



THE QUALIFICATION OF NDT INSPECTION PERSONNEL
IN THE NAVAL NUCLEAR PROPULSION PROGRAM

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Abstract

As the U.S. Navy entered the age of nuclear propulsion it realized that the safety requirements necessary to protect the lives of naval personnel on board nuclear powered vessels, as well as protecting the civilian population, required a higher quality of NDT inspection than was currently available in industry. As a result, the Naval Reactors (NR) office established an NDT qualification program under the jurisdiction of the Naval Sea Systems Command Technical Representative (NSTR) located in Pittsburgh, PA. The Bettis Laboratory (a prime contractor laboratory operated for the government by Westinghouse Electric Corporation) was given the lead in developing and administering the resulting qualification program. Each facility, whether military or civilian, that is engaged in applicable NDT inspections in the Naval Nuclear Propulsion Program (NNPP) is required to send representatives to the Bettis Laboratory where they take qualification examinations, the passing of which certifies them as NDT Examiners. They are then responsible for qualifying and monitoring those inspection personnel at their facility who are performing NDT inspections. This paper discusses the mechanics and philosophy of this program.

I. Introduction

The NAVSEA NDT examiner qualification program is administered for NSTR by the Bettis Laboratory with assistance from the three other prime contractors in the NNPP [General Electric Knolls Atomic Power Laboratory (KAPL), General Electric Machinery Apparatus Operation (MAO) and Westinghouse Plant Apparatus Division (WPAD)]. Qualification examinations are administered for one week of each month. The examinations for each NDT method consist of both written and operational (hands-on) parts, each of which takes approximately one-half day. During the examination week, each of the four prime contractors provides a qualified Test Administrator who assists Bettis in the administering of the examinations.

In addition to assisting in the administering of the examinations, each of the four prime contractors has lead for one of the four major NDT methods (magnetic particle, liquid penetrant, radiography and ultra-sonic) in the program. Visual and dimensional techniques are included in the liquid penetrant and magnetic particle examinations. This includes the preparation of both written and operational examination material. Once material is prepared, the lead prime contractor must obtain appropriate concurrence from the other prime contractors and

final approval from NSTR before the material is incorporated into the NDT examination program.

Separate examinations are given for weld inspections and component or base material inspections.

II. Program Structure

NDT examiners are qualified only at Bettis. These examiners in turn return to their facilities where they prepare and administer qualification examinations for inspection personnel in the following general categories:

1. Supervisors (those who supervise inspectors and operators)
2. Inspectors (those who inspect and disposition product)
3. Operators (those who operate inspection equipment but do not disposition product)

The NDT examiner is responsible for knowing the appropriate NDT method for each application and periodically monitoring those engaged in inspection. In cases where the facility is a small shop, the examiner may function as both examiner and inspector. This places an additional responsibility on the facility management as there is no qualified monitor for the inspection.

III. Examination Material

The NDT examiner qualification program is structured to require multiple concurrence of all examination material by experienced NDT engineers to provide a high assurance of good examination content. All written examinations are reviewed in depth by at least one other prime contractor. All operational (hands-on) examinations are reviewed by a representative from each prime contractor, including performance of an inspection of proposed test props. The results of this review are used to establish a range of correct answers for the operational examination.

IV. Structure of Examination

As noted above, the qualification consists of both written and operational examinations, each of which is approximately one-half day in length. All phases of the written and operational examination are open-book with the candidate having access to applicable specifications and technical references. Time limits are adhered to for each phase of the examination. For most inspection methods, the candidate completes all phases of the examination for a particular inspection method during an eight hour day.

A. Written Examinations

1. Composition

The written examinations, which normally contain 50 questions, generally consist of two parts involving theory and specification questions.

2. Construction

Most questions are of multiple choice or key sheet (matching) construction. The number of true/false questions is limited to 20%. The multiple choice questions have 4 possible answers. Only one correct answer is allowed and no "all of the above" or "none of the above" answers are permitted.

3. Generation of Examinations

All written examinations are generated by computer random selection from a question bank. The question bank for each test method contains a minimum of 150 questions (three times the number used in an examination) which are broken down into various sub-groups such as theory, method requirements, acceptance criteria, qualification requirements, etc. The computer randomly selects a preselected number of questions from each category. New examinations are generated for each day. Since several questions may contain similar content, questions of such a nature are cross-referenced and once one is selected, the computer automatically locks out any other similar questions.

B. Operational Exam

1. Composition

Many of the operational examinations consist of two parts. For example, in the visible red dye penetrant examination for the inspection of welds, the NDT examiner candidate is required to perform an inspection of a test prop containing three welds. In addition, the candidate is given a series of sketches containing simulated penetrant indications which must be evaluated and dispositioned. In weld radiography, the candidate is required to read several radiographs, chosen from a film bank, as well as illustrate graphically on paper the parameters necessary for adequate radiographic shots of several specific welds.

2. Operational Test Props

The test props chosen for the operational examinations are comprehensive and generic in nature, designed to adequately examine an individual's ability to properly perform the inspection and

detect defects. Several different test props are available for each inspection method so that the same test props are not used each day.

3. Examination Administration

The operational examinations are administrated on a "one on one" basis with a prime contractor Test Administrator observing the entire process. The candidate is graded both on results and inspection technique.

C. Grading

Grading checklists are used, which are designed to provide uniform grading results. A minimum grade of 80% on each part of the examination is required for passing. This includes the associated parts of both the written and operational examinations. Examinations are overgraded by an individual who oversees the program to assure that there are no grading errors. No oral upgrading is permitted for a candidate's grade.

V. Closeout Interview with Candidate

A. Review of Grade

Upon completion of the examination, the examination results are reviewed individually with the candidate in a confidential manner. If the candidate has passed, each missed question is reviewed to assure that the candidates understand their mistakes. If the candidate fails, the review is more general with a few specific examples used to illustrate the candidate's weak points. A full review is not conducted in such a case to prevent compromising the examination. The operational examinations are never reviewed in their entirety to prevent compromising of the test props.

VI. Review of NDT Examiner Responsibilities

Prior to leaving Bettis, all candidates that pass are given a lecture on the responsibilities of an NDT examiner.

A. Malpractice

Each candidate is cautioned about the criminal aspects of deliberate malpractice as well as being given several examples that have been encountered in industry. Each candidate is also required to sign a statement acknowledging the responsibilities of an NDT examiner concerning deliberate malpractice.

B. Qualification of Facility Inspection Personnel

All qualified NDT examiners are provided with a set of instructions as to how to set up and operate a qualification program to qualify inspection personnel at their facilities. This includes requirements on the content of written examinations such as:

1. No more than 20% of questions can be of a true/false type.
2. Minimum number of questions in an examination.
3. More than one examination to prevent compromising of the examination.
4. The percentage mix of various question categories (i.e. theory, application, acceptance criteria, etc.)
5. No oral upgrading permitted.

Instructions are also provided for operational examination material. These include requirements for:

1. Test piece design
2. Number of test props
3. Types of discontinuities
4. Consistent grading system
5. Examination content

C. Monitoring of Inspection Activities

The NDT examiners are required to periodically monitor the work of all personnel performing inspections. In addition, all vendors are subject to NDT appraisals sponsored by NSTR.

VI. Upgrading of the Program

The NDT examiner qualification program is continually upgraded in the following manner:

1. Test Administrators Critique Sheets

At the close of each examination week, each prime contractor Test Administrator completes a critique sheet on which any observed anomalies are noted for investigation and correction if appropriate.

2. Computer Analysis of Answers to Written Question

Examiner candidate answers for written questions are input into a computer program after each examination session. These data are periodically analyzed to determine if any particular question is being answered correctly too often (which might indicate a question that is too easy) or is being missed too often (which might indicate poor wording).

3. Prime contractor analysis of Operational Examination Results

The results of the operational examination are forwarded to the lead prime contractor for that inspection on a monthly basis for periodic evaluation.

4. Revision of the Applicable Military Standards

Each time the specifications are revised (each 3-5 years) the examination is reviewed again as it is being upgraded for applicability to the revised standards.

VII. Summary

In summary, the navy NDT examiner qualification program is designed, and continually upgraded, to provide a high assurance that personnel performing NDT inspections to the requirements of the NNPP are knowledgeable, competent and possess a high degree of integrity to ensure that the safety and reliability of our nuclear fleet is maintained.

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