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Manual on Training, Qualification and Certification of Quality Assurance Personnel



INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA, 1986

**MANUAL ON TRAINING,
QUALIFICATION AND CERTIFICATION
OF QUALITY ASSURANCE PERSONNEL**

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FOREWORD

The International Atomic Energy Agency's plans for establishing safety standards for nuclear power plants, referred to as the Nuclear Safety Standards (NUSS) programme, are set out in IAEA document GC(XVIII)/526/Mod. 1. The objective of the programme is to proceed with the development of three types of document:

- (a) Codes of Practice for thermal neutron nuclear power plants, which establish the objectives and minimum requirements that must be fulfilled to provide adequate safety for these plants;
- (b) Safety Guides, which provide additional requirements and recommend procedures that should be followed to implement the Codes of Practice;
- (c) User's Manuals, intended primarily for nuclear power plant operators, which normally present possible methods and techniques for solving specific problems.

Work on Codes and Guides was initiated in 1975 in five main fields: governmental organization, siting, design, operation and quality assurance.

In the field of quality assurance (QA) a Code of Practice and ten Safety Guides have been published. These publications are used in a number of Member States to establish QA requirements for nuclear power plants. To facilitate their use the Technical Review Committee on Quality Assurance has stressed on a number of occasions the need for User's Manuals and recommended that the Agency proceed with the development of these Manuals. The Manuals should provide Member States implementing the Code and Safety Guides with examples of procedures, practices and documents illustrating QA methods and techniques used in those organizations in Member States having broad experience in QA. The same opinion was expressed in discussions during the International Symposium on Quality Assurance for Nuclear Power Plants, held in Paris in May 1981. A number of topics were identified at the symposium for which User's Manuals could provide additional information and facilitate correct implementation of the Code and Guides in nuclear power plant project activities.

To implement the recommendations mentioned above, work has been initiated in the Secretariat to develop those User's Manuals which are most needed in Member States embarking on nuclear power programmes and starting QA activities. In view of the difference between User's Manuals and Codes and Safety Guides, work on User's Manuals is undertaken outside the NUSS programme's established procedures for development, review and approval of documents. For User's Manuals it was decided to follow the standard practices

used in the development of Agency publications such as Guidebooks and Technical Reports. This procedure is expected to reduce the time and cost of preparation of User's Manuals, which are at the lowest level in the hierarchy of NUSS programme documents and do not contain requirements for which formulation of a broad consensus of QA experts would be needed.

The full consistency of the User's Manuals with the Code and Safety Guides is ensured by information exchange between the Secretariat and members of the Technical Review Committee on Quality Assurance and the Senior Advisory Group of the NUSS programme. Also, members of the latter two groups, in the capacity of consultants to the Agency and members of advisory groups, are engaged in the development, review and approval of User's Manuals before these are recommended to the Director General for publication.

The present User's Manual contains supporting material and illustrative examples relating to practices for implementing QA personnel qualification and training requirements, as formulated in the Code of Practice on Quality Assurance for Safety in Nuclear Power Plants (IAEA Safety Series No. 50-C-QA, 1978), and additional requirements and recommendations presented in the QA Safety Guides. Consistent with accepted practice for codes and guides, and in accordance with a proposal of the Senior Advisory Group, 'shall' and 'should' are used in this Manual to distinguish for the user between a firm requirement and a desirable option.

This Manual is intended primarily for organizations that are establishing QA programmes for nuclear power plants and are engaged in selecting staff and training personnel to perform QA functions. It attempts to categorize QA personnel with respect to the functions they perform and to identify for each category of staff the qualification and training needs. The Manual includes examples of syllabuses of training courses that are held by organizations with broad experience in personnel training.

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1. INTRODUCTION

1.1. GENERAL

The International Atomic Energy Agency's Code of Practice on Quality Assurance for Safety in Nuclear Power Plants (IAEA Safety Series No. 50-C-QA, 1978) states that in the quality assurance programme for a nuclear power plant, plans shall be developed for selecting and training staff to perform activities affecting quality. Among the staff it defines the persons and groups performing the quality assurance functions of:

- “(a) ensuring that an appropriate quality assurance programme is established and effectively executed, and
- (b) verifying that activities have been correctly performed”.

The Safety Guide on Quality Assurance Organization for Nuclear Power Plants (IAEA Safety Series No. 50-SG-QA7, 1983) provides guidance on the establishment of an appropriate organization in order to meet the requirements of the Code of Practice. The Guide further elaborates the requirements for the selection of staff performing activities affecting quality on the basis of their qualifications, which include general education, experience and proficiency necessary for the assigned tasks, placing particular importance on the qualifications of the personnel performing the quality assurance functions cited above.

The Safety Guide describes the need for indoctrination of these personnel with respect to the specific project objectives, requirements and practices, and for formal training, when appropriate, to ensure that proficiency is achieved and maintained. The personnel performing quality assurance functions are referred to in the Guide as the quality assurance unit. The Guide recognizes that the size and structure of the QA unit may vary widely among organizations because of the many variables involved, such as the number of personnel, the type of activity being performed and the location or locations where activities are performed. It also provides examples of qualification requirements for inspection, testing and auditing personnel.

The IAEA publication, Manpower Development for Nuclear Power (Technical Reports Series No. 200, 1980), provides guidance on manpower requirements for a nuclear power project and on manpower education, qualification and training for various engineering disciplines involved. This includes general guidance on requirements for personnel performing QA functions and on their qualification.

These personnel are referred to in the above-mentioned publication as quality assurance or quality control personnel.

This User's Manual is intended to provide general guidance on the qualification and training requirements of the personnel responsible for performing specific QA functions in nuclear power plants as defined in the Code of Practice. For the purpose of this Manual and consistent with Technical Reports Series No. 200, the personnel performing QA functions are referred to as quality assurance personnel.

1.2. SCOPE OF MANUAL

The Manual is applicable to those participants in a nuclear power project who are associated with establishment and implementation of the various QA programmes during the life cycle of the project. It provides examples of typical QA functions to be undertaken and the associated qualification requirements, training programmes, training techniques and methods of certification of personnel implementing these functions.

The necessary qualification and training requirements and practices for QA personnel are dependent primarily on the functions or activities to be performed. The two main functions of the QA unit noted previously as (a) ensuring QA programme establishment and execution and (b) verifying that activities have been correctly performed have been found in practice to require different qualifications and training of personnel. Therefore, for the purpose of this Manual the QA personnel may be classified in two groups who perform:

- QA programmatic and evaluation functions
- Inspection and test functions.

These titles do not necessarily represent separate or individual organizational groups or units and may be composed of one or of several different organizations.

Besides these typical QA personnel there are other personnel who perform activities closely related to QA, such as project management and technical support personnel. Although they are not considered as QA personnel, they perform activities affecting quality and shall be properly qualified and trained to perform their activities in a correct and efficient manner. This requires training and qualification in specific activities related to implementation of the applicable codes and standards, such as design verification, in-service inspection or other activities covered by the QA programme. These personnel, besides having specific qualifications, must also be familiar with the QA principles, practices and techniques to be employed, and should receive appropriate training and orientation concerning the objectives and limitations of QA. However, strictly they are not QA personnel and their various qualification requirements and necessary skills will not be considered in this Manual.

1.3. RESPONSIBILITY OF ORGANIZATIONS WITH REGARD TO QA

The organization having overall responsibility for a nuclear power plant, referred to hereinafter as the responsible organization, shall be responsible for the establishment and implementation of an effective training, qualification and, as necessary, certification programme for all QA personnel in the framework of the overall QA programme for the plant. The responsible organization, when delegating to other organizations the work of establishing and implementing all or part of the overall QA programme, may also delegate the work of personnel training and qualification, but shall retain responsibility for ensuring its adequacy and effectiveness.

Personnel selected for QA assignments shall have the experience and qualifications commensurate with the scope and complexity of the activities to be performed. Each organization participating in the nuclear power project shall establish the personnel qualification requirements and the methodology to be used for qualification. It is the responsibility of each organization to establish in the framework of its constituent QA programme the required training, qualification and certification programmes.

The responsible or delegated organization shall identify those QA functions that require qualified QA personnel and the minimum qualification requirements for such personnel. Written procedures shall be established for the qualification of these personnel to assure that only those who meet the stated qualification requirements are permitted to perform the activities.

1.4. PERSONNEL CATEGORIZATION

With respect to activities to be performed, QA personnel may be classified into several groups or categories to denote their functions and the respective qualifications and training they should have. For the purpose of this Manual, and as specified in Section 1.2, QA personnel may be classified into two groups:

- QA programmatic and evaluation function personnel
- Inspection and test personnel.

In some organizations it is customary to call these two groups quality assurance and quality control personnel, respectively.

Within each group, several categories of personnel may exist. Each category performs specific QA functions identified in the QA programme. For QA programmatic and evaluation function personnel the following categories usually exist:

- Surveillance personnel
- Auditing personnel
- QA specialist
- QA line management.

in electrical engineering	Level 1
	Level 2
	Level 3
in mechanical engineering	Level 1
	Level 2
	Level 3
in NDE	Level 1
	Level 2
	Level 3.

In addition to these categories, and as mentioned in Section 1.2, there exist specific QA related functions which the indicated categories of personnel are not qualified to perform; examples are design verification, equipment testing and in-service inspection and evaluation. The personnel performing these functions usually do not belong to a QA unit and are consequently not considered in this categorization of QA personnel.

1.5. MANPOWER REQUIREMENTS AND TECHNICAL QUALIFICATIONS

IAEA Technical Reports Series No. 200 provides guidance on manpower requirements and technical qualifications for quality assurance/quality control personnel for a nuclear power project, such as for the plant owner (utility), architect-engineer, equipment suppliers and other site constructors and operators of nuclear power plant. The report also provides information on required educational requirements and experience and on specialized training for these personnel. For completeness, tables containing this information are reproduced in Annex I-5.

2. QA PROGRAMMATIC AND EVALUATION FUNCTIONS

2.1. FUNCTIONS AND ACTIVITIES

Safety Guide No. 50-SG-QA7 outlines the typical programmatic and evaluation functions performed by the QA unit. These may include the following:

- (a) Planning, designing and developing the QA programme, including its practices, procedures and techniques. This function may also include several activities associated with documenting the programme in plans, descriptions, procedures or other appropriate forms, and with management of QA records.
- (b) Determining and assessing the acceptability of quality achievement through given verification activities. This function may include such activities as

audits and/or surveillance to determine that the QA programme is established and to verify that it is being effectively executed.

- (c) Control of non-conformance and identification and elimination of significant conditions that can adversely affect quality.
- (d) Activities related to personnel qualification, training, indoctrination and certification.

These functions and related activities are similar for all project life cycle phases and for overall and constituent QA programmes.

2.2. CATEGORIZATION OF QA PROGRAMMATIC AND EVALUATION FUNCTION PERSONNEL

Consistent with existing practices, this Manual establishes four typical categories of QA personnel performing programmatic and evaluation functions, each with its own requirements for qualification and training:

Category I: Surveillance personnel

Personnel performing surveillance should be capable of witnessing or monitoring manufacturing, construction, installation and/or inspection and test activities and of evaluating these activities to ensure that performance is in accordance with applicable requirements. Surveillance normally includes witnessing, monitoring, documenting, evaluating and assessing the conformance of an activity, but does not include direct inspection and testing for the purpose of accepting or rejecting items.

Functions and activities of surveillance personnel are further defined in Section 2.3.

Category II: Auditing personnel

According to the definition an audit is a documented activity performed to determine, by investigation, examination and evaluation of objective evidence, the adequacy of and adherence to established procedures, instructions, specifications, codes, standards, administrative or operational programmes and other applicable documents, and the effectiveness of implementation.

Auditing personnel should be capable of determining that an adequate QA programme exists and that QA implementing procedures have been developed and documented; of examining objective evidence to determine that the QA programme is implemented in compliance with specific requirements; of evaluating the effectiveness of the QA programme; of identifying programme deficiencies and non-conformance; of recommending corrective action; and of assessing the status and adequacy of the QA programme.

Functions and activities of auditing personnel are further defined in Section 2.4.

Category III: QA specialist

QA specialists should be able to establish and document the QA programme, plan and supervise QA functions, evaluate the adequacy and effectiveness of constituent and delegated QA programmes, and provide records of satisfactory completion of their activities.

Functions and activities of QA specialists are further defined in Section 2.5.

Category IV: QA line management

QA line management, in addition to having the capabilities of a QA specialist, should be able to evaluate the adequacy and effectiveness of execution of the QA programme functions and the specific training and indoctrination programmes for all personnel responsible for QA programme implementation.

Functions and activities of QA line management are further defined in Section 2.6.

2.3. CATEGORY I: SURVEILLANCE PERSONNEL

2.3.1. Functions and activities

Surveillance personnel perform monitoring activities within their own organization, at the facilities of suppliers or at plant construction sites. They normally perform their functions at two qualification levels, called 2 and 3 to be consistent with the levels defined for Category V, inspection and test personnel:

Level 2: Monitoring and random witnessing of activities, review of QA records and reporting of findings to the management. However, at this level surveillance personnel are not normally authorized to sign quality release forms allowing shipment, installation or use.

Level 3: The same activities as for Level 2 but with the additional authority to grant a quality release for shipment, installation or use and to make decisions on non-conformance in accordance with engineering instructions.

2.3.2. Qualification

The responsible or delegated organization should define qualification criteria for surveillance personnel according to the evaluation of the tasks identified. Annex I-1 provides an example of a method used for evaluating and qualifying

personnel performing surveillance functions. This information can be used in conjunction with the general guidance presented in Annex I-5 on the qualification and training necessary for QA/QC personnel.

2.3.3. Training

There are no specific standards for training of surveillance personnel. The responsible or delegated organization should define the required training in accordance with the activities and tasks to be performed. Annexes II-1, II-2, II-3 and II-9 contain some examples of training requirements and suggested course contents for surveillance personnel. In most organizations it is common practice that the surveillance personnel obtain training equivalent in scope to that of inspection and test personnel. In such cases training requirements also include course contents presented in Annexes II-6 and II-7. When a certificate is required, as is the practice in some engineering disciplines or examination techniques, this requirement may restrict activities of surveillance personnel to witnessing only.

2.4. CATEGORY II: AUDITING PERSONNEL

2.4.1. Auditor

2.4.1.1. *Functions and activities*

Typical auditor functions and activities include the following:

- (a) Reviewing pertinent policies, procedures and instructions related to the activity covered by an audit, and evaluating their consistency with applicable regulations, codes and standards;
- (b) Preparing, assembling and reviewing appropriate documents related to an audit and establishing check-lists;
- (c) Selecting and reviewing objective evidence of achieved quality;
- (d) Conducting interviews;
- (e) Identifying deficiencies in the QA programme;
- (f) Preparing written findings;
- (g) Exchanging information with other audit team members and the lead auditor;
- (h) Discussing findings with the lead auditor;
- (i) Assisting the lead auditor as required.

2.4.1.2. *Qualification*

Each auditing organization should determine and document the qualification requirements for its auditors. Annex I-2 and Annex I-3 (Annex VI of Safety Guide No. 50-SG-QA7) provide examples of requirements related to qualification

of auditors. In addition to the professional qualification, auditors should possess the following attributes as these contribute to their effectiveness:

- Ability to communicate (choice and flow of words; clarity of thought; listening, understanding and responding; writing skills).
- Ability to plan and control (organize, initiate, observe, analyse).
- Ability to gain co-operation (with audit team members, personnel of the audited organization and superiors).
- Ability to reach decisions (separate facts from opinion; compile information and evidence; compare evidence with requirements).
- Ability to work independently, systematically and energetically.
- Ability to acquire and use special knowledge and skills.
- Ability to adapt to changing work assignments and conditions.
- Good appearance and conduct.
- Emotional stability (calm, self-confident, persistent, insistent, task oriented).
- Good character (honest, reliable, constructive, helpful, diplomatic).
- Good attitude (interest, work habits, initiative, careful, curious, open minded).

QA auditors are often chosen from QA programmatic and evaluation function personnel Category III (QA specialist). In these cases specialist qualifications and training in the auditing process are required.

In some organizations qualification of auditors is to be confirmed by certification. When certification is required the responsible auditing organization should establish the appropriate certification criteria.

Maintenance of auditors' proficiency, including recertification when required, is practised in accordance with Section 4 of this Manual and includes one or more of the following methods:

- Regular participation in QA audits;
- Review and study of codes, standards, procedures, practices and other documents related to QA programmes;
- Participation in training courses and seminars.

Guidance on maintenance of qualification and requalification of auditors is given in Annex I-3.

2.4.1.3. Training

Training to the required level of competence should be given both by class-room training and through participation in QA audits. The class-room training should include:

- QA requirements and principles;
- Audit fundamentals, objectives, characteristics, planning, organization, performance and results;

- Methods of examining, questioning, evaluating and documenting specific audit items and methods of resolving audit findings;
- Procedures for carrying out audits and reporting results;
- Specialized training in communication and interviewing skills.

Annex II-4 contains some examples of training requirements and suggested course contents for auditing personnel.

2.4.2. Lead auditor

In the category of auditing personnel specific functions and responsibilities are assigned to lead auditors.

2.4.2.1. *Functions and activities*

The typical lead auditor functions and activities, in addition to those for an auditor, include the following:

- (a) Preparing an individual audit plan in conformance with the established overall audit plan and schedule;
- (b) Ensuring that the audit team thoroughly understands the objectives and scope of the audit;
- (c) Preparing and issuing audit notification;
- (d) Conducting the pre-audit meeting to confirm the audit scope and planned dates, meet personnel of the audited organization, discuss the sequence and duration of the audit, set the time for the post-audit meeting and establish channels of communication;
- (e) Ensuring that procedures and check-lists are properly prepared;
- (f) Making adjustment to the audit plan when required;
- (g) Reviewing all observations and firmly establishing the facts related to the findings;
- (h) Co-ordinating audit team activities and establishing the pace of the audit;
- (i) Conducting the post-audit meeting to present findings, clarify any misunderstandings and reach an agreement on audit findings and the time frame for resolution of the problems identified by the findings;
- (j) Reporting audit results.

Additional functions and activities may include the following:

- (k) Defining the audit objectives and scope;
- (l) Identifying pertinent regulations, codes, standards, policies and procedures related to the subject or activity covered by an audit;
- (m) Following up corrective actions based on the audit and closing the audit.

2.4.2.2. *Qualification and certification*

Each auditing organization should determine and document the qualification requirements for its lead auditors. Annex VI of Safety Guide No. 50-SG-QA7 provides an example of requirements related to the qualification of lead auditors and is reproduced here as Annex I-3.

Selection of the lead auditor should be made with the following attributes in mind, in addition to those identified for auditors, as these contribute to his/her effectiveness:

- Ability to lead (supervise, delegate, gain acceptance, direct team towards objectives, deal with the management of the personnel of the audited organization);
- Ability to administer (record keeping, reporting).

The qualification of lead auditors may be confirmed by certification, in which case recertification should be performed at defined intervals. In the example given in Annex I-3 the lead auditor is certified by his/her employer. Maintenance of qualification is discussed in Section 5.

2.4.2.3. *Training*

Training of the lead auditor in addition to auditor training should include, if applicable:

- Planning methods and techniques
- Methods of supervision and administration.

2.5. CATEGORY III: QA SPECIALIST

2.5.1. **Functions and activities**

The typical QA specialist functions and activities include the following:

- (a) Establishing and documenting the QA programme, including, when appropriate, preparation of programmatic and work oriented documents in accordance with the applicable requirements;
- (b) Interpreting QA programme requirements;
- (c) Reviewing, commenting on and evaluating constituent and delegated QA programmes, including, when appropriate, programmatic and work oriented documents;
- (d) Evaluating documents such as specifications, drawings, procurement documents and records to ensure that QA requirements are met;
- (e) Planning and developing QA related training and indoctrination materials, methods, aids, etc.;

- (f) Developing, operating and maintaining a QA records system, as defined in the Safety Guide entitled Quality Assurance Records System (IAEA Safety Series No. 50-SG-QA2, 1979);
- (g) Developing, operating and maintaining controls for specified QA documents, such as QA manuals, programmatic and work oriented documents, non-conformance reports and corrective action reports.

2.5.2. Qualification and training

The responsible organization, as well as each organization to which it delegates the work, should determine and document the education and experience necessary for the performance of the assigned tasks.

With reference to Technical Reports Series No. 200 and Annex I-5, which give guidance on the qualification requirements of various QA personnel, the category of QA specialist is included under the following headings:

- Utility QA/QC headquarters staff
- Project engineering QA/QC headquarters staff
- Operation and maintenance QA/QC engineer
- Nuclear fuel cycle (waste management) QA/QC engineer.

An outline of typical QA training courses for QA specialists is given in Annex II-5. However, training in QA fundamentals and auditing techniques would also be necessary.

2.6. CATEGORY IV: QA LINE MANAGEMENT

2.6.1. Functions and activities

The typical QA line management functions and activities include the following:

- (a) Ensuring the establishment, documentation and effective execution of the QA programme in accordance with the applicable requirements;
- (b) Planning, directing and controlling QA activities, including handling of non-conformance, initiation of corrective action and management of the QA records system;
- (c) Managing QA training, qualification, certification and indoctrination programmes;
- (d) Assessing and reporting to senior management on the effectiveness of the QA programme;
- (e) Establishing appropriate resources and organization for the project or task, including personnel and equipment.

2.6.2. Qualification and training

The responsible or delegated organization should determine and document the education and experience necessary for the performance of the assigned tasks. Technical Reports Series No. 200 and Annex I-5 give guidance on the qualification requirements for various QA management functions under the following headings:

- Utility project management (QA group)
- Utility QA/QC manager
- Nuclear fuel cycle (fuel fabrication) QC manager
- Nuclear fuel cycle (waste management) head of QA group.

For the purpose of this Manual these personnel as appropriate are considered as QA line management. Outlines of typical QA training courses for QA line management are given in Annexes II-1 and II-9. This guidance may be applicable to QA line management for delegated QA programmes, although the specialized training in nuclear technology and QA/QC experience in nuclear power plant would not usually be relevant to QA line management of suppliers of plant items and services.

3. INSPECTION AND TEST FUNCTIONS

3.1. FUNCTIONS AND ACTIVITIES

IAEA Safety Guide No. 50-SG-QA7 outlines the typical inspection and test functions of a QA unit, which include determining and assessing the acceptability of quality achievement through verification activities such as inspections and tests for acceptance of items and services.

These functions and activities are similar for all project life cycle phases and for overall and constituent quality assurance programmes. In some organizations they are traditionally called quality control functions and quality control activities.

3.2. CATEGORIZATION OF INSPECTION AND TEST PERSONNEL

With regard to functional activities and relevant qualification and training, personnel performing inspection and test functions may be categorized as a single category with possible specialization in various technical disciplines or methods of inspection and testing. In this Manual inspection and test personnel will be denoted as Category V of QA personnel.

Depending on their qualifications, inspection and test personnel should be capable of performing the appropriate activities related to the definitions of

inspection and testing. Inspection consists of quality control actions which by means of examination, observation or measurement determine the conformance of items and/or activities with predetermined quality requirements. Testing is the verification of the capability of an item to meet specified requirements by subjecting the item to a set of physical, chemical, environmental or operational conditions.

In view of the complexity of inspections and tests these functions can be performed at various levels of competence and qualification. Consequently, the qualifications of inspection and test personnel may be classified into capability levels based on existing national requirements and practices. Where no national standards exist, the recommendation of IAEA Safety Guide No. 50-SG-QA7 may be used. Three levels of capability for all groups of inspection and test personnel are recommended in Annex V of the Guide, reproduced here in Annex I-4. Normally, Level 3 is reached after passing through Levels 1 and 2, but in some organizations entering Level 3 is allowed also by a route other than Levels 1 and 2, such as some external form of examination, approval and certification.

3.3. CATEGORY V: INSPECTION AND TEST PERSONNEL

Personnel who perform inspections and tests for the purpose of accepting items or services may be grouped according to the types of activity they perform and the respective specialization required. National practices and qualification standards distinguish two groups of inspection and test personnel:

- Personnel performing non-destructive examination (NDE technicians)
- Personnel performing other types of inspection and testing (QC inspectors).

3.3.1. Personnel performing NDE

3.3.1.1. *Functions and activities*

NDE personnel perform inspections using non-destructive examination techniques such as:

- Radiographic examination (RT)
- Magnetic particle examination (MT)
- Liquid penetrant examination (PT)
- Ultrasonic examination (UT)
- Eddy current examination (ET)
- Leak testing (LT)
- Visual examination (VT).

These activities require specific technical knowledge and respective qualification of the personnel. The qualification requirements may be classified into a number

of levels according to the capabilities and the nature of the responsibilities of the personnel.

3.3.1.2. Qualification, training and certification

Several national standards exist for NDE personnel which define the levels of capability and qualification according to the activity performed. Annex III-1 provides examples of national standards and certification systems for NDE personnel in various IAEA Member States.

These national standards also provide recommendations on qualification criteria and on conditions for periodic evaluation of proficiency, documentation and certification, as befits the qualification. In addition, the standards provide information on appropriate training programmes and, in some cases, preferable personal characteristics. An outline of training programmes for different NDE techniques is presented in Annex II-6.

Maintenance of qualification is discussed in Section 5.

3.3.2. Personnel performing direct inspections and tests except NDE

3.3.2.1. Functions and activities

Inspection and test personnel not specialized in NDE may be classified on the basis of the technical disciplines in which they perform their activities. There may be many options for specialization, depending on the type of industry and its specific needs. Some typical options for inspection and testing are as follows:

- Mechanical equipment inspections
- Electrical inspections
- Instrumentation and control equipment inspections
- Civil construction inspections.

In some organizations options for specialized disciplines exist, such as:

- Welding inspections
- Concrete inspections and tests
- Geotechnical-soil inspections and tests
- Equipment performance tests.

Activities of these inspection and test personnel may also be classified into three levels as defined in Annex I-4.

3.3.2.2. Qualification, training and certification

Safety Guide No. 50-SG-QA7 provides guidance for defining the qualification requirements of these personnel as regards education and experience and for

documenting this qualification. Annex III-2 of this Manual provides examples of national standard qualification and certification requirements for personnel of various engineering disciplines. Where no national standards exist, the recommendations presented in Annex I-4 may be used.

Qualification should be periodically reviewed in order to assure maintenance of proficiency. The frequency of this review should be defined, and recommendations of Safety Guide No. 50-SG-QA7 may be used in this connection.

Training of inspection and test personnel should include indoctrination in QA and theoretical and practical training in the techniques to be used in inspections and tests. Such personnel should also receive the necessary orientation in QA programmatic procedures to be implemented within their organization and should be trained in the use of the work oriented procedure(s) specific to their organization and relevant to their assigned tasks. Examples of suggested course contents for training of inspection and test personnel in various disciplines are given in Annexes II-7 and II-8.

4. TRAINING AND QUALIFICATION

4.1. QUALIFICATION REQUIREMENTS

The qualification of a person for a specific job means the possession of the necessary physical attributes, knowledge, skills and experience necessary to perform assigned duties in a competent manner. The necessary physical attributes are ensured during recruiting and selection of staff.

Other prerequisites for qualification are gained through education, training and experience. Usually, the qualifications of QA personnel are measured against established requirements such as standards or specific tests that qualify an individual to perform a required function. Certification of qualification represents a formal act of determining, verifying and attesting in writing to the qualification of personnel in accordance with specified requirements.

4.1.1. Physical attributes

Physical attributes that are normally required of QA personnel, and particularly inspection and test staff, include natural or corrected near distance visual acuity, a healthy physique, a normal range of motion and dexterity, and freedom from acrophobia.

4.1.2. Education

High school and university degree curricula in QA exist in some countries, although they are a recent phenomenon. In the developed countries there are a

number of schools offering two-year education programmes for an Associate degree (United States of America) or four-year programmes for a Bachelor's degree in quality related disciplines, including quality assurance and quality control. It is true, however, that most of the staff entering the QA profession come from many other engineering disciplines without formal education in quality related subjects. For this reason most of the QA professionals are transferred from other technologies. Also, promotions in QA disciplines, such as to the positions of QA specialists and QA managers, are usually from the levels of inspectors and technicians and are based more on experience and additional training than on additional education. For all these reasons continuing education can be considered an advantage but not a prerequisite in entering the QA profession.

Technical Reports Series No. 200 and Annex I-5 of this Manual show the levels of education required for specific functions and tasks in QA disciplines. It is recognized that education requirements may vary widely among the organizations participating in a nuclear power project and among countries. Educational background will certainly be taken into consideration when the appropriate training programmes are identified for specific functions and tasks. It is the responsibility of each organization to identify the educational requirements and the appropriate subject matter for training of its staff on the basis of its specific needs. Additionally, it is the responsibility of each organization to ensure that its personnel have received the training appropriate to their assigned job functions and education. In such a way, a person with a higher educational level may be exempted from portions of the training programme provided that satisfactory knowledge is demonstrated in the respective evaluation.

4.1.3. Training

The fundamental approach to achievement of qualification in QA disciplines is by performance based training. The desired aim of training is to provide the trainee with the knowledge and skills necessary to perform satisfactorily. The basis for organizing successful training is to develop a performance based instruction programme which should be specific in respect of both organizations' needs and responsibilities and the education, skill and previous experience of the recruited staff. For these needs an analysis and assessment of the particular organizations should be conducted. The results should be used to establish training programme objectives, training methods and the form of instruction, such as class-room training and on-the-job training.

From the results of the analysis one should also derive performance measures to be used in evaluating employees' performance and to assess training effectiveness.

One should distinguish three training phases:

Initial training should be provided to all those individuals entering the QA profession. This training should be selective, depending on the previous experience,

Position \ Skill	General																																									
	Results factor						Contribution factor																		Supervisory factor																	
	Quality of work			Volume of acceptable work			Planning work			Organizing work			Initiative			Adaptability			Innovation			Decision making			Orientation			Communication			Leadership style			Staff development			Administration					
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			

A: more than meets requirements
 B: meets work requirements
 C: development or improvement required

FIG. 1. Individual qualification record form showing general skills.

education and previous training of the trainee. An individual may be exempted from portions of the initial training programme when satisfactory ability is demonstrated in an appropriate evaluation.

Continuing training should be provided to all QA staff to ensure that personnel remain proficient in the performance of their jobs. This kind of training should particularly take into account those changes which have been made in industrial standards, organizational procedures, etc., in addition to experience accumulated inside the organization and from the industry. A long term continuing training programme should also serve to maintain and upgrade the knowledge of QA personnel on those topics and equipment which are infrequently used.

Retraining should be provided to those QA personnel who were qualified but have failed to maintain their proficiency in accordance with qualification requirements.

4.2. TRAINING ASSESSMENT

Each level of management of the responsible and delegated organizations should perform initial and periodic staff assessments to determine specific training needs. Examples of formats for documenting assessments are given in Figs 1 and 2.

The individual's supervisor or another designated person should be responsible for:

- Identifying the individual's skill level and recording it on the appropriate form (e.g. Fig. 1);
- Selecting suitable training courses, rotational assignments, on-the-job training, etc., required to upgrade the individual's skill where this is found necessary (Fig. 2);
- Scheduling and arranging training (an example of a format for documenting a training plan is given in Fig. 3).

Examples of qualification and training record forms are given in Annex IV.

4.3. TRAINING OBJECTIVES

Training generally centres around the following objectives, irrespective of the subject being taught:

- Indoctrination of personnel in their roles and applicable policies, procedures, codes and standards;
- Qualification of personnel to assure their functional roles in the organization;
- Improvement of personnel attitude and performance on the job;
- Maintenance of personnel proficiency to keep personnel up to date in the applicable field;

Position \ Skill	Technical																																
	Proficiency			QA requirements			QA standards			Regulatory requirements			Process knowledge			Product knowledge			Company's policies and procedures			Company's QA programme and organization			Auditing methods and techniques			Sampling techniques					
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			

A: more than meets requirements
B: meets work requirements
C: development or improvement required

FIG. 2. Individual qualification record form showing technical skills.

- Development of personnel in areas of weakness and interest;
- Documentation of training, education, experience and qualification as objective evidence.

4.4. TRAINING METHODS

Several methods are commonly used in training. All have strengths and weaknesses as regards cost effectiveness. Selected methods will depend on the overall programme objectives, the personnel being trained, the instructor and the subject. Commonly used methods and their specific characteristics are listed below:

- (a) Class-room lectures, in which one or more instructors deliver lectures or tutor students in certain subjects. Slides, flip charts or other visual aids may be used.
- (b) Class-room workshops, with active student participation. Instructors or students bring problems and the group helps to solve them with the assistance of the instructor.
- (c) Class-room laboratories, in which instructors tutor students in the use of specialized equipment.
- (d) On-the-job training, in which trainees learn by association with fellow workers and supervisors. Training is conducted through participation in nuclear power plant construction, startup, operation maintenance or technical services under the direction of experienced personnel.
- (e) Audio-visual training, in which students receive full time instruction through the use of audio-visual aids. An instructor is available only for limited instruction and a question period.
- (f) Seminar training, in which students convene as requirements dictate for special sessions on specific topics.
- (g) Computer assisted instruction, in which trainees use preprogrammed teaching modules at computer terminals.
- (h) Extended training, in which trainees convene for short training sessions (of about one hour) on a regular basis. Usually the instructor delivers class-room lectures during these sessions.
- (i) Independent study suited to the individual.

4.5. GUIDELINES FOR TRAINING ACTIVITIES

Typical guidelines for the management for establishing and conducting training activities are summarized below.

Department _____ Section _____ Year _____

Name and job title	Specific learning needs	Proposed response	Planned action	Action taken	Observed results

FIG. 3. Example of a staff training and development plan.

4.5.1. Guidelines for management

- (a) Clearly identify the purpose and objectives of the course.
- (b) Select effective and qualified training staff who are knowledgeable and experienced in the areas to be covered; select training techniques, etc.
- (c) Allow trainers sufficient time to prepare their training material.
- (d) Provide adequate resources to develop training aids.
- (e) Separate the administration of the training course from the actual training.
- (f) Provide comfortable training facilities.
- (g) Ensure an efficient teacher/student ratio.
- (h) Evaluate the effectiveness of the course after its completion.

4.5.2. Guidelines for teaching

- (a) When preparing a course, clearly define the course objectives, topics and assignments to best meet those objectives.
- (b) Tailor the training to personnel and organizational needs. All training must start with recognition of the knowledge, skills and attitudes of the students.
- (c) Plan the course and allocate sufficient time to cover the various topics.
- (d) Distribute a course outline and schedule to give students an overview of the course.
- (e) Utilize techniques to motivate the students.
- (f) Maximize participation: the more actively involved the person being trained, the better the learning environment.
- (g) Obtain prompt and continuous feedback from students. Make certain that they know what they are supposed to be learning.
- (h) Reinforce the main topics by regular review during the training session.
- (i) Remember that teaching should be stimulating and enjoyable. Properly done, it should be a rewarding and satisfying experience for all concerned.
- (j) Ensure regular follow-up after the training session. This can be accomplished by post-course assignments directly related to the job. Assignments should be selected by the student in his/her area of concern or interest. The instructor should arrange follow-up by the student's line management.

4.6. EVALUATION OF TRAINEES

During the induction period each trainee should be evaluated in order to obtain evidence of the results of training and of the trainee's proficiency in a specific task. Different methods of evaluation are appropriate, depending on the training phase and the trainee's duties and tasks in a specific job.

Evaluation during class-room training is performed through assessment of written answers to questions, or through multiple-choice or essay-type examinations.

At the conclusion of a training programme or at the conclusion of a course module, a final comprehensive written examination is held. The examination should cover subjects included in the training programme and should be designed to measure the ability of the trainee to apply theoretical knowledge.

Evaluation of performance demonstrations should be documented. This should include the identification of tasks and instructors, the method of final checking, and records of the trainee's competence in performing the assigned tasks.

Job performance after training should be followed and evaluated. In some organizations a formal appraisal of the trainee is conducted in order to determine the needs and topics for continuing training.

5. MAINTENANCE OF QUALIFICATION

5.1. MAINTENANCE OF PROFICIENCY

Quality assurance personnel shall maintain their proficiency through regular and active participation in the activities they have been qualified to perform; the review and study of codes, standards, procedures, instructions and other documents related to their work; and participation in training programmes. On the basis of a periodic assessment, the relevant organization may extend the qualification or request retraining in order to achieve the required proficiency.

5.2. RECERTIFICATION

Quality assurance personnel who are certified and fail to maintain their proficiency in accordance with their organizations' requirements shall require recertification.

6. RECORDS

Records of personnel training, qualification and certification, if required, shall be established and maintained by each organization. Records of each individual's performance in the training and qualification programmes should be maintained in a retrievable manner. These records should provide evidence of written and oral examination and scores. Programme contents and written

evaluations of their efficiency should also be maintained. Access to qualification records should be allowed to functional supervisors to provide a basis for the assignment of tests to qualified individuals. The administration, storage and safe keeping of records should follow the recommendations of Safety Guide No. 50-SG-QA2, Quality Assurance Records System.

Annex I
QUALIFICATION

Annex I-1

QUALIFICATION OF SURVEILLANCE PERSONNEL (CATEGORY I)

This Annex describes a method used for evaluating and qualifying personnel who perform surveillance functions as described in Section 2.3. This method may be used to evaluate initial and continued proficiency. As indicated in Section 2.3.1, surveillance personnel are generally classified into two levels, which are comparable to Levels 2 and 3 in the classification of inspection and test personnel (Category V).

A.I-1.1. DETERMINATION OF INITIAL CAPABILITY

The capabilities of the candidate for qualification should be initially determined by evaluating the candidate's education, experience, training test results and capability demonstration against criteria defined by the employer for each qualification level. Section A.I-1.6 presents a scoring system used by some companies to evaluate personnel according to education and experience criteria. Annex II-3 provides guidance to define which type of training (e.g. class-room or on-the-job) should be given to achieve the required proficiency.

A.I-1.2. EVALUATION OF PERFORMANCE

Proficiency should be re-evaluated at intervals not to exceed three years. Re-evaluation should be based on evidence of continued satisfactory performance or redetermination of capability as specified above. A person who has not performed surveillance activities for one year or more should be re-evaluated by redetermination of capability as specified above.

A.I-1.3. CERTIFICATION OF QUALIFICATION

When required by regulatory or contractual requirements, the qualification of personnel should be certified in an appropriate form that includes the following information:

- Employer's name
- Name of person being certified
- Level of capability
- Activities certified to be performed
- Basis used for certification, including such factors as:
 - Education, experience and training
 - Examination result, where applicable
 - Result of capability demonstration

- Results of periodic evaluation
- Results of physical examination
- Signature of employer’s designated representative
- Date of certification and expiration date of certification.

A.I-1.4. PHYSICAL CHARACTERISTICS

The employer should identify any special physical characteristics required for the performance of surveillance. These should at least include satisfactory near and colour vision. Appropriate requirements should be met at the time of initial certification and should be verified by re-examination at intervals not to exceed one year.

A.I-1.5. RECORDS

A file of records of personnel qualifications should be established and maintained by the employer. Conditions for collection, storage and control of required records should be defined in accordance with recommendations of IAEA Safety Guide No. 50-SG-QA2.

A.I-1.6. EXAMPLE OF CRITERIA FOR DETERMINING REQUISITE EDUCATION AND EXPERIENCE

This section presents a scoring system that may be used in making the determination of initial capability recommended in Section A.I-1.1. The system is similar to those used for auditors or lead auditors but adapted to surveillance activities.

Level 2 personnel should accumulate a minimum of 5 credits and Level 3 personnel a minimum of 10 credits under the scoring system, which is as follows:

Education (5 credits maximum)

- 1 credit for completion of basic education, including some technical courses;
or
- 2 credits for completion of basic education and associated graduation; or
- 3 credits for a university degree (two-year course); or
- 5 credits for a university degree (four-year course).

Experience (8 credits maximum)

- 1 credit for each full year of technical experience in manufacturing, construction, operation or maintenance, up to a maximum of 5 credits.

To this add one of the following if appropriate:

- 1 credit if two or more years have been in the nuclear field; or
- 2 credits if two or more years have been in QA; or
- 3 credits if two or more years have been in the surveillance of nuclear activities.

Award of credits by management (2 credits maximum)

The employee may be awarded up to 2 credits for other performance factors applicable to surveillance which are not specified above. Examples are sound judgement, maturity, technical knowledge, remarks made during examination, test performance and QA training.

Annex I-2

QUALIFICATION OF QUALITY ASSURANCE PROGRAMME AUDITORS (CATEGORY II)

This Annex describes a method used for evaluating and qualifying personnel who perform QA programme audits. This method may be used to evaluate initial and continued proficiency.

To be qualified as an auditor an individual should accumulate a minimum of 5 credits under a scoring system, described below, which assigns credits on the basis of years of education and experience. In any case, the individual should have at least either one year of QA experience or two years of general technical experience (Fig. 4).

Education (4 credits maximum)

- 1 credit for completion of basic education; or
- 2 credits for completion of high school education.

To this add the following if appropriate:

- 1 credit for graduation from a college;
- 1 credit for completion of a university course.

Experience (4 credits maximum)

- 1 credit for each full year of technical experience in general engineering, manufacturing, construction, operation or maintenance, to a maximum of 4 credits.

If this amounts to less than 4 credits, add one of the following if appropriate:

- 1 credit if two or more years have been in the nuclear field; or
- 2 credits if two or more years have been in QA; or

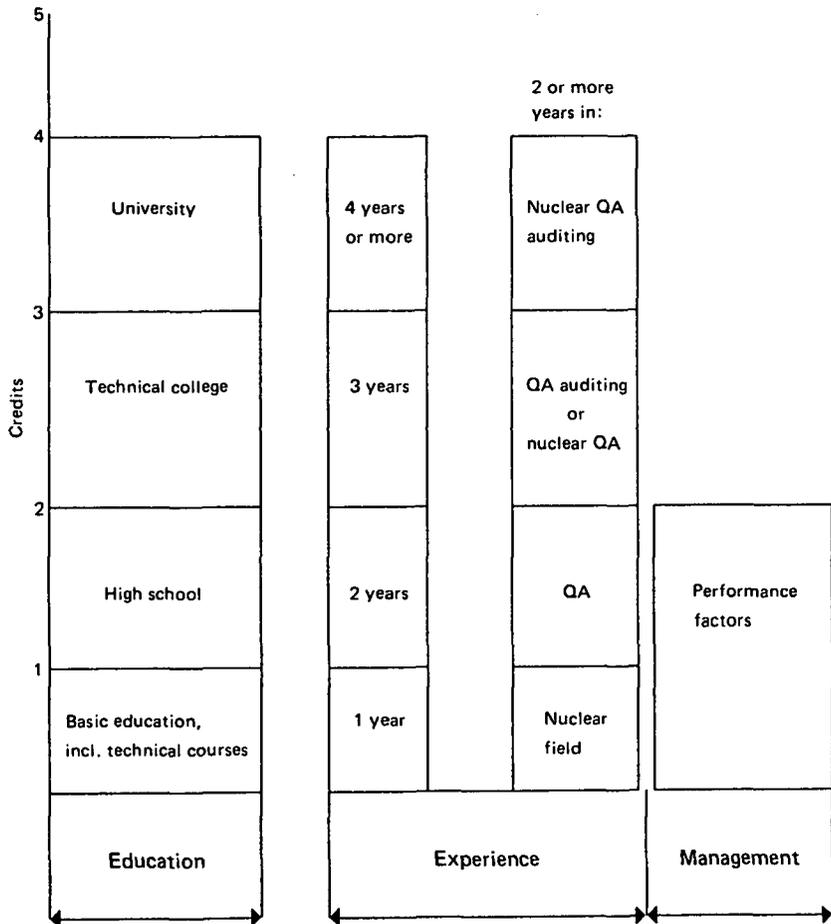


FIG. 4. Scoring system for qualification of auditors (minimum: 5 credits).

- 3 credits if two or more years have been in QA auditing or in nuclear QA; or
- 4 credits if two or more years have been in nuclear QA auditing.

Award of credits by management (2 credits maximum)

The auditor's employer may grant up to 2 credits for other performance factors applicable to auditing which are not specified above. Examples are QA training courses, sound judgement and maturity.

Details related to training of auditors are given in Section 2.4.1.3 and Annex II-4.

Annex I-3

QUALIFICATION AND CERTIFICATION OF LEAD AUDITORS

Annex VI of Safety Guide No. 50-SG-QA7 provides an example of requirements related to qualification and certification of lead auditors and is reproduced here.

A.I-3.1. INTRODUCTION

This Annex describes a method for evaluating and certifying personnel who perform quality assurance programme audits. This method may be used to evaluate initial and continued proficiency.

A.I-3.2. QUALIFICATION OF AUDITORS

The responsible auditing organization should establish the qualification requirements for audit personnel, and the requirements for use of technical specialists to accomplish the auditing of quality assurance programmes. Personnel selected for quality assurance auditing assignments should have experience or training commensurate with the scope, complexity, or special nature of the activities to be audited. Auditors should have, or be given, appropriate training or orientation to develop their competence for performing required audits. Competence of personnel to perform the various auditing functions should be developed by one or more of the following methods:

- (a) Orientation to provide a working knowledge and understanding of the quality assurance requirements and the auditing organization's procedures for implementing audits and reporting results.
- (b) General and specialized training in audit performance. General training should include fundamentals, objectives, characteristics, organization, performance, and results of quality assurance auditing. Specialized training should include methods of examining, questioning, evaluating, and documenting specific audit items and methods of resolving audit findings.
- (c) On-the-job training, guidance, and counselling under the direct supervision of a Lead Auditor. Such training should include planning, performing, reporting and follow-up action involved in conducting audits.

A.I-3.3. QUALIFICATION OF LEAD AUDITORS

To be qualified as a Lead Auditor, an individual should accumulate a minimum score of ten credits under a scoring system, described in this section, which assigns credits on the basis of years of education and experience.

A.I-3.3.1. Education (4 credits maximum)

For successful completion of 12 years of basic education, score one (1) credit; if 2 of the years are in a QA related discipline, score an additional one (1) credit.

or

For successful completion of 14 years of basic education, score two (2) credits; for graduation from a college or university in a QA related discipline, score an additional one (1) credit; also score one (1) credit for successful completion of 2 years of advanced study in a QA related discipline at a recognized institution.

A.I-3.3.2. Experience (9 credits maximum)

Score one (1) credit for each full year of technical experience in engineering, manufacturing, construction, operating or maintenance, to a maximum of five (5) credits. To this add one of the following, if appropriate:

If 2 or more years of this experience have been in the nuclear field, score one (1) additional credit; or

If 2 or more years of this experience have been in quality assurance, score two (2) additional credits; or

If 2 or more years of this experience have been in auditing, score three (3) additional credits; or

If 2 or more years of this experience have been in nuclear quality assurance, score three (3) additional credits; or

If 2 or more years of this experience have been in nuclear quality assurance auditing, score four (4) additional credits.

A.I-3.3.3. Other credentials of professional competence (2 credits maximum)

Score two (2) credits for a certification of competency in engineering, science or quality assurance specialties, that has been issued and approved by a governmental agency, or national professional or technical society.

A.I-3.3.4. Award of credits by management (2 credits maximum)

The Lead Auditor's employer may grant up to two (2) credits for other performance factors applicable to auditing, which are not specified in this section. Examples of these factors are leadership, sound judgement, maturity, analytical ability, tenacity, past performance and quality assurance training courses.

A.I-3.3.5. Communications skill

A prospective Lead Auditor should have the capability to communicate effectively, both orally and in writing. These skills should be attested to in writing by the Lead Auditor's employer.

A.I-3.3.6. Training

A prospective Lead Auditor should have training to the extent necessary to assure competence in auditing skills. Training in the following areas should be given, based upon management evaluation of the particular needs of each candidate:

- (a) Knowledge and understanding of the nuclear related codes, standards, regulations and other regulatory requirements, as applicable.
- (b) General structure of quality assurance programmes as a whole and of applicable elements.
- (c) Auditing techniques of examining, questioning, evaluating and reporting; methods of identifying and following up on corrective action items; and resolving audit findings.
- (d) Audit planning in quality related functions for the following activities: design, purchasing, fabrication, handling, shipping, storage, cleaning, erection, installation, inspection, testing, statistics, non-destructive examination, maintenance, repair, operation, modification of nuclear facilities or associated components, and safety aspects of the nuclear facility.
- (e) On-the-job training, including the elements of audit activity.

A.I-3.3.7. Audit participation

The prospective Lead Auditor should have participated in a minimum of five quality assurance audits within a period of 3 years preceding the date of qualification. One of these audits should be a nuclear quality assurance audit, and it should occur within the year preceding the date of qualification.

A.I-3.3.8. Examination

The prospective Lead Auditor should pass an examination which evaluates his comprehension of, and ability to apply, the body of knowledge outlined in paragraph A.I-3.3.6. The examination may be oral, written, practical or any combination of the three types. The development and administration of the examination should be in accordance with paragraph A.I-3.4.2.

A.I-3.3.9. Maintenance of qualification

Lead Auditors should maintain their proficiency through: regular and active participation in the audit process; review and study of codes, standards, procedures, instructions and other documents related to quality assurance programmes and, where appropriate, participation in training programmes. Based on an annual assessment, management may extend the qualification, require retraining, or require requalification. Assessments and evaluations should be documented.

A.I-3.3.10. Requalification

Requalification should be required for Lead Auditors who fail to maintain their proficiency for a period of two years. It should include retraining in accordance with the recommendations of paragraph A.I.3.3.6, re-examination in accordance with paragraph A.I-3.3.8, and participation as an auditor in at least one nuclear quality assurance audit.

A.I-3.4. ADMINISTRATION

A.I-3.4.1. Organizational responsibility

Training of auditors should be the responsibility of the employer. The responsible auditing organization should select, and assign as auditors, personnel who are independent of any direct responsibility for performance of the activities which they audit. The Lead Auditor should, before commencing the audit, ensure that assigned personnel collectively have experience or training commensurate with the scope, complexity, or special nature of the activities to be audited.

A.I-3.4.2. Qualification examination

The development and administration of the examination for Lead Auditor (see paragraph A.I-3.3.8) is the responsibility of the employer. The employer may delegate this activity to an independent certifying agency, but should retain responsibility for conformance of the examination and its administration to the applicable requirements. Integrity of the examination should be maintained by the employer or certifying agency through appropriate confidentiality of files and, where applicable, proctoring of examinations. Copies of the objective evidence regarding the type and content of the examinations should be retained by the employer in accordance with the recommendations of Subsection A.I-3.5.

A.I-3.5. RECORDS

A.I-3.5.1. General

Records of personnel qualifications for Auditors and Lead Auditors who perform audits should be established and maintained by the employer. Collection, storage, and control of records should be in accordance with specified requirements.

A.I-3.5.2. Certification of qualification

Each Lead Auditor should be certified by his employer as being qualified to lead audits. The certification should, as a minimum, document the following:

- (a) Employer's name
- (b) Lead Auditor's name
- (c) Date of certification or recertification
- (d) Basis for qualification (i.e. education, experience, communication skills, training, examination, etc.)
- (e) Signature of person designated by the employer to be responsible for such certification.

An example of a format for documenting the records of a Lead Auditor is given in Fig. 5.

A.I-3.5.3. Updating of Lead Auditor's records

Records for each Lead Auditor should be maintained and updated annually.

Annex I-4

QUALIFICATION OF INSPECTION AND TEST PERSONNEL

Annex V of Safety Guide No. 50-SG-QA7 provides an example of requirements related to qualification and certification of inspection and test personnel and is reproduced here.

A.I-4.1. INTRODUCTION

This Annex describes a method by which personnel who perform inspections and tests for the purpose of accepting items or services may be evaluated for

RECORD OF LEAD AUDITOR QUALIFICATIONS		NAME:		DATE:	
EMPLOYER:					
QUALIFICATION REQUIREMENTS			CREDITS		
EDUCATION - University/Degree/Date			4 Pts. Max.		
1. Undergraduate Level					
2. Graduate Level					
EXPERIENCE - Company/Dates			9 Pts. Max.		
Industry (5 pts. max.) and Nuclear Industry (NI), or Quality Assurance (QA), or Auditing (AU), Combined NI, QA, AU					
PROFESSIONAL ACCOMPLISHMENT - Certificate/Date			2 Pts. Max.		
1. P.E.					
2. Society					
MANAGEMENT - Justification/Evaluator/Date			2 Pts. Max.		
Explain:					
Evaluated by: (Name & Title)			Date		
			Total Points		
AUDIT COMMUNICATION SKILLS					
Evaluated by: (Name & Title)			Date		
AUDIT TRAINING COURSES					
Course Title or Topic			Date		
1.					
2.					
AUDIT PARTICIPATION					
Location		Audit		Date	
1.					
2.					
3.					
4.					
5.					
EXAMINATION			Passed		Date
AUDITOR QUALIFICATION CERTIFIED BY: (Signature & Title)				Date Certified:	
ANNUAL EVALUATION (Signature & Date)					

FIG. 5. Example format for documenting a Lead Auditor's qualifications.

initial and continued proficiency, and be certified as qualified to perform the inspections and tests.

A.I-4.2. CERTIFICATION

A.I-4.2.1. Determination of initial capability

The capabilities of a candidate for certification should be initially determined by evaluating the candidate's education, experience, training, test results and capability demonstration.

A.I-4.2.2. Evaluation of performance

The job performance of inspection and testing personnel should be re-evaluated at intervals not to exceed three years. Re-evaluation should be based on evidence of continued satisfactory performance or redetermination of capability, as specified in paragraph A.I-4.2.1. If, during this evaluation or at any other time, it is determined by either the employer or the responsible organization that the capabilities of an individual are not in accordance with the qualifications specified for the job, that person should be removed from that activity until such time as the required capability has been demonstrated. Any person who has not performed inspection or testing activities in his qualified area for a period of one year or more should be re-evaluated by a redetermination of required capability in accordance with paragraph A.I-4.2.1.

A.I-4.2.3. Written certification of qualification

The qualification of personnel should be certified in writing in an appropriate form that includes the following information:

- (1) Employer's name
- (2) Name, and any other required identification of the person being certified
- (3) Level of capability
- (4) Activities certified to perform
- (5) Basis used for certification, including such factors as:
 - (a) Education, experience and training
 - (b) Test results, where applicable
 - (c) Results of capability demonstration
- (6) Results of periodic evaluations
- (7) Results of physical examinations, when required
- (8) Signature of employer's designated representative
- (9) Date of certification and expiration date of certification.

A.I-4.2.4. Physical characteristics

The employer or the responsible organization should identify any special physical characteristics required for the performance of each activity. Appropriate requirements should be met at the time of initial certification and should be verified by re-examination at intervals not to exceed one year.

A.I-4.3. QUALIFICATION

A.I-4.3.1. General

The recommendations in this section define the minimum capabilities that qualify personnel to perform inspections and tests. When a single inspection or test requires implementation by a team or group, personnel not meeting the recommendations of this section may be used to collect data or to operate plant equipment, provided they are supervised or overseen by a qualified individual.

The qualification of inspection and testing personnel may be categorized into three levels on the basis of national requirements. The recommendations for each level are limiting, not with regard to organizational position or professional status, but with regard to functional activities.

A.I-4.3.2. Personnel capabilities for Level 1

A person at Level 1 should be capable of performing and documenting the required inspections and tests in accordance with documented procedures, acceptance standards and/or acceptable practices. The individual should be familiar with the tools and equipment to be employed and should have demonstrated proficiency in their use. The individual should also be capable of determining that the calibration status of measuring and test equipment is proper for use, and that the inspection and test procedures being used have been approved by the appropriate authority.

A.I-4.3.3. Personnel capabilities for Level 2

A person at Level 2 should have all of the capabilities required at Level 1 for the inspection or test category or class in question. Additionally, a person at Level 2 should have demonstrated capabilities: to plan inspections and tests; to set up tests, including preparation and set-up of related equipment, as appropriate; to supervise or maintain surveillance over the inspections and tests; to supervise and certify lower level personnel; to report inspection and test results; and to evaluate the validity and acceptability of inspection and test results.

A.I-4.3.4. Personnel capabilities for Level 3

A person at Level 3 should have all the capabilities required at Level 2 for the inspection or test category or class in question. In addition, the individual should also be capable of evaluating the adequacy of specific programmes used to train and evaluate inspection and test personnel.

A.I-4.4. RECORDS

A file of records of personnel qualification should be established and maintained by the employer. Collection, storage and control of records required should be in accordance with specified requirements or recommendations.

A.I-4.5. EDUCATION AND EXPERIENCE

This section contains guidelines which may be useful in making the initial determination of capability recommended in paragraph A.I-4.2.1. Although specific recommendations are made concerning education and experience, it is recognized that other factors (e.g. previous performance, or satisfactory demonstration of capability) may provide reasonable assurance that a person can competently perform a particular task.

Education and experience requirements for different levels of proficiency are described in paragraphs A.I-4.5.1 to A.I-4.5.3.

A.I-4.5.1. Personnel at Level 1 should have:

- (1) 2 years of related experience in equivalent inspection or testing activities:
– or –
- (2) successfully completed 10 years of basic education, plus 6 months of related experience in equivalent inspection or testing activities;
– or –
- (3) successfully completed 12 years of basic education, including 2 years in a related discipline, plus 3 months of related experience in equivalent inspection or testing activities.

A.I-4.5.2. Personnel at Level 2 should have:

- (1) 1 year of satisfactory performance at Level 1 in the corresponding inspection or test category or class;
– or –

- (2) successfully completed 10 years of basic education, plus 3 years of related experience in equivalent inspection or testing activities;
– or –
- (3) successfully completed 12 years of basic education, including 2 years in a related discipline, plus 1 year of related experience in equivalent inspection or testing activities;
– or –
- (4) successfully completed 14 years of basic education, including graduation from a college or university in a related discipline, plus 6 months of related experience in equivalent inspection or testing activities.

A.I-4.5.3. Personnel at Level 3 should have:

- (1) 6 years of satisfactory performance at Level 2 in the corresponding inspection or test category or class;
– or –
- (2) successfully completed 10 years of basic education, plus 10 years of related experience in equivalent inspection or testing activities;
– or –
- (3) successfully completed 10 years of basic education, plus 8 years of related experience in equivalent inspection or testing activities, of which at least 2 years were at Level 2 and at least 2 years were associated with nuclear facilities (alternatively, the individual shall have sufficient training to be acquainted with the relevant quality assurance aspects of a nuclear facility);
– or –
- (4) successfully completed 12 years of basic education, including 2 years in a related discipline, plus 7 years of related experience in equivalent inspection or testing activities, of which at least 2 years were associated with nuclear facilities (alternatively, the individual shall have sufficient training to be acquainted with the relevant quality assurance aspects of a nuclear facility);
– or –
- (5) successfully completed 14 years of basic education, including graduation from a college or university in a related discipline, plus 5 years of related experience in equivalent inspection or testing activities, of which at least 2 years were associated with nuclear facilities (alternatively, the individual shall have sufficient training to be acquainted with the relevant quality assurance aspects of a nuclear facility).

Annex I-5

MANPOWER REQUIREMENTS AND TECHNICAL QUALIFICATIONS FOR QUALITY ASSURANCE/QUALITY CONTROL PERSONNEL

IAEA Technical Reports Series No. 200 provides examples of manpower requirements and technical qualifications for quality assurance/quality control personnel for nuclear power project activities. For completeness the tabulated information from the Technical Report is reproduced in this Annex. Tables I to IV include the manpower requirements:

- (a) During the construction phase of the project for:
 - Utility QA/QC activity
 - Project engineering QA/QC activity (architect engineering)
 - Suppliers' QA/QC activity;
- (b) During the operation and maintenance phase of the project for:
 - Operating organization activities;
- (c) During the nuclear fuel cycle for:
 - Fuel fabrication
 - Waste management.

TABLE I. MANPOWER REQUIREMENTS AND TECHNICAL QUALIFICATIONS
Activity: Quality assurance/Quality control (QA/QC)

Function/Task	Number (range)	Qualifications		
		Education	Experience	Specialized training
<i>UTILITY QA/QC ACTIVITY</i>				
<i>Manager</i> Responsibility for development and execution of the utility's QA/QC programme.	1	M.S. in engineering.	10–15 years in profession; 5–8 years in QA/QC of nuclear power projects. Demonstrated managerial ability.	Course in nuclear technology (1 year); QA course.
<i>Headquarters staff</i> Development of QA/QC programme and procedures; review, evaluation and audit supplier QA/QC programmes.	5–10	B.S. in engineering.	5–10 years in QA/QC; 2–3 years in nuclear power projects.	Basic course in nuclear power; QA course; 6–12 months' on-the-job training.
<i>Auditors</i> Surveillance and auditing of QA/QC activities of suppliers.	6–12	B.S. in engineering.	5–10 years in profession; 3–5 years in QA/QC or in nuclear power plant engineering.	Basic course in nuclear power; QA course, 6–12 months' on-the-job training (lead auditors must be certified).

<i>On-site auditors</i>				
Surveillance and auditing of site QA/QC activities of the constructor.	5-7	B.S. in engineering.	5-10 years in profession; 3-5 years in QA/QC, preferably in nuclear power plant construction.	Basic course in nuclear power; QA course; 6-12 months' on-the-job training (lead auditors must be certified).
<i>QA documentation personnel</i>				
Responsibility for development and maintenance of QA documentation and records.	5-7	Technician.	3-5 years of administrative/documentation work.	Course on QA systems and records, 3-6 months' on-the-job training.
<i>QC laboratory technicians</i>				
Concrete testing, NDE, etc.	5-7	Technician.	3-5 years in materials testing; QC.	Basic course on nuclear power; NDE course (technicians should be certified in NDE).
PROJECT ENGINEERING QA/QC ACTIVITY				
<i>Headquarters staff</i>				
Responsibility for review of specifications and design; development of procurement QA/QC plans and procedures.	5-7	B.S. in engineering.	8-10 years in profession; 5-10 years in QA/QC; 2-3 years in nuclear power engineering.	Course in nuclear technology (1 year); QA course; 3-6 months' on-the-job training.
<i>Site QA/QC technicians</i>				
Surveillance of sub-contractors' inspection and testing activities, sampling inspection.	6-10	Technician.	8-10 years' QC in inspection and NDE.	Basic course in nuclear power; NDE course (should have certification in inspection and NDE).

TABLE I. (cont.)

Function/Task	Number (range)	Qualifications		
		Education	Experience	Specialized training
<i>SUPPLIERS' QA/QC ACTIVITY</i>				
<i>NSSS supplier's site QA/QC</i>				
Surveillance and testing during installation of the NSSS; and of interface of NSSS with other systems.	1-3	B.S. in engineering.	5-10 years in profession; 3-5 years in nuclear power project QA/QC.	Course in nuclear technology (1-2 years); courses on QA/QC, NDE (should be certified in NDE and inspection).
	4-6	Technician.	5-10 years in QC testing and inspection.	Basic course in nuclear power; courses on NDE, QA/QC; 2-3 months' on-the-job training.
<i>Other suppliers' and contractors' QA/QC</i>				
Inspection, testing and other QC activities during construction and installation of structures, mechanical and electrical components, control and instrumentation system, etc.	7-10	B.S. in engineering.	3-5 years in profession; 2-3 years in QA/QC activities.	Courses on NDE and QA/QC; 3-6 months' on-the-job training.
	30-40	Technician (mechanical, electrical, electronics).	5-10 years in QC testing and inspection.	Courses on NDE and QC.
Total	30-50	Professionals.		
	<u>50-70</u>	Technicians.		
	<u><u>80-120</u></u>			

TABLE II. MANPOWER REQUIREMENTS AND TECHNICAL QUALIFICATIONS

Activity: Operation and maintenance

Function/Task	Number (range)	Qualifications		
		Education	Experience	Specialized training
<p><i>QUALITY ASSURANCE DIVISION</i></p> <p><i>Quality assurance engineer</i></p> <p>Responsibility for planning, implementing and supervising QA procedures and actions during plant operation and maintenance.</p>	1-2	B.S. in engineering (preferably mechanical).	8-10 years in profession; 4-6 years in QA/QC; at least 2-3 years in power plant, preferably nuclear.	Basic course in nuclear power; QA/QC course; instruction in the specific power plant systems, components, equipment, procedures. Participation during erection and commissioning.
<p><i>QA/QC technicians and auditors</i></p> <p>Performance of QA/QC tasks, inspection, testing, auditing during plant operation and maintenance.</p>	6-8	Technicians (mechanical, electrical, civil, welding).	5-10 years in specific field; at least 3-5 years in QA/QC activities.	Basic course in nuclear power; QA/QC course.

TABLE III. MANPOWER REQUIREMENTS AND TECHNICAL QUALIFICATIONS

Activity: Nuclear fuel cycle (fuel fabrication)^a

Function/Task	Number (range) ^a	Qualifications		
		Education	Experience	Specialized training
<i>Quality control manager</i>	1	B.S. in metallurgical or chemical engineering.	5 years in quality control management in high quality light equipment manufacturing plants. Familiarity with NDE methods and equipment and with statistical quality control procedures.	Basic course in nuclear power. Specialized courses in nuclear materials properties, including radiation effects; course in QA/QC.
<i>Inspection foremen</i>	3-4	Mechanical technician.	5 years in supervision of inspection of high quality precision equipment. Familiarity with statistical quality control methods and with NDE methods.	Introductory course in nuclear power.

^a Refers to a 250 t/a plant (approximative). Only management and supervisory personnel are included.

TABLE IV. MANPOWER REQUIREMENTS AND TECHNICAL QUALIFICATIONS
Activity: Nuclear fuel cycle (waste management)^a

Function/Task	Number (range)	Qualifications		
		Education	Experience	Specialized training
<i>Head of QA group</i>	1	M.S. in chemistry.	5–10 years in analytical chemistry and radiochemistry.	Courses in radioactive materials handling and nuclear waste treatment procedures.
<i>QA/QC engineer</i>	1	B.S. in chemistry.	3–5 years in analytical chemistry and radiochemistry.	Courses in radioactive materials handling and nuclear waste treatment procedures.
<i>QA/QC technicians</i>	5	Technicians in chemistry.	1–3 years in analytical chemistry.	Courses in radiochemistry; basic course in nuclear power; courses in radioactive materials handling and nuclear waste treatment procedures.

^a Refers to a 40 t/a nuclear fuel reprocessing plant.

Annex II
TRAINING

Annex II-1

QUALITY ASSURANCE PRINCIPLES

This Annex gives an example of training to provide background and general knowledge in QA principles and techniques required by personnel with limited previous experience in application of QA to nuclear power plant projects. The example refers to the content of a course which should cover all essential elements of QA that are relevant to the needs of QA personnel.

The same course content may be used as a basis for training, indoctrination and orientation of other personnel performing activities affecting quality. The content may of course be tailored to the specific needs of the trainees.

The course should cover in detail the QA principles and objectives established in the IAEA Code of Practice on Quality Assurance for Safety in Nuclear Power Plants (Safety Series No. 50-C-QA, 1978) and in all other applicable codes and QA standards. The following is a typical syllabus for this course. It could be given in one to five weeks, depending on needs.

1. Introduction to Quality Assurance
 - 1.1. Historical development of QA concepts
 - 1.2. Relationship of QA, QC and reliability
 - 1.3. International and national codes, standards and guides
2. Elements of Quality Assurance
 - 2.1. QA programme
 - 2.2. Organization
 - 2.3. Document control
 - 2.4. Design control
 - 2.5. Procurement control
 - 2.6. Material control
 - 2.7. Process control
 - 2.8. Inspection and test control
 - 2.9. Non-conformance control
 - 2.10. Corrective actions
 - 2.11. Record control
 - 2.12. Audits
3. Development of a Quality Assurance Programme
 - 3.1. Basis for the QA programme
 - 3.2. Identification of the scope of the QA programme and application
 - 3.3. QA programme documentation
 - 3.4. Development of procedures and instructions
 - 3.5. Development of work plans
 - 3.6. Management programme review

4. Quality Assurance/Quality Control Methods and Techniques
 - 4.1. Inspection and surveillance
 - 4.2. Testing
 - 4.3. Non-destructive examination
 - 4.4. Auditing
5. Implementation of Quality Assurance in Nuclear Projects
 - 5.1. Pre-construction activities
 - 5.2. Design process
 - 5.3. Procurement
 - 5.4. Component fabrication
 - 5.5. Construction
 - 5.6. Testing and startup
 - 5.7. Operation
6. Economics of Quality Assurance
 - 6.1. Internal and external costs
 - 6.2. Cost-benefit consideration
7. Manpower Requirements for Quality Assurance
 - 7.1. Manpower requirements during design and construction
 - 7.2. Manpower requirements during operation
 - 7.3. Training and qualification of QA personnel.

Annex II-2

SURVEILLANCE PRINCIPLES AND METHODS

This Annex provides an example of a course the purpose of which is to familiarize surveillance personnel with:

- General principles for surveillance activities with regard to surveillance of equipment suppliers;
- Surveillance methods;
- Review of requirements to be met by suppliers;
- Duties and responsibilities of surveillance personnel.

Surveillance personnel should meet the following prerequisites:

- Attendance at and completion of a course on QA principles (Annex II-1), or other achievement of required proficiency in QA principles;
- On-the-job training by observation of the activities of Level 3 surveillance personnel.

The course content is as follows:

1. General principles applicable to supplier surveillance (based on applicable paragraphs of the IAEA Code of Practice, Quality Assurance for Safety in Nuclear Power Plants (Safety Series No. 50-C-QA, 1978), and the IAEA Safety Guide, Quality Assurance in the Procurement of Items and Services for Nuclear Power Plants (Safety Series No. 50-SG-QA3, 1979).
2. General regulatory and contractual requirements to be met by the supplier concerning inspection, witness and hold points, control of non-conformance, preparation of records, etc.
3. Duties and responsibilities of surveillance personnel; study of all applicable instructions for performing surveillance; study of procedures and instructions for inspections and tests.
4. Examination (with open book) to demonstrate understanding of the content of the course.

A course on general surveillance principles and methods could be given in one to two weeks.

Annex II-3

TYPICAL TRAINING FOR SURVEILLANCE PERSONNEL (CATEGORY I)

As surveillance activities may involve several engineering disciplines, depending on the activities to be surveyed and the organization to which the personnel belong, it may be appropriate for the surveillance personnel to be specialized according to the technical discipline and location of the work to be surveyed.

As for inspection and test personnel, several typical options may be defined. In Tables V and VI are proposed some examples of such personnel classification depending, respectively, on whether the surveillance personnel belong to the responsible organization or to a delegated organization.

In any case, the personnel should have successfully passed through courses on QA principles (Annex II-1) and surveillance principles (Annex II-2) and procedures, as defined in the relevant QA programme. A course on a specialized surveillance discipline could be given in three to five weeks, to be followed by respective on-the-job training at a nuclear power plant construction site or at an equipment supplier's facilities.

TABLE V. SPECIALIZATION AND ASSOCIATED CAPABILITIES OF PERSONNEL OF RESPONSIBLE ORGANIZATION PERFORMING SURVEILLANCE FUNCTIONS

Specialization Capability/ knowledge required	Commissioning		Mechanical engineering		Civil engineering		Electrical equip- ment, instrumen- tation and control	
	Level 2	Level 3	Level 2	Level 3	Level 2	Level 3	Level 2	Level 3
Understanding of clean conditions and housekeeping requirements	X	X	X	X	X	X	X	X
Working knowledge of applicable safety rules	X	X	X	X	X	X	X	X
Understanding of engineering, testing and commissioning procedure documents	X	X						
Familiarity with relevant new processes (microprocessing, data acquisition techniques, etc.)	X	X						
Knowledge and use of all appropriate survey, measuring and test instruments			X	X	X	X	X	X
Adequate knowledge of appropriate fabrication, construction and erection techniques			X	X	X	X	X	X
			including welding		including concrete		including microprocessing principles	

Directing operation of specific plant system through reactor testing, startup and early power operation	X	X			
Review and approval of inspection, test and surveillance procedure		X	X	X	X
Evaluation of adequacy of activities to accomplish objectives		X	X	X	X
Reporting and certifying validity of results and acceptance of equipment from suppliers		X	X	X	X

Note: If the candidate does not achieve proficiency in the required subject, specific training should be given (course or on-the-job training).

TABLE VI. SPECIALIZATION AND ASSOCIATED CAPABILITIES OF SURVEILLANCE PERSONNEL FOR A DELEGATED ORGANIZATION (e.g. NSSS SUPPLIER)

Specialization	Capability/ knowledge required	Appropriate NDE techniques ^a	Principles of nuclear power plant systems	Fundamentals of neutron physics	Fundamentals of nuclear power plant operation	Statistical methods	Micro- processing	Welding techniques	Fundamentals of electricity
<i>Surveillance on site of:</i>									
<i>Erection activities for:</i>									
Mechanical equipment	Level 2					X			
	Level 3	X (LT)	X			X			
Electrical equipment	Level 2					X			
	Level 3		X			X	X		X
Welding and erection of pressure components	Level 2					X			
	Level 3	X (LT, RT)	X			X		X	
<i>Startup activities</i>	Level 2					X			
	Level 3			X	X	X			
<i>Surveillance in shop of:</i>									
Mechanical and pressure components	Level 2					X			
	Level 3	X (all)				X		X	
Electrical components	Level 2					X			
	Level 3					X	X		X
Electro-mechanical items	Level 2					X			X
	Level 3					X			X
Electronic items	Level 2					X			
	Level 3					X	X		X

Note: If the candidate does not meet the applicable requirements, he/she should receive specific training, including courses and on-the-job training, in order to achieve proficiency before assignment to a Level 2 or Level 3 position.

^a The proficiency in NDE techniques to be achieved for surveillance personnel should assure their capability of ascertaining that all the applicable requirements are met and of determining the acceptability of the results.

Annex II-4

TRAINING COURSE FOR QUALITY ASSURANCE PROGRAMME AUDITORS (CATEGORY II)

A training course on QA programme auditing should cover in detail the requirements and objectives of audits established in the IAEA Code of Practice on Quality Assurance for Safety in Nuclear Power Plants (Safety Series No. 50-C-QA, 1978) and in the Safety Guide on Quality Assurance Auditing for Nuclear Power Plants (Safety Series No. 50-SG-QA10, 1980). Further, it should cover the guidance on auditing methods and techniques presented in the IAEA Manual on Quality Assurance Programme Auditing (Technical Reports Series No. 237, 1984). The following is a typical syllabus. It is assumed that the participants already have a general knowledge of QA principles and techniques, which is required for QA personnel performing QA programmatic and evaluation functions. The time needed is approximately one week of class-room activities.

1. Introduction
 - 1.1. Review of QA requirements
 - 1.2. Definition of audit and audit types
2. Audit Objectives
 - 2.1. Internal audit (within the organization)
 - 2.2. External audits
 - 2.2.1. Evaluation of suppliers' QA programme
 - 2.2.2. Evaluation of suppliers' performance
 - 2.2.3. Regulatory inspection and audit
3. Development of an Audit Programme and Schedule
 - 3.1. Development of an audit organization
 - 3.2. Planning and scheduling an audit
 - 3.3. Determination of the scope of an audit
 - 3.4. Audit personnel administration
 - 3.5. Audit documentation
 - 3.5.1. Audit procedures
 - 3.5.2. Audit check-lists
4. Methodology of an Audit
 - 4.1. Audit preparation
 - 4.2. Audit performance
 - 4.2.1. Pre-audit conference
 - 4.2.2. Conducting of audit
 - 4.2.3. Findings
 - 4.2.4. Evaluation and analysis
 - 4.2.5. Post-audit conference

5. Audit Reporting
 - 5.1. Communication between audit team and auditor
 - 5.2. Method of reporting
 - 5.3. Audit format and content
6. Audit Techniques
 - 6.1. Sampling methods
 - 6.2. Assembling and review of audit materials
 - 6.3. Interviewing
 - 6.4. Tracing
 - 6.5. Corroboration
 - 6.6. Witnessing implementation
7. Post-audit Activities
 - 7.1. Post-audit conference
 - 7.2. Reporting
 - 7.3. Response
 - 7.4. Follow-up audit
8. Audit Records
9. Human Factors Related to Audit
 - 9.1. Psychology of auditing
 - 9.2. Audit team motivation.

Annex II-5

TRAINING OF QUALITY ASSURANCE SPECIALISTS (CATEGORY III)

This Annex outlines typical indoctrination and training courses for QA specialists. QA specialists should already be trained in QA principles to achieve the required level of competence (Annex II-1). They should be required to attend other appropriate courses as relevant to their experience before being assigned specific functions and activities.

The major topics of specialized training include the following:

- Introduction to nuclear power plant systems, components, equipment, procedures, etc., including relevant technical knowledge of operating principles (Annex II-9);
- Specific regulatory requirements, codes and standards;
- IAEA Safety Guides on QA in nuclear power plants;
- Documentation of a QA programme through QA programme description, procedures and instructions;

- Review and evaluation of QA programme documentation, including programmatic and work oriented procedures;
- Development of communication and writing skills;
- Training techniques;
- For QA personnel in operating organizations, QA aspects of plant operation, such as:
 - Plant operation
 - In-service inspection programme and techniques
 - Preventive and corrective maintenance
 - Refuelling
 - Fire protection
 - Physical plant security
 - Radiation protection and waste management.

Class-room training should be followed by relevant on-the-job training under the supervision of experienced personnel.

Annex II-6

TYPICAL TRAINING FOR INSPECTION AND TEST PERSONNEL PERFORMING NON-DESTRUCTIVE EXAMINATION (CATEGORY V)

This Annex provides examples of class-room training in different examination techniques for NDE personnel (Section 3.3.1). The qualification requirements for these personnel are specified in national standards. Complete training of NDE personnel consists of two components: the basic or theoretical component is suitable for development in class-room training; the practical skill that needs to be demonstrated is obtained through on-the-job training.

Current industrial standards identify three levels of capability for the group of NDE personnel (Section 3.2 and Annex I-4). Respective training programmes may differ from one level to the other and reflect various national practices. In the following examples of training courses the essential topics are given without a subject breakdown corresponding to the three levels of capability.

Radiographic Examination (RT)

(class-room training: two to four weeks)

1. Introduction to NDE and historical development of industrial radiography
2. Physical principles
 - Nature of radiation
 - Sources of radiation

3. Interaction between penetrating radiation and matter
 - Absorption
 - Radiography
 - Radiometry
4. Radiation sources
 - X-ray sources
 - Isotopic sources
5. Radiation detection
 - Imaging
 - Imaging devices
 - Gas ionization
 - Instrumentation
6. Personnel safety and radiological protection
7. Radiographic process
 - Basic imaging considerations
 - Application of radiographic process
8. Test result interpretation
 - Basic considerations
 - Material considerations
 - Codes, standards and procedures
9. Evaluation of examination
 - Determination of type, location, configuration and dimensions of flaws
 - Acceptance/rejection criteria
10. Examination report or log-book.

Magnetic Particle Examination (MT)

(class-room training: up to one week)

1. Principles of magnets and magnetic fields
2. Characteristics of magnetic fields
 - Effects of discontinuities on materials
 - Magnetization by electric current
 - Methods of magnetization
3. Inspection materials (wet, dry)
4. Principles of demagnetization
5. Magnetic particle test equipment
 - Selection of equipment
 - Manual inspection equipment
 - Mechanized inspection equipment
6. Types of discontinuity located by MT
7. Magnetic particle test indication and interpretation.

Liquid Penetrant Examination (PT)
(class-room training: up to one week)

1. Principles of PT methods and method selection
2. Liquid penetrant processing
3. Liquid penetrant test equipment
4. PT indications
 - From cracks
 - From laminar discontinuity
 - From porosity
 - Irrelevant indications
5. Inspection procedures and standards.

Ultrasonic Examination (UT)
(class-room training: three to five weeks)

1. Fundamental properties of sound
2. Principles of wave propagation
 - Modes of vibration
 - Acoustic impedance
 - Reflection
 - Refraction and mode conversion
 - Diffraction, dispersion and attenuation
3. Ultrasonic wave generation
 - Piezoelectricity and types of crystal
 - Characteristics of search units
4. UT examination methods
 - Contact examination
 - Immersion examination
 - Resonance examination
5. UT equipment
 - Pulse-echo instruments
 - Scanning equipment
 - Monitors and recording devices
6. Operation of UT equipment
7. Examination procedures
 - Selection of test parameters
 - Test standards
 - Interpretation of results
 - Examination records
 - Equipment performance variation
8. Variables affecting examination results.

Eddy Current Examination (ET)

(class-room training: two to four weeks)

1. Eddy current theory
 - Generation of eddy current
 - Effects of fields
 - Properties of eddy current
2. Types of sensing element
 - Probes
 - Coils (through, encircling or annular)
 - Choice of sensing elements
3. Coil impedance and factors affecting it
4. Signal/noise ratio
5. Selection of test frequency
6. Coupling
7. Field strength and its selection
8. Instrument types and characteristics
 - Single- and multiple-frequency
 - Amplification
 - Phase detection
 - Differentiation or filtering
9. Readout mechanism
10. Application of ET
 - Flaw detection
 - Sorting for properties related to conductivity and permeability
 - Thickness evaluation
11. Standards and operation procedures.

Leak Testing (LT)

(class-room training: one to two weeks)

1. Fundamentals of testing
2. Testing standards
3. Choice of procedure for leak testing
4. Leak testing methods and techniques
 - Bubble testing material and equipment
 - Pressure change test
5. Reference system testing
6. Halogen diode leak detection
 - Principles
 - Test equipment
 - Calibration of halogen leak

7. Mass spectrometer leak testing
 - Principles of mass spectrometer testing
 - Principles of vacuum technology
 - Volume equipment
 - Helium mass spectrometer.

Visual Examination (VT)

(class-room training: up to one week)

1. Principles of visual examination
2. Direct visual testing method
3. Geometrical optics and application in examination
4. Equipment to facilitate visual inspection
 - Borescopes
 - Cameras
 - Telescopes
 - Gauges
5. Inspection of pump casings, valve bodies, reactor vessels, etc.
6. Cleanliness requirements and training techniques.

Annex II-7

TYPICAL TRAINING FOR INSPECTION AND TEST PERSONNEL IN VARIOUS ENGINEERING DISCIPLINES (CATEGORY V)

This Annex presents examples of training courses to provide background and general knowledge in QA principles and techniques (see also Annexes II-1 and II-2) and in relevant techniques as required by personnel who should be qualified as inspection and test personnel in various engineering disciplines. The examples cover all essential elements, but can be adjusted to satisfy the specific needs of trainees.

The applicable course should cover in detail the inspection and test principles and objectives established in the following IAEA Safety Guides: Quality Assurance During Site Construction of Nuclear Power Plants (Safety Series No. 50-SG-QA4, 1981), Quality Assurance in the Manufacture of Items for Nuclear Power Plants (Safety Series No. 50-SG-QA8, 1981) and Quality Assurance in the Procurement, Design and Manufacture of Nuclear Fuel Assemblies (Safety Series No. 50-SG-QA11, 1983). The course should also cover specific requirements of the applicable codes and standards in the given engineering discipline.

Inspection and Testing of Mechanical Equipment
(length of course: three to five weeks)

1. Introduction to quality assurance: terms, definitions, concepts and principles
2. Nuclear codes and standards for mechanical application
3. Inspection planning and documentation
 - Inspection and test planning
 - Procedures and instructions
 - Inspection and test records
4. Inspection and test methods and techniques
 - Destructive tests
 - Non-destructive examination
 - Measurement techniques
 - Basic inspection tools
 - Hydrostatic and pneumatic testing
5. Review of mechanical equipment and its inspection
 - Pressure components
 - Valves
 - Pipes and piping systems
 - Pumps and seals
 - Insulation
 - Fasteners
 - Hangers
 - Cranes
6. Pre-installation inspection
 - Handling and storing
 - Housekeeping
 - Cleaning
 - Site conditions
 - Physical conditions of equipment
7. Installation process control
 - Process and procedures control
 - In-process inspection of equipment
 - Post-installation verification
8. Inspection of welds
 - Control of welding operation
 - Inspection of welds
9. Evaluation of inspection and test results
10. Reporting and maintaining records
11. Pre-operational testing
 - Construction verification testing
12. Inspection and testing of installed systems

13. Inspection and testing during plant operation
 - Operations
 - Maintenance
 - In-service inspection
 - Fire protection
 - Radiological protection.

Inspection and Testing of Electrical Equipment, Instrumentation and Control Systems

(length of course: two to three weeks)

1. Introduction to quality assurance: terms, definitions, concepts and principles
2. Nuclear codes and standards for electrical application
3. General safety requirements for electrical systems
4. Inspection planning and documentation
 - Inspection and test planning
 - Procedures and instructions
 - Inspection and test records
5. Electrical inspection techniques and methods
6. Review of electrical equipment, instrumentation and control systems and their inspection
 - Electrical equipment
 - Measuring and test equipment
 - Nuclear instrumentation
 - Raceways
 - Cables
 - Insulation
 - Pressure seals and fire stops
 - Instrumentation and control equipment
 - Valve operation
7. Process control
 - Process and procedures control
 - Cable spacing and termination
 - In-process inspection
 - Installation verification
8. Evaluation of inspection and test results
9. Reporting and maintaining records
10. Pre-installation inspection
 - Handling and storing
 - Housekeeping
 - Cleaning
 - Site conditions
 - Physical conditions

11. Inspection and testing of installed systems
12. Inspection and testing during plant operation
 - Operations
 - Maintenance
 - In-service inspection

Inspection and Testing of Civil Structures and Installations
(length of course: three to five weeks)

1. Introduction to quality assurance: terms, definitions, concepts and principles
2. Nuclear codes and standards for civil application
3. Inspection planning and documentation
 - Inspection and test planning
 - Procedures and instructions
 - Inspection and test records
4. Inspection and test methods and techniques
 - Soil testing
 - Subsurface investigation
 - Concrete testing
5. Process control
 - Process and procedures control
 - Structural steel fabrication and connection
 - Cadweld
 - Grouting
 - Masonry
 - Drilling-in anchors
 - Rigging
 - In-process inspection
 - Verification
6. Evaluation of inspection and test results
7. Reporting and maintaining records
8. Inspection of:
 - Soils, rocks and earthworks
 - Foundation piles and caisson construction
 - Concrete (material, mixing, transporting, preplacement, placement, finishing and repair, curing)
 - Masonry
 - Reinforcing steel
 - Construction steel (assembly, erection, bolting, welding)
 - Protective coatings
 - Insulation
 - Glass and glazing
9. Inspection and testing during plant operation.

Annex II-8

STATISTICAL METHODS FOR QUALITY EVALUATION

The purpose of the course outlined below is to familiarize inspection and test and surveillance personnel with the statistical methods to be used during inspections, tests and surveillance.

1. General
 - Purpose and scope
 - Working methods
 - Introduction to statistics
2. Sampling by attributes and variables
 - Definitions, efficiency function, various sampling methods
3. Sampling plan
 - Definition and selection of characteristics
 - Development of a plan
 - Implementation
 - Evaluation of results
4. Workshop

Recognized documents and/or national standards related to sampling methods should be used as references.

Annex II-9

OPERATING PRINCIPLES OF A LIGHT WATER REACTOR POWER PLANT

The purpose of the course outlined below is to familiarize relevant QA personnel with the main systems and components of a nuclear power plant and their functions. This type of course should be presented to all QA personnel performing programmatic and evaluation functions.

1. Introduction (purpose, scope)
2. Nuclear steam supply system
3. Secondary systems
4. Turbine and associated systems
5. Generator and associated systems
6. Condenser and associated systems
7. Plant control system

8. Auxiliary systems
 - Water systems
 - Water treatment
 - Auxiliary steam supply, overheated water
 - Intermediate freezing circuits
 - Compressed air and gas systems
 - Electric power distribution
 - Fuel handling system
9. Reactor operation
10. Characteristics of nuclear power plant
 - Operating limits and conditions.

Annex III

**NATIONAL STANDARDS FOR TRAINING,
QUALIFICATION AND CERTIFICATION**

Annex III-1

NATIONAL STANDARDS AND CERTIFICATION SYSTEMS
FOR NDE PERSONNEL (GROUP 1)

Country	NDE technique	Standard/Certification system
Canada	Radiographic	Canadian Government Specification Board (CGSB): CGSB, 48-GP-4M: Certification of Non-destructive Testing Personnel (Industrial Radiography Method)
	Ultrasonic	CGSB, 48-GP-7M (Industrial Ultrasonic Method)
	Magnetic particle	CGSB, 48-GP-8M (Magnetic Particle Method)
	Liquid penetrant	CGSB, 48-GP-9M (Liquid Penetrant Method)
	Eddy current	CGSB, 48-GP-13M (Eddy Current Method)
Czechoslovakia	Radiographic	Non-destructive Testing Centre, National Research Institute for Materials: Regulatory Guide, CDS No. 3/1981: Qualification of Non-destructive Testing Personnel
	Magnetic particle	
	Eddy current	
	Liquid penetrant	
	Non-destructive testing of civil works	
Denmark, Finland, Norway, Sweden		System Nord Test (Unicert): Nord Test DOC GEN 010 (1977-06)
France		Association française de normalisation (AFNOR), Comité français des essais non-destructifs (COFREND):
	Radiographic	AFNOR, NF-A-09 010 (COFREND):
	Ultrasonic	Contrôle non-destructif – Certification des agents – Règlement général
	Eddy current	
	Magnetic particle	
	Liquid penetrant	
	Leak testing	
Neutron radiography		
Federal Republic of Germany		Deutsche Gesellschaft für zerstörungsfreie Prüfung (DGfzP) (internal rules): Richtlinie über die Qualifikation und Zertifizierung von Personal der zerstörungsfreien Prüfung (Dec. 1984)
Italy		Comitato Italiano di Coordinamento per le Prove non distruttive (CIC-PnD): CIC-PnD 1: Qualificazione e Certificazione del Personale Addetto Alle Prove non distruttive con Funzioni di Secondo Livello

Annex III-1. (cont.)

Country	NDE technique	Standard/Certification system
Japan		Japanese Non-destructive Inspection Society (NDIS): NDIS 0601-77 (English version)
Spain	Radiographic Ultrasonic Magnetic particle Eddy current Leak testing	Asociación Española para el Control de la Calidad (AECC): AECC, END-G1: Recomendaciones para la Cualificación y Certificación del Personal de Ensayos no Destructivos AECC, END-G2: Certificación de Nivel III en Ensayos no Destructivos
United Kingdom	Ultrasonic Magnetic particle Liquid penetrant Radiographic Eddy current	Central Electricity Generating Board (CEGB): CEGB, National Non-destructive Testing Unit, ES/QA/NNDTU/3: Guidance on the Training of Personnel Engaged in Non-destructive Testing CEGB, Standard 989904: Approval of Non- destructive Test Personnel Certification Scheme for Weld Inspection Personnel (CSWIP) Steel Castings Research and Trade Association/ Founding Industry Training Board (SCRATA/ FITB): Ultrasonic Operators, Castings (SCRATA, Forgings) Electricity Supply Industry: Standard 98-3: Registration of Non-destructive Testing Personnel
United States of America	Radiographic Magnetic particle Ultrasonic Liquid penetrant Eddy current Neutron radiography Leak testing Acoustic emission	American Society for Non-destructive Testing (ASNT): ASNT-TC-1A: Non-destructive Testing Personnel Qualification and Certification

Annex III-2

NATIONAL STANDARDS FOR QUALIFICATION/CERTIFICATION OF INSPECTION AND TEST PERSONNEL (GROUP 2)

Country	Activity	Personnel level	Standard
Canada	Welding inspection		Canadian Standards Association (CSA): CSA W 178.2: Certification of Welding Inspectors
United States of America	All disciplines	1, 2, 3	American National Standards Institute/ American Society of Mechanical Engineers: ANSI/ASME N45.2.6: Qualifications of Inspection, Examination and Testing Personnel for Nuclear Power Plants ANSI/ASME-NQA-1: QA Programme Requirements for Nuclear Facilities
	Welding inspection		American Welding Society, Quality Conformance Inspection: Standard for Qualification and Certification of Welding Inspectors

Annex IV

**EXAMPLES OF PERSONNEL QUALIFICATION
RECORD FORMS**

AUDITOR'S NAME _____

REV	CLASSIFICATION*	DATE	CERTIFIED BY

* CLASSIFICATION:
 Trainee - Under 6 points
 Auditor - 6 points and over
 Lead Auditor - Minimum 10 points

TYPE OF AUDITING: (check one)
 Internal Auditing Vendor Evaluation Site

AUDITOR'S SIGNATURE VERIFICATION _____

	POINTS					
	ALLOW- ABLE	REV__ EARNED	REV__ EARNED	REV__ EARNED	REV__ EARNED	REV__ EARNED
A. EDUCATION						
1. Associate Degree (AA) or	1					
2. Associate Degree (AAS) or	2					
3. Bachelor Degree (BA) or	2					
4. Bachelor Degree (BS)	3					
5. and Master's Degree (MS)	1					
SUBTOTAL NOT TO EXCEED 4 POINTS						
B. PROFESSIONAL ACCOMPLISHMENT						
1. Professional Engineer	2					
2. Professional Society Certification	2					
3. Certificate	2					
SUBTOTAL NOT TO EXCEED 2 POINTS						

C. EXPERIENCE						
1. Technical (Engr. Manuf. Constr. Oper. or Maintenance - 1 year or more) and	5					
2a. Nuclear (2 years or more)	1					
b. or Quality Assurance (2 years or more)	2					
c. or Auditing (2 years or more)	3					
d. or Nuclear Quality Assurance (2 years or more)	3					
e. or Nuclear Quality Assurance Auditing (2 years or more)	4					
SUBTOTAL NOT TO EXCEED 9 POINTS						
D. MANAGEMENT EVALUATION	2					
<i>Evaluator - Initial and Date</i> →						
SUBTOTAL NOT TO EXCEED 2 POINTS						
GRAND TOTAL						

COMMUNICATION SKILLS VERIFIED BY _____ DATE _____

EXAMINATION FOR LEAD AUDITOR VERIFIED BY _____ DATE _____

Example 1. Quality assurance auditor qualifications record.

*This certifies that as of this date _____
is qualified through practical examination as Lead Auditor.*

*The examination consisted of the examinee's demonstration of practical
knowledge, understanding and application of codes, standards, company
procedures and audit check-lists applicable to quality assurance
programme auditing.*

EVALUATION CERTIFICATION

By _____ Date _____

Position _____

Examination performed at:

_____ Location _____

Example 3. Quality assurance engineering: statement of lead auditor qualification.

FACTORS		SUMMARY (SEE ATTACHED FORMS FOR DETAILS)		
EDUCATION	DEGREE OR DIPLOMA _____	DATE _____		
	MAJOR COURSE OF STUDY _____			
RELATED EXPERIENCE	ACTIVITY	YEARS	MONTHS	
		TOTAL		
PREVIOUS CERTIFICATIONS SUBMITTED	LEVEL _____	IN _____	FROM _____	
	LEVEL _____	IN _____	FROM _____	
	LEVEL _____	IN _____	FROM _____	
	LEVEL _____	IN _____	FROM _____	
TRAINING CURRICULUM	DISCIPLINE _____			
	DATE COMPLETED _____	LOCATION _____		

DEMONSTRATED CAPABILITY	WRITTEN SCORE _____ PRACTICAL SCORE _____
EYE EXAM	DATE _____ RESULTS _____

IN ACCORDANCE WITH _____ REVISION _____ THE CANDIDATE IS QUALIFIED TO PERFORM THE DUTIES OF:

LEVEL _____ ACTIVITY _____

RESTRICTIONS (IF ANY) _____

BASIS FOR QUALIFICATION _____

TYPE EVALUATION - INITIAL PERIODIC RE-EVALUATION UPGRADE FROM L - _____

EVALUATED BY _____ SIGNATURE _____

LEVEL _____ DATE OF EVALUATION _____ LOCATION _____

Example 4. Summary of qualifications.

NAME _____

DEPT NO. _____

I – PRESENT RELATED WORK EXPERIENCE

Location: _____ From: _____

Position: _____ Supervisor: _____

Brief Description of Duties: _____

II – PRIOR RELATED WORK EXPERIENCE

Company: _____ Location: _____ From: _____ To: _____

Position: _____ Supervisor: _____

Brief Description of Duties: _____

Company: _____ Location: _____ From: _____ To: _____

Position: _____ Supervisor: _____

Brief Description of Duties: _____

Company: _____ Location: _____ From: _____ To: _____

Position: _____ Supervisor: _____

Brief Description of Duties: _____

Company: _____ Location: _____ From: _____ To: _____

Position: _____ Supervisor: _____

Brief Description of Duties: _____

If additional space is required, check here and use continuation sheet.

I certify that to the best of my knowledge all information contained herein is correct.

SIGNATURE

DATE

Example 5. Record of related work experience.

NAME _____

DEPT NO. _____

A: FORMAL EDUCATION (HIGH SCHOOL AND ABOVE)

NAME AND LOCATION OF INSTITUTION	DATES		MAJOR	EARNED	
	FROM	TO		CREDITS	DEGREE

B: LICENCES/CERTIFICATES (SUBMIT EVIDENCE)

TYPE OF LICENCE OR CERTIFIED ACTIVITY	REGISTRATION NO. (IF ANY) OR CERTIFIED LEVEL	ISSUED BY

C: PREVIOUS RELATED TRAINING COURSES

COURSE NUMBER AND TITLE	COMPANY ¹	LOCATION	DATES	TYPE ²

NAME _____

DEPT NO. _____

LEVEL AND ACTIVITY _____ LOCATION _____

	PROGRAMME	DATE COMPLETED	EXAMINATION SCORES
I.	INDOCTRINATION		
	A. Philosophy of Quality	A _____	
	B. Quality Programme	B _____	
	C. Codes & Standards	C _____	
	D. Project Objectives	D _____	
II.	TRAINING ONE		
	A. Function & Responsibilities of Surveillance Personnel	A _____	
	B. Surveillance Techniques and Methodologies		
	1. Formal/Independent Study	B1 _____	B1 _____ (Written)
	2. OJT	B2 _____	B2 _____ (Practical)
III.	TRAINING TWO		
	A. Procedure Training	A _____	

IV. TRAINING THREE

A. Drawings & Specification Control Systems A _____

V. TRAINING FOUR

A. Surveillance Management Workshop A _____ A _____ (Oral)

DEMONSTRATED CAPABILITY

Written Exam in _____ Score _____ Out of 100

Practical Exam in _____ Score _____ Out of 100

VERIFIED BY _____ DATE _____
QUALITY RESOURCE AND TRAINING MANAGEMENT

Example 7. Training and examinations: surveillance curriculum.

NAME _____

DEPT NO. _____

LEVEL AND
ACTIVITY _____

LOCATION _____

PROGRAMME	DATE COMPLETED	EXAMINATION SCORES
I. INDOCTRINATION		
A. Philosophy of Quality	A _____	
B. Quality Programme	B _____	
C. Codes & Standards	C _____	
D. Project Objectives	D _____	
II. TRAINING ONE		
A. Function & Responsibilities of an Inspector	A _____	
B. Inspection Techniques and Methodologies		
1. Formal/Independent Study	B1 _____	B1 _____ (Written)
2. OJT	B2 _____	B2 _____ (Practical)
III. TRAINING TWO		
A. Procedure Training	A _____	

Surname:		Record <input style="width: 80px;" type="text"/>		No. <input style="width: 60px;" type="text"/>							
First name:				Date	Initials						
Date of entry:		Record started									
		Review Rev. 1									
		" Rev. 2									
		" Rev. 3									
		" Rev. 4									
		" Rev. 5									
		" Rev. 6									
<table style="width: 100%; border: none;"> <tr> <td style="width: 30%; vertical-align: top;"> Mechanic } Boiler maker } <input type="checkbox"/> Welder } </td> <td style="width: 30%; vertical-align: top;"> NDE: RT <input type="checkbox"/> PT <input type="checkbox"/> UT <input type="checkbox"/> MT <input type="checkbox"/> </td> <td style="width: 40%; vertical-align: top;"> Mechanical tests <input type="checkbox"/> Welding <input type="checkbox"/> Electricity <input type="checkbox"/> Microprocessors <input type="checkbox"/> </td> </tr> <tr> <td style="vertical-align: top;"> Electrician <input type="checkbox"/> Electro-mechanic <input type="checkbox"/> Electronics technician <input type="checkbox"/> </td> <td></td> <td></td> </tr> </table>		Mechanic } Boiler maker } <input type="checkbox"/> Welder }	NDE: RT <input type="checkbox"/> PT <input type="checkbox"/> UT <input type="checkbox"/> MT <input type="checkbox"/>	Mechanical tests <input type="checkbox"/> Welding <input type="checkbox"/> Electricity <input type="checkbox"/> Microprocessors <input type="checkbox"/>	Electrician <input type="checkbox"/> Electro-mechanic <input type="checkbox"/> Electronics technician <input type="checkbox"/>			Approval of Materials Quality Department			
Mechanic } Boiler maker } <input type="checkbox"/> Welder }	NDE: RT <input type="checkbox"/> PT <input type="checkbox"/> UT <input type="checkbox"/> MT <input type="checkbox"/>	Mechanical tests <input type="checkbox"/> Welding <input type="checkbox"/> Electricity <input type="checkbox"/> Microprocessors <input type="checkbox"/>									
Electrician <input type="checkbox"/> Electro-mechanic <input type="checkbox"/> Electronics technician <input type="checkbox"/>											
		Date									
		Name									
		Signature									

Dates of first qualifications			
	Trainee	Level I	Level II
- Mechanic – Boiler maker – Welder
- Electrician
- Electro-mechanic
- Electronics technician
Remarks			

Example 9. Plant inspector qualification record (representing the practice of some organizations in France).

	Criteria	Points											
		Allowable	Awarded										
(1) Level of education	<input type="checkbox"/> Certificate of national education (CAP); vocational certificate (BP); school leaving certificate (other than technical or scientific)	1											
	<input type="checkbox"/> Technical or scientific school leaving certificate	2											
	<input type="checkbox"/> University degree in technology (DUT); senior technician, National Centre for Arts and Crafts (CNAM); senior technician's certificate (BTS)	3											
	<input type="checkbox"/> CNAM technical or scientific course: 0.5 per full course (max. 4)	0.5-4											
	<input type="checkbox"/> University degree in science or engineering	5											
	(Maximum non-cumulative points: 5)												
		+	+										
(2) Industrial experience	- Specialized (maximum cumulative points: 7)		0-7										
	<table border="1" style="display: inline-table; vertical-align: middle;"><tr><th style="width: 50px;">Firm</th><th style="width: 50px;">Else-where</th></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr></table> Years of: Manufacture; verification; maintenance (specialized work)	Firm	Else-where	0.5/year	
	Firm	Else-where											
											
											
....												
....												
<table border="1" style="display: inline-table; vertical-align: middle;"><tr><th style="width: 50px;">Firm</th><th style="width: 50px;">Else-where</th></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr></table> Years of: Methods; preparation; design office	Firm	Else-where	0.75/year		
Firm	Else-where												
....												
....												
....												
....												
<table border="1" style="display: inline-table; vertical-align: middle;"><tr><th style="width: 50px;">Firm</th><th style="width: 50px;">Else-where</th></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr></table> Years of: Technician; quality control; lab. testing; QA	Firm	Else-where	1/year		
Firm	Else-where												
....												
....												
....												
....												
<table border="1" style="display: inline-table; vertical-align: middle;"><tr><th style="width: 50px;">Firm</th><th style="width: 50px;">Else-where</th></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr><tr><td>....</td><td>....</td></tr></table> Years of: Inspection*	Firm	Else-where	1.5/year		
Firm	Else-where												
....												
....												
....												
....												
		+	+										

(3) Supervisor's discretion	Points awarded by supervisor on the basis of individual performance	0-2	
(4)	* + 1 point if at least 1 year's experience at firm	1	+
	Minimum number of points required for Level II qualification Total number of points earned	10	=

Example 9. (cont.)

(1) General training in specific subjects: Level I (may be received in the first year of service at Level I)							
Description	Type of training				Date of training	Remarks	
	Desired	Examination	Actual	Examination passed			
Introduction to QA	Induction	Firm Headquarters	No	.....	.....	.....
	Local and temporary staff	QPP.200	No	.....	.....	.....
Advanced inspector training		QPP.500	No	.....	.....	.....
		QPP.400	Yes	.....	.....	.....
Introduction to statistical evaluation of quality		QPP.800	Yes	.....	.....	.....

(2) Further training						
Description	Course	Date	Examination	Description	Date	Examination
PWR systems	QPP.1500	.....	Yes	.....	.....	.....
Films on general introduction to PWR power plants	QPP.700	.....	No	.....	.....	.....
Use and rules of application of the design and construction rules	QPP (miscellaneous)	.....	No	.....	.....	.....

(1) Specialized training in specific subjects: Level II (plant)								
Inspector's specialization	Length of service at Level I and as trainee	Length of service at Level II	Types of specialized training in specific subjects				Remarks	
			Desired		Actual			
			Types	Examination	Types	Examination passed		Date
Mechanic/ Boiler maker/ Welder			NDE: RT	Yes				
			PT	Yes				
			UT	Yes				
			MT	Yes				
			Mechanical tests					
Electrician			Welding					
			Electricity					
			Microprocessors	Yes				
Electro-mechanic			<p>Note: To obtain the Level II qualification in a particular subject, a Level I inspector should have passed examinations in two of the above types of specialized training in specific subjects.</p>					
Electronics technician								

(2) Further training						
Types	Course	Examination	Date	Types	Examination	Date
PWR systems	QPP.1500	Yes				

The undersigned,

hereby certifies that Mr.

in view of his:

- physical fitness
- experience
- general training in specific subjects
- specialized training in specific subjects

as attested by the qualification record dated

is authorized as of today and until

to occupy the position of Plant Inspector, Level

- | | | | | |
|------------------------|---|--------------------------|------------------|--------------------------|
| Mechanic | } | <input type="checkbox"/> | NDE: RT | <input type="checkbox"/> |
| Boiler maker | | | PT | <input type="checkbox"/> |
| Welder | | | UT | <input type="checkbox"/> |
| Electrician | | <input type="checkbox"/> | MT | <input type="checkbox"/> |
| Electro-mechanic | | <input type="checkbox"/> | Mechanical tests | <input type="checkbox"/> |
| Electronics technician | | <input type="checkbox"/> | Welding | <input type="checkbox"/> |
| | | | Electricity | <input type="checkbox"/> |
| | | | Microprocessors | <input type="checkbox"/> |

Head, Materials Quality Department

Date and signature

Example 10. Inspector qualification certificate.

DEFINITIONS

The definitions given below may not necessarily conform to definitions adopted elsewhere for international use.

audit. A documented activity performed to determine by investigation, examination and evaluation of objective evidence the adequacy of, and adherence to, established procedures, instructions, specifications, codes, standards, administrative or operational programmes and other applicable documents, and the effectiveness of implementation.

certification. The act of verifying and attesting in writing to the qualifications of personnel, processes, procedures or items in accordance with specified requirements.

documentation. Recorded or pictorial information describing, defining, specifying, reporting or certifying activities, requirements, procedures or results related to quality assurance.

education. Instruction in general and technical subjects according to curricula which form part of the national educational system of a country.

examination. An element of inspection consisting of investigation of materials, components, supplies or services, to determine conformance with those specified requirements which can be determined by such investigation.¹

inspection. Quality control actions which by means of examination, observation or measurement determine the conformance of materials, parts, components, systems and structures, as well as processes and procedures, with pre-determined quality requirements.

item. A general term covering structures, systems, components, parts or materials.

non-conformance. A deficiency in characteristics, documentation or procedure which renders the quality of an item unacceptable or indeterminate.

objective evidence. Qualitative or quantitative information, record or statement of fact, pertaining to the quality of an item or service, which is based on observation, measurement or test and which can be verified.

proficiency. Possession of the knowledge and experience needed for success in accomplishing an activity.

¹ Quality assurance examination is usually non-destructive and includes simple physical manipulation, gauging and measurement.

qualification. A characteristic or ability gained through education, training or experience, as measured against established requirements such as standards or tests, that qualifies an individual to perform a required function; the act of achieving or attributing such a characteristic or ability.

quality assurance. Planned and systematic actions necessary to provide adequate confidence that an item or facility will perform satisfactorily in service.

quality control. Quality assurance actions which provide a means to control and measure the characteristics of an item, process or facility in accordance with established requirements.

records. Documents which furnish objective evidence of the quality of items and activities affecting quality.

specification. A written statement of requirements to be satisfied by a product, a material or a process, indicating the procedure by means of which it may be determined whether the specified requirements are satisfied.

surveillance. The witnessing or monitoring of activities and/or review of records on a random basis to evaluate these activities to ensure that their performance is in accordance with applicable requirements.

testing. The determination or verification of the capability of an item to meet specified requirements by subjecting the item to a set of physical, chemical, environmental or operational conditions.

trainee. A person who undergoes training, specifically for the purpose of being qualified for a specific job function or area of competence.

training. Instruction and guided practice in subjects related to a particular industry or type of task or specific task, according to curricula which do not form part of the national educational system. On-the-job training is a form of guided practice.

verification. The act of reviewing, inspecting, testing, checking, auditing or otherwise determining and documenting whether items, processes, services or documents conform to specified requirements.

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CONSULTANTS MEETINGS (C)

Vienna

20-24 June and 30 August-2 September 1983

ADVISORY GROUP MEETING (A)

Vienna

12-14 March 1984

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