EXAMINATIONS

Title 10 CFR Part 55.11 states that "an application for a license pursuant to the regulations in this part will be approved if the Commission finds that," among other things, "the applicant has passed a written examination and operating test as may be prescribed by the Commission to determine that he has learned to operate and, in the case of a senior operator, to operate and to direct the licensed activities of licensed operators in a competent and safe manner." The scope of the examinations is addressed in Sections 55.20 through 55.23.

Written Examinations

The written examinations for reactor operators (Section 55.21) consists of seven categories and generally requires six to eight hrs to complete. Most of the questions require essay-type answers. The seven categories in the operator examination are:

A. Principles of Reactor Operation.
B. Features of Facility Design.
C. General Operating Characteristics.
D. Instrumentation and Controls.
E. Safety and Emergency Systems.
F. Standard and Emergency Operating Procedures.
G. Radiation Control and Safety.

Phase, Transition Phase, In-Hull Phase and Proficiency Phase make up the basic prototype training plan.

The students are assigned to one of the prototypes upon completion of Nuclear Power School. When the class arrives, it starts classroom training which is primarily conducted in spaces outside the prototype hull. After five weeks, the student starts making the transition into the hull and he then begins watchstanding training under instruction. The purpose of prototype training is to give the man in-hull experience operating the reactor plant, operating equipment very much like that he will be operating at sea, using procedures like those he will be using at sea. The major objective of prototype training is to make the best use of the training that is done in the hull within the constraints of reactor safety. At the conclusion of the watchstanding training under instruction, the man qualifies by passing written and oral exams. This allows him to stand the watch and to operate the equipment on his own--without the presence of an instructor. After he has qualified, and in the period before his class graduates, he stands watch to gain proficiency as a watchstander.

A part of the training during transition phase is watchstanding, to qualify at the prototype, all students are required to stand a given minimum number of watches under the instruction of qualified staff watchstanders. During these watches, the staff watchstander is responsible for the watch station; however, he fulfills this responsibility by using the student to carry out watchstanding duties.

During these watches, the student is expected to act as if he were responsible for that watch. The staff instructor watches each move and stops and corrects the student if he starts to make a mistake.

The student is graded on each watch, and must receive a satisfactory grade or he does not get credit for the watch. The student is expected to significantly improve his watchstanding capability as he gains experience of each watchstation. This factor is taken into account when assigning him a grade.

During the watch, there are prescribed things the student must do, such as starting up and shutting down a piece of equipment. These are called "practical factors." The student does these under instruction, with the staff instructor providing direct supervision. The emphasis is on the student doing the operation himself. This is accomplished by first talking through the operation and then letting the student perform it.

Prototype plant operations are scheduled to coincide with the extent the class has progressed through the training program. For the first student training watches, the plant is held in a steady-state steaming condition. This means the reactor is at a constant power and a steady-state condition exists in the engine room. Later on, the schedule calls for more complicated operations, such as startups and shutdowns of the steam plant, startups and shutdowns of the reactor, and casualty drills. It is important to note that in the case of the officer student qualifying as Engineering Officer of the Watch, he not only stands training watches and completes practical factors as Engineering Officer of the Watch, but also stands watch at the enlisted watch stations and does practical factors there also.

This gives the officer a better overall feel for what is happening throughout the plant. As an example, at one of the prototypes the officer student must stand a minimum of about 180 hours of training watches, of which seventy per cent are devoted to watches other than Engineering Officer of the Watch.

During watchstanding training, the student is also instructed on proper communication procedures and formality in communications. He is also instructed in logkeeping and other normal duties of a watchstander. At the conclusion of prototype training, there are four performance areas that the student must pass to become qualified:

First, the student must have a satisfactory final watchstanding grade. This grade is the average received for the watches he stood under instruction. The grading becomes more severe for later watches as more is expected of the student and the plant operations become more complex.

Second, for officer students, a final evaluated watch must be passed. This is done by a board of three members as noted previously. If the student fails this watch, he completes remedial training and tries again, after being upgraded in his weak areas. Typically, he will not be given more than two to three chances before a decision is made on whether he should be disenrolled.

Third, the student must pass a final comprehensive written examination. These are drawn from an examination bank and cover each of the areas of mechanical, electrical, reactor, chemistry, radiological controls, and the overall plant. The exam is four hours in length for enlisted personnel and eight hours for officers. These examinations are graded and reviewed with the student prior

to his final oral board. If the student fails in any area, he is reexamined after an upgrading program. If he fails a reexamination, he will normally be disenrolled from the school.

Lastly, each student receives a final oral board. This is a good technique for probing his knowledge in depth. It is much easier, in this way to assess what the student actually knows, since every flaw in his answers can be noted. Any significant knowledge weakness in reactor safety will cause the student to fail the board.

The oral boards are conducted formally. There is a chairman of the board. The board examines the student's record. Each member asks questions. All members grade the answer. The questioning continues until all are satisfied. For an officer, this usually takes two to three hours. Once he has qualified, the student enters the proficiency phase of prototype training. The primary purpose of this phase is to become proficient as a watchstander. In this phase, the student gets watchstanding experience as the man on watch at the station. He takes the watch by himself, and there is no staff watchstander present to help him.

Lectures are also scheduled to increase the student's knowledge in various areas. In addition, the qualified student has an opportunity to participate in various maintenance tasks.

For this part of the program, the lectures and tasks are scheduled on a case basis. The object is to give students as much additional training as we can while he is gaining watchstanding experience. Obviously, not all students get

the same amount of proficiency training, since they qualify at different times.

The entire class graduates at the same time and are transferred to the fleet. A small number of those who have demonstrated above average performance at the Nuclear Power School and the Prototype are retained on the staff to qualify as instructors.

Phase 4 of the program is when the officers and enlisted personnel report to the fleet. They have learned "how to qualify." The shipboard qualification program consists of Basic Engineering Qualification (BEQ) and individual watchstation qualification. Basic Engineering Qualification provides a cross-rate background level of knowledge for all nuclear trained personnel, and allows the operator to build on the principles learned at the Nuclear Power School and the Prototype. This qualification consists of various nuclear propulsion plant knowledge requirements including subjects such as reactor theory, systems design, principles of operating and casualty procedures, Engineering Department Organization, Radiological Controls and Chemistry. In most cases, BEQ will be pursued concurrently with initial watch qualification and some portions are prerequisites for each watchstation. Advanced watch qualifications such as Reactor Operator require completion of BEQ in its entirety.

The shipboard program of watch qualification for officer and enlisted personnel varies from that at the prototype, in that it is less rigidly structured. The individual is expected to complete practical factors and training watch requirements concurrent with study and checkout on shipboard

propulsion plant systems. Since he has just completed prototype qualification, this is not an unreasonable expectation.

Each officer, upon reporting to his first nuclear ship, must qualify as Engineering Officer of the Watch (EOOW). He completes Basic Engineering Qualification and selected theoretical and practical portions of enlisted watch-stander qualification requirements as prerequisites to the advanced requirements for EOOW. It usually takes three to six months to complete this qualification depending on the ability of the officer, the ship's operating schedule and the similarity of the shipboard plant with that of the prototype the officer attended.

The first step in shipboard qualification for an enlisted operator is to qualify rapidly on an in-rate watchstation so that he may become a useful member of the crew. The length of time required will vary depending on the watchstation, and the additional factors previously mentioned as affecting officer qualification rate. For example, an Engineering Laboratory Technician (ELT) may be able to qualify as a shipboard ELT in only a few days because shipboard Radiological Controls and Chemistry equipment, procedures, and associated systems are very similar to those at all prototypes. But it will usually take several weeks or months for him to qualify at other watchstations.

The submarine and surface ship force commanders have promulgated recommended qualification paths for each rate and have provided guidelines indicating the approximate length of time the average individual is expected to complete each watch qualification. Experience has shown that many operators will qualify in less time than the guideline period while a few will exceed it. Ultimately

each enlisted man is required to qualify on his most advanced in-rate watchstation, and upon gaining appropriate seniority and experience, to qualify as Engineering Watch Supervisor (EWS), the most senior enlisted watch.

Previously qualified personnel, officer and enlisted, returning from shore duty or transferring from another ship will be examined on the senior watchstation on which they were previously qualified. The results of this examination will determine the type and length of qualification required for requalification in their new ship.

Phase 5 of ship training is spent on "recurring training." There is a continuing need to reinforce initial training and provide training which increases the level of knowledge of all nuclear operators. To maintain high standards in the Navy nuclear propulsion program ships, Commanding Officers must conduct recurring training. This training is also a vehicle for improving the watchstander's ability to handle casualties, and supports more advance watch qualification.

The methods used in conducting nuclear propulsion plant recurring training in ships are the same proven ways of accomplishing training described and are in use at Nuclear Power School and prototypes. Lectures and seminars are conducted on a departmental and divisional basis. In most cases a monitor, senior to the instructor or seminar leader is present to assist in keeping the training session "on track," and to provide feedback to the command and the instructor on the quality of the lecture or seminar. Lectures are given by experienced personnel who are specifically selected to fit the topic and

audience. Selection of instructors, lecturers and monitors is an important quality control measure.

A comprehensive examination program is a key factor in any formal training program. Examinations are necessary to ensure understanding and retention of the material covered in lectures and seminars. Therefore, examinations are given covering most "recurring training" sessions and are designed to be tough enough to challenge the most knowledgeable crew members.

In addition to classroom type training, the recurring training program is also composed of practical evolutions and casualty drills. These form an important part of the shipboard training plan, allowing the nuclear propulsion plant operator to build on his theoretical knowledge of the propulsion plant and put into practice the principles of operating and casualty procedures he has studied. The Engineering Department Manual for Naval Nuclear Propulsion Plants lists the required drills and evolutions and indicates whether the drill should be walked-through or actually conducted. In some cases, part of the casualty action may be walked-through and part actually carried out. Within the constraints of reactor and ship safety, a conscious effort is made to carry out these casualty drills in a realistic manner.