IAEA SAFETY STANDARDS SERIES

Building Competence in Radiation Protection and the Safe Use of Radiation Sources

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SAFETY GUIDE

No. RS-G-1.4

INTERNATIONAL
ATOMIC ENERGY AGENCY
VIENNA

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JOINTLY SPONSORED BY
THE INTERNATIONAL ATOMIC ENERGY AGENCY,
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FOREWORD

by Mohamed ElBaradei
Director General

One of the statutory functions of the IAEA is to establish or adopt standards of safety for the protection of health, life and property in the development and application of nuclear energy for peaceful purposes, and to provide for the application of these standards to its own operations as well as to assisted operations and, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of nuclear energy.

The following advisory bodies oversee the development of safety standards: the Commission for Safety Standards (CSS); the Nuclear Safety Standards Committee (NUSSC); the Radiation Safety Standards Committee (RASSC); the Transport Safety Standards Committee (TRANSSC); and the Waste Safety Standards Committee (WASSC). Member States are widely represented on these committees.

In order to ensure the broadest international consensus, safety standards are also submitted to all Member States for comment before approval by the IAEA Board of Governors (for Safety Fundamentals and Safety Requirements) or, on behalf of the Director General, by the Publications Committee (for Safety Guides).

The IAEA's safety standards are not legally binding on Member States but may be adopted by them, at their own discretion, for use in national regulations in respect of their own activities. The standards are binding on the IAEA in relation to its own operations and on States in relation to operations assisted by the IAEA. Any State wishing to enter into an agreement with the IAEA for its assistance in connection with the siting, design, construction, commissioning, operation or decommissioning of a nuclear facility or any other activities will be required to follow those parts of the safety standards that pertain to the activities to be covered by the agreement. However, it should be recalled that the final decisions and legal responsibilities in any licensing procedures rest with the States.

Although the safety standards establish an essential basis for safety, the incorporation of more detailed requirements, in accordance with national practice, may also be necessary. Moreover, there will generally be special aspects that need to be assessed on a case by case basis.

The physical protection of fissile and radioactive materials and of nuclear power plants as a whole is mentioned where appropriate but is not treated in detail; obligations of States in this respect should be addressed on the basis of the relevant instruments and publications developed under the auspices of the IAEA. Non-radiological aspects of industrial safety and environmental protection are also

not explicitly considered; it is recognized that States should fulfil their international undertakings and obligations in relation to these.

The requirements and recommendations set forth in the IAEA safety standards might not be fully satisfied by some facilities built to earlier standards. Decisions on the way in which the safety standards are applied to such facilities will be taken by individual States.

The attention of States is drawn to the fact that the safety standards of the IAEA, while not legally binding, are developed with the aim of ensuring that the peaceful uses of nuclear energy and of radioactive materials are undertaken in a manner that enables States to meet their obligations under generally accepted principles of international law and rules such as those relating to environmental protection. According to one such general principle, the territory of a State must not be used in such a way as to cause damage in another State. States thus have an obligation of diligence and standard of care.

Civil nuclear activities conducted within the jurisdiction of States are, as any other activities, subject to obligations to which States may subscribe under international conventions, in addition to generally accepted principles of international law. States are expected to adopt within their national legal systems such legislation (including regulations) and other standards and measures as may be necessary to fulfil all of their international obligations effectively.

PREFACE

An essential element of a national infrastructure for radiation protection and safety is the maintenance of an adequate number of competent personnel. This is emphasized in the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources and in the IAEA publication on Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety.

The IAEA has assigned high priority to its programme for education and training in radiation safety over many years and has issued a number of technical publications to support training in protection and safety. The Safety Report on Training in Radiation Protection and the Safe Use of Radiation Sources addresses the development and provision of classroom based training, distance learning and on the job training in protection and safety. Standard syllabuses, training course manuals and visual aid materials are available and kept up to date to assist in the establishment of national training programmes. Every year the IAEA organizes training courses in different languages for both basic professional training and on specialized topics in protection and safety, and facilitates fellowships and scientific visits to well regarded institutions for on the job training.

This Safety Guide makes recommendations concerning the building of competence in protection and safety, which relate to the training and assessment of qualification of new personnel and retraining of existing personnel in order to develop and maintain appropriate levels of competence. The qualification required for each category of job is determined on the basis of minimum educational levels, training and work experience. Participation in refresher training is necessary in order to maintain competence, to refresh acquired knowledge and to complement it with new developments in the field. This Safety Guide also suggests a structure for a national strategy for building competence.

This Safety Guide is jointly sponsored by the IAEA, the International Labour Office (ILO), the Pan American Health Organization (PAHO) and the World Health Organization (WHO). The IAEA gratefully acknowledges the contribution of experts from several countries and from the ILO, PAHO and WHO to the drafting and review of the text.

EDITORIAL NOTE

An appendix, when included, is considered to form an integral part of the standard and to have the same status as the main text. Annexes, footnotes and bibliographies, if included, are used to provide additional information or practical examples that might be helpful to the user.

The safety standards use the form 'shall' in making statements about requirements, responsibilities and obligations. Use of the form 'should' denotes recommendations of a desired option.

The English version of the text is the authoritative version.

CONTENTS

1. INTRODUCTION

BACKGROUND

1.1. The three IAEA Safety Fundamentals publications [1–3] all call for the availability of adequately trained staff. The International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources (BSS) [4] require as one of the main points of safety culture that "the responsibilities of each individual, including those at senior management levels, for protection and safety be clearly identified and each individual be suitably trained and qualified" (Ref. [4], para. 2.28(c)). The Safety Requirements publication on Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety (Ref. [5], para. 6.17) also emphasizes that "Achievement of a high level of safety will be greatly facilitated by an adequate supporting infrastructure for nuclear, radiation, radioactive waste and transport related activities. Government and, as appropriate, concerned organizations shall therefore pay attention to and provide for, among other things, the following: (1) training and education…".

1.2. Education, training and experience are of primary importance for achieving competence in any area of work. Persons who are to be responsible for nuclear, radiation, transport or radioactive waste safety should have an adequate level of understanding of concepts relating to radiation protection and should also be acquainted with the safe and secure use of radiation sources. Generally, training has as a prerequisite a specified educational level. In addition, persons may need an appropriate level of work experience to fulfil particular responsibilities. Qualification of these persons necessitates recognition of the adequacy of the combination of their educational level, training and work experience. This may include consideration of the equivalence of certain elements of this combination. In some circumstances, such qualified persons may have to be authorized by a regulatory body to carry out certain functions or to assume certain responsibilities.

1.3. Any person who is occupationally exposed to ionizing radiation, or who may be exposed in the course of work, should receive adequate training in radiation protection and in the safe use of radiation sources. In addition, there are people who, while not exposed to ionizing radiation, need to be trained in protection and safety in order to perform their duties competently. Employers, registrants and licensees have responsibilities in relation to protection and safety and should be informed or should undergo suitable training. Staff of regulatory bodies who have specific responsibilities in relation to the safety of radiation sources or who would be involved

in intervention in the event of accidents, such as emergency response personnel, also need to acquire and maintain competence.

OBJECTIVE

1.4. This Safety Guide presents recommendations on how to meet the requirements concerning training in radiation safety and in radiation protection aspects of nuclear, transport and radioactive waste safety contained in the BSS [4] and Refs [5, 6]. This Safety Guide provides guidance to national regulatory authorities on the establishment of minimum qualification requirements in the area of protection and safety for nuclear and radiation related technologies. It also provides guidance on a national strategy for building competence in this area.

SCOPE

1.5. This Safety Guide addresses training in protection and safety aspects in relation to all practices and intervention situations in nuclear and radiation related technologies, but not training in the use of the technology itself. In this regard, the interface between technological design and radiation safety should be carefully structured into training programmes. This Safety Guide addresses:

— The categories of persons to be trained;
— The requirements for education, training and experience for each category;
— The processes of qualification and authorization of persons;
— A national strategy for building competence.

1.6. The specific technical aspects of nuclear installations,[1] such as siting, design, construction, operation and maintenance, are not considered here. Detailed guidance on training in these aspects is given in Ref. [7] and will be given in future Safety Guides.

[1] A nuclear installation is a nuclear fuel fabrication plant, a nuclear reactor (including subcritical and critical assemblies), a research reactor, a nuclear power plant, a spent fuel storage facility, an enrichment plant or a reprocessing facility.

STRUCTURE

1.7. The text is organized as follows. Section 2 outlines the responsibilities for training at different levels. Section 3 describes categories of persons to be trained and recommends the minimum requirements for educational level, training and work experience. Section 3 also deals with the assessment of qualification and the process of authorization that is needed to carry out work in specific areas. The different ways of demonstrating competence are also discussed and the need for refresher training and continuous professional development is emphasized. Accreditation of specific courses or training centres to ensure the quality of training is discussed. Section 4 suggests a systematic structured strategy for building competence to address the State's needs.

2. RESPONSIBILITIES FOR BUILDING COMPETENCE IN PROTECTION AND SAFETY

GOVERNMENTAL RESPONSIBILITIES

2.1. The BSS require that employers, registrants or licensees have the primary responsibility for the provision of training to workers (Ref. [4], para. I.4 (h)). Moreover, the training criteria for medical and paramedical personnel should be specified or subject to approval, as appropriate, by the regulatory body in consultation with relevant professional bodies (Ref. [4], para. II.1 (f)). The government should ensure that an adequate legislative framework is established which requires appropriate training of all personnel engaged in activities relating to nuclear, radiation, radioactive waste and transport safety. The legislation should assign responsibilities for the provision of training. The government should, where appropriate, specify which persons should have particular qualifications and the process to be employed for the recognition of such qualifications.

2.2. Where more than one authority has responsibility for protection and safety, for example if medical applications are regulated by the health ministry and industrial applications by another ministry or by the regulatory body, there may be differences in requirements for qualification of workers in these two areas. National minimum requirements for qualification acceptable to all parties involved in licensing for these types of applications should be established.

2.3. In assigning responsibilities for emergency planning and preparedness at the national level, governments should clearly assign responsibility for training the

particular groups that may be involved. These groups will include medical doctors, paramedical and fire brigade personnel, police officers, military and civil protection personnel, emergency workers and their representatives, radiation protection, monitoring and rescue staff, and other decision makers and advisers. Members of the public living near nuclear installations should be suitably informed about the protection and safety aspects of the nuclear installation and the emergency plan [8].

2.4. The government should, in addition, ensure that a system is in place to provide suitable instruction or information, as appropriate, on protection and safety to other parties such as:

— Teaching staff in research and educational establishments [9];
— Students, since educational material on protection and safety could beneficially be included in school curricula, particularly for students of medicine, dentistry or physics, for example, who might later work with radiation sources or radiation generators;
— Others who may have responsibilities in incidents involving radioactive materials, such as industrial safety officers in recycling facilities and customs staff and border police at national borders.

2.5. Whenever appropriate, a strategy for building competence in protection and safety should be established at the national level (see Section 4).[2] Input should be obtained from all relevant parties, which may include the regulatory body, other governmental organizations, licensees or registrants, and training centres.

RESPONSIBILITIES OF THE REGULATORY BODY

2.6. The regulatory body should provide guidance on qualification requirements for each category of job found in particular practices or intervention situations. This guidance should address the minimum educational level, minimum training and retraining requirements and minimum experience for each job category. In addition, the regulatory body should enforce regulations concerning the recognition of qualifications or authorization processes relating to certain duties and/or responsibilities, such as those of radiation protection officers. Alternatively, the

[2] ‘Building competence’ comprises training and assessing the qualification of new personnel and retraining existing personnel in order to develop and maintain appropriate levels of competence. Competence means the ability to apply knowledge, skills and attitudes so as to perform a job in an effective and efficient manner and to an established standard.

regulatory body should review and approve, if appropriate, proposals regarding training requirements made by employers, registrants and licensees.

2.7. Training requirements in the protection and safety of radiation sources should be established for the following areas:

— The production and use of radiation sources (including maintenance and calibration) for medical, industrial, veterinary or agricultural purposes, or for education, training or research;
— Regulatory activities (e.g. inspection, safety assessment, legal and other regulatory issues);
— Activities involving nuclear fuel;[3]
— Decommissioning and radioactive waste management;
— Transport of radioactive material;
— Emergency planning and preparedness;
— Exposure to enhanced levels of natural radiation in workplaces, such as in the mining and processing of raw materials or in the oil and gas industries.

2.8. The regulatory body should not be responsible for providing training, except for training of its own staff. However, whenever appropriate, the regulatory body should provide guidance in respect of the types of training required, the course content, the duration and level of training, and the assessment of trainees. Training centres and courses dealing with safety and with protection related aspects of nuclear, transport and waste safety may be accredited by the regulatory body or by other professional bodies recognized by the regulatory body [10].

2.9. The regulatory body should ensure that up to date records are maintained which include:

— Information on accredited training centres and training courses;
— National and international agreements relating to training and educational aspects;
— The records of personal authorizations issued.

[3] 'Activities involving nuclear fuel' means all operations associated with the production of nuclear energy, including mining, milling, processing and enrichment of uranium or thorium, manufacture of nuclear fuel, operation of nuclear reactors, reprocessing of nuclear fuel, decommissioning and any activity for the management of radioactive waste, and any research or development activity relating to any of the foregoing.

2.10. The regulatory body should contribute to the process of building competence in protection and safety (see Section 4).

2.11. The regulatory body should ensure that information from the feedback of operational experience and lessons to be learned from accidents or other relevant abnormal situations are disseminated to all parties involved in training.

2.12. The regulatory body should provide initial and refresher training for its own staff dealing with the national system of notification, registration, licensing and control, including inspection, enforcement and legal aspects, of nuclear and radiation related technologies. The training should ensure that the personnel of the regulatory body are aware of developments in technology and of safety principles and concepts (Ref. [5], para. 4.7). Provision should also be made for training personnel of the regulatory body who will be involved in the implementation of emergency plans. The regulatory body should keep up to date records of the training and qualification processes undergone by its own staff.

2.13. The regulatory body should require that all employers, licensees or registrants, including manufacturers, installers, suppliers, maintenance personnel and distributors of radiation sources and radiation generators:

— Implement personnel training and qualification programmes for their own employees in protection and safety. In these programmes account should be taken of the hazards of ionizing radiation, including potential exposures, in the respective workplaces, and of the related safety systems. This should include the provision of suitable information on protection and safety for senior managers, for the promotion of safety culture.
— Keep up to date records of personnel qualifications, including education, the organization and content of training, and work experience. This database should be made available to the regulatory body on request.

RESPONSIBILITIES OF EMPLOYERS, REGISTRANTS OR LICENSEES

2.14. Training is a major component of any programme on protection and safety. Employers, registrants or licensees:

— Should ensure that all persons who require training, qualification or authorization be suitably trained, qualified and authorized according to the requirements of the regulatory body, including the provision of suitable information on protection and safety for senior managers, for the promotion of safety culture.

— Should carry out at periodic intervals practical drills on emergency planning and preparedness, which should be part of the training and retraining programme for persons required to respond in interventions; information from feedback from the practical drills should be disseminated to all staff.
— Should consult and report back to workers through their representatives, where appropriate, about their concerns for protection and safety and the need for appropriate training programmes.
— Should provide regular refresher training on protection and safety to workers through short training courses, seminars and communications in which the following subjects should be addressed:

  - Protection and safety matters,
  - Legal and regulatory matters,
  - Workers' concerns about protection and safety matters,
  - Lessons learned from experience gained locally and around the world,
  - Specific needs for training.

— Should assess the effectiveness of training programmes and review training provisions regularly, consulting workers through their representatives, where appropriate, and should make improvements whenever necessary.
— Should keep up to date training records as recommended in para. 2.13.

2.15. Training may be carried out by the employer either in suitable training installations in the workplace or at external training centres. Licensees or registrants should not delegate to others the responsibility for ensuring that their own employees are adequately trained.

RESPONSIBILITIES OF WORKERS

2.16. In accordance with the fostering of a safety culture (Ref. [4], para. 2.28), workers should maintain a positive attitude to protection and safety and should actively participate in any training proposed or provided by their employer.

2.17 Whenever necessary, workers should provide feedback from operational experience to their employer in order to contribute to the identification of training needs.

3. EDUCATION, TRAINING AND WORK EXPERIENCE

GENERAL

3.1. This section specifies categories of persons to be trained in safety and in protection related aspects of nuclear, transport and radioactive waste safety and the minimum qualifications required. These qualification requirements are concerned with:

— Minimum educational levels,[4]
— Training,
— Work experience.

3.2. Procedures should be established for assessing the necessary qualifications and for determining the adequacy of the educational levels, previous training and work experience of candidates for training. For certain particular functions or responsibilities, qualified persons should be formally authorized, generally by the regulatory body.

3.3. In addition to the minimum qualifications, various personal attributes should be considered in the selection of candidates for particular functions or responsibilities. Personnel working with ionizing radiation should demonstrate reliability, self-control, responsibility and the ability to work in a team. Some positions may also necessitate certain standards of health and fitness. Additionally, personnel should have particular personal attributes as relevant, such as communication skills (for example for discussing safety issues with workers and managers and drafting procedures), leadership skills (for enforcing standards of performance and initiating urgent and necessary actions), analytical skills (for assessing radiation hazards in the workplace and interpreting results from dose monitoring), skills relating to the human–machine interface (for using survey equipment and recognizing deficiencies in electromechanical controls and displays) and multitask management skills (for performing several tasks at the same time, which would be required in an emergency).

[4] Educational levels are classified into three categories: (a) basic level, corresponding to 6–10 years of schooling; (b) secondary level, corresponding to a total of 10–12 years of schooling; (c) tertiary level, corresponding to education up to and including a university degree or diploma.

EDUCATIONAL LEVEL

3.4. The categories under consideration are specified in paras 3.16–3.65. A qualified expert should have a tertiary educational level. Radiation protection officers or other specialist technicians should generally have a scientific or technical diploma. Qualified operators may have various educational levels but should have at least a secondary educational level. General workers should have had at least a basic level education and this should be considered in the design of training.

3.5. Assessment of educational levels is generally straightforward; the characteristics of the national education system should be taken into consideration. In the case of education in another country, the equivalence of the education should be considered and a comparison should be made of the level and content of curricula.

TRAINING

3.6. Employers, registrants or licensees, in consultation with their employees, should assess training needs on the basis of an analysis of the competences necessary to accomplish specific tasks. This analysis should identify the particular tasks to be undertaken and the knowledge and skills that are prerequisites for protection and safety. Training should cover both theoretical and practical aspects of protection and safety, and the content and duration of each part should be determined. In addition, the level of detail in which each element of the curriculum is to be covered should be established.

3.7. Training should cover basic theory, practice and case studies on protection and safety, as appropriate [10]. Examples of safety culture should be emphasized and a questioning attitude to protection and safety and a willingness to learn should be encouraged. Practical aspects of training should include demonstrations, simulations, visits to nuclear and radiation facilities, and on the job training. On the job training should be carefully structured, with particular consideration given to supervision and assessment of the effectiveness of the training.

3.8. Assessment of the effectiveness of training should be carried out by means of ongoing evaluation and final examination of the theoretical and practical aspects of the training as appropriate. Particular attention should be given to establishing standards for the performance of individuals in examinations. Any weakness of a student in a particular topic should be clearly identified for retraining purposes. Successful completion of the training should be formally recognized.

3.9. Training should be reinforced regularly and its content should be updated as necessary. Even if a job has not changed since the completion of initial training, workers need periodic refresher training to reinforce their knowledge of theoretical and practical aspects of safety and protection. Refresher training should include lessons from incidents and accidents that have occurred in similar facilities. Refresher training before conducting infrequent activities is especially important.

WORK EXPERIENCE

3.10. Training provides the trainee with certain knowledge and skills. However, in some cases these skills should be developed before a person is considered able to carry out certain designated functions independently or to assume designated responsibilities. Trainees should therefore work under supervision for a period of time until they have acquired sufficient experience and self-confidence to perform the desired function or discharge their responsibilities reliably. The amount and type of work experience necessary to qualify a person for a particular function or responsibility depends on the job category and on the practice.

3.11. The trainee's work experience needs to be formally assessed by a supervisor to ensure its relevance for a particular function or responsibility.

QUALIFICATION AND AUTHORIZATION PROCESSES

3.12. If the educational level is acceptable, then following the successful completion of the required training and the necessary period of work experience, the trainee may be formally recognized as qualified, if required. Specific personal attributes may also be considered in the assessment of qualification. The recognition of such a qualification may be accorded by the employer, by the regulatory body or by a designated board, society, or professional or academic body.

3.13. The regulatory body may require certain functions to be undertaken by authorized persons. Such authorization to perform the duties or delegate the responsibilities to certain positions should be granted by the regulatory body or by the employer, as appropriate, to suitably qualified persons upon application and review of the person's credentials. Employers, licensees or registrants may have legal obligations to appoint only authorized persons in designated positions, for example as radiation protection officers.

ACCREDITATION OF TRAINING CENTRES AND COURSES

3.14. It may be appropriate and convenient for the regulatory body to recognize certain training centres and courses for their quality and suitability. Such recognition can be formally conferred by a process of accreditation. The requirements for accreditation of training centres and courses should be defined by the regulatory body in one or more national standards. These standards should establish requirements for training facilities, teaching staff, content, material and methods for training, examination procedures and training records [10]. Compliance with the requirements of the standards should be ascertained by the regulatory body using compliance criteria. Both requirements and criteria should be periodically reviewed to ensure that they are effective and up to date. Training centres and courses should comply with the requirements in the national standards in order to obtain and retain the accreditation.

3.15. The regulatory body should maintain updated records of accredited centres and courses, which should be publicly available.

CATEGORIES OF PERSONS TO BE TRAINED

3.16. The major goal of training is to provide essential knowledge and skills and to foster correct attitudes for radiation protection and the safe use of radiation sources. Any person who is occupationally exposed to ionizing radiation, or who may be exposed in the course of work, should receive adequate training in radiation protection and the safe use of radiation sources. In addition, there are persons such as suppliers, managers, designers, engineers and planners who, while not exposed to ionizing radiation, need to be trained in protection and safety in order to perform their duties competently.

3.17. According to the BSS, employers, registrants and licensees have several responsibilities in relation to protection and safety (Ref. [4], Appendix I). These professional personnel and other senior managers as relevant should be informed about, or should undergo suitable training, as appropriate, in:

— The basic principles of and requirements for radiation protection;
— Their main responsibilities in relation to radiation risk management;
— The relevant legislation and regulations governing radiation protection;
— The concept of safety culture;
— The principal elements of a radiation protection programme for occupational, medical and public exposure.

3.18. This Safety Guide recommends the minimum qualification that should be required for certain professional or job categories. Each of these categories is considered in detail below, and the minimum educational level, training, work experience and personal attributes that should be demonstrated are specified. In addition, recommendations are made concerning qualification and authorization requirements. The professional or job categories are:

— Qualified experts,
— Radiation protection officers,
— Workers,
— Qualified operators,
— Health professionals.

3.19. This Safety Guide also recommends and considers in detail below the minimum qualification that should be required for people from organizations with specific responsibilities in relation to the safety of radiation sources or who would be involved in intervention in the event of accidents, such as:

— Staff of regulatory authorities,
— Emergency response personnel.

Qualified experts

3.20. A qualified expert is defined in the BSS as “An individual who, by virtue of certification by appropriate boards or societies, professional licences or academic qualifications and experience, is duly recognized as having expertise in a relevant field of specialization, e.g. medical physics, radiation protection, occupational health, fire safety, quality assurance or any relevant engineering or safety specialty” (Ref. [4], Glossary).

3.21. Qualified experts should provide advice on and/or conduct activities in their field of specialization and should promote safety culture. Whenever necessary, users of radiation sources should seek advice from a qualified expert. Individual qualified experts are unlikely to have expertise in all areas but will probably be specialized in specific topics. A qualified expert should have a sound understanding of the specific applications to be dealt with. Examples of qualified experts in some applications of ionizing radiation are described below.

— Qualified experts in radiation protection at a nuclear installation may deal with a wide range of protection and safety activities, such as the designation of areas,

individual monitoring, planning for safety of personnel in activities involved in a major shutdown, and emergency response preparedness.

— Qualified experts in radiation protection in various industrial applications may deal with a wide range of protection and safety activities relating to applications of ionizing radiation in industry, ranging from level and thickness gauging systems to industrial radiography and irradiators.
— Qualified experts in medical applications may have an advisory role and/or conduct activities in areas such as radiotherapy, diagnostic radiology and nuclear medicine. They are likely to be hospital medical physicists (see para. 3.48). According to the BSS (Ref. [4], para. II.1 (d)), "Registrants and licensees shall ensure that…for therapeutic uses of radiation (including teletherapy and brachytherapy), the calibration, dosimetry and quality assurance requirements of the Standards be conducted by or under supervision of a qualified expert in radiotherapy physics". Also (Ref. [4], para. II.2), "Registrants and licensees should ensure that for diagnostic uses of radiation the imaging and quality assurance requirements of the Standards be fulfilled with the advice of a qualified expert in either radiodiagnostic physics or nuclear medicine physics, as appropriate".
— Qualified experts in waste safety may provide advice on and/or conduct safety assessments for near surface repositories for radioactive waste. They may be, for example, geologists specialized in the migration of radionuclides through geological media.
— Qualified experts in the transport of radioactive material may provide advice to, for example, transport companies, airport cargo handlers or the transport section of a nuclear facility. A qualified expert may provide advice on topics such as the design and construction of packaging for radioactive materials, quality assurance and emergency procedures for transport accidents.

3.22. A qualified expert should have had a formal education, normally to the tertiary level in science or engineering (see footnote 4).

3.23. A broad knowledge of radiation protection would be that specified, for example, in the IAEA Standard Syllabus of Postgraduate Educational Courses in Radiation Protection and the Safety of Radiation Sources [11]. This level of knowledge may be obtained through formal education, specific training and work experience. Additionally, qualified experts should have a thorough knowledge of specific topics related to their field of expertise and should keep up to date with developments in that field.

3.24. Extensive work experience in relevant areas is necessary to provide the necessary background information and competence to understand new and complex

situations, and to give direction and guidance for the solution of problems in topics related to protection and safety.

3.25. Qualified experts may be required to have highly developed personal attributes, including communication skills, leadership skills and analytical skills, since they give advice to a wide range of personnel, such as workers, managers, health professionals and staff of government authorities, and provide training.

3.26. The regulatory body should encourage the establishment of a system of recognition of qualified experts for use either by the regulatory body itself or by appropriate professional societies.

Radiation protection officers

3.27. The BSS define a radiation protection officer as "An individual technically competent in radiation protection matters relevant for a given type of practice who is designated by the registrant or licensee to oversee the application of the requirements of the Standards" (Ref. [4], Glossary).

3.28. Radiation protection officers are employees who should be designated by the registrant or licensee to supervise radiation safety within a facility and to ensure that work is carried out safely and in accordance with the relevant national requirements. They should provide the links between the workplace, the registrant or licensee, the qualified expert and the regulatory body, and should ensure that operations involving radiation are in compliance with established regulations. They should be fully familiar with operations performed in a facility, its organizational infrastructure and working procedures, and should have an understanding of the relevant regulatory requirements. They should have sufficient authority to be able to perform these functions effectively. They should also be responsible for organizing training of workers. A radiation protection officer should be the central point of reference within a company for radiation protection matters, and may carry out or directly supervise contingency plans in the event of an accident or incident. They may also be assigned responsibilities concerning safety aspects of radioactive waste management as well as protection of the public in the vicinity of the facility. Some examples of specific functions of radiation protection officers are as follows.

— In a nuclear installation, a radiation protection officer may have duties ranging from controlling occupational exposures to ensuring satisfactory compliance with licence conditions, including the safe management of radioactive waste in the facility.

— In a non-destructive testing company, a radiation protection officer should be concerned with safe operation in fixed industrial radiography or with mobile devices on site. The radiation protection officer will be required to supervise, for example, the setting up of barriers around controlled areas, the provision of personal dosimetry services, dose rate monitoring, the transport and storage of sources, and the implementation of emergency response plans, including those for misplaced or lost sources.
— In an industry using gauging systems, a radiation protection officer should supervise radiation protection measures relating to gauge operation, maintenance, leak testing, and exchange and storage of sources.
— In a medical facility, a radiation protection officer should have responsibilities associated with radiation safety, including the protection of workers and patients and ensuring the appropriate condition of the equipment used. A medical facility may have a number of radiation protection officers, each with a specific responsibility, such as for diagnostic radiology, radiotherapy and nuclear medicine. They may also be responsible for operations involving radioactive waste management in the facility.
— In research laboratories, a radiation protection officer should be responsible for the supervision of the safe handling of sealed and unsealed radiation sources and radiation generating equipment. Duties may include the explanation of local rules and working procedures to staff, dose monitoring and the implementation of emergency procedures in the event of an accident such as a spill of radioactive material. The importance of a safety culture should be stressed to laboratory workers.

3.29. The educational level of a radiation protection officer will be dependent on the skills and technical requirements of the job as well as on radiation protection needs. Education to a secondary level should be the minimum requirement for a radiation protection officer for level gauges, for instance. However, for some applications, a tertiary educational level may be considered appropriate.

3.30. Radiation protection officers should have had sufficient relevant training to enable them to supervise effectively work with radiation sources, to ensure compliance with local rules and national regulations, to ensure a suitable response in the event of an emergency and to train workers in protection and safety. A broad level of knowledge of radiation protection would be that specified, for example, in Ref. [11], including training in emergency preparedness and response. Radiation protection officers should receive further training in their specific area of work, for example in radiation protection at nuclear power plants.

3.31. An additional prerequisite for radiation protection officers should be suitable experience in a particular practice. This will help to ensure that they understand how radiation protection requirements appropriate to a practice or an intervention can be effectively fulfilled.

3.32. A radiation protection officer should have specific personal attributes such as communication skills, leadership skills, analytical skills, skills relating to the human–machine interface and multitask management skills.

3.33. The designation of a radiation protection officer by an employer should depend on an assessment of qualifications to ensure that safety standards are applied in accordance with national regulations.

3.34. Authorization may be required for a radiation protection officer in a specific practice, as specified in national regulations. The regulatory body may require that it be formally notified of the designation of a radiation protection officer for a specific practice.

Workers

3.35. According to the BSS, a worker is "Any person who works, whether full time, part time or temporarily, for an employer and who has recognized rights and duties in relation to occupational radiation protection. (A self-employed person is regarded as having the duties of both an employer and a worker.)" (Ref. [4], Glossary). These persons will need to be provided with the appropriate information, instruction and training on protection and safety [12]. Persons categorized as workers cover a wide range. Some workers are potentially exposed to radiation at high levels (such as in laboratories for radioisotope production). Other workers (such as personnel working in the vicinity of a level gauge, industrial radiography assistants or maintenance personnel) may occasionally be exposed to low levels of radiation. Other workers (such as suppliers, designers, engineers and planners) may not be occupationally exposed but their work may have an impact on the levels of exposure of other workers or members of the public.

3.36. Educational requirements will vary considerably depending on the application of radiation concerned. For many applications a basic educational level will be sufficient to understand safety and warning signs and to follow instructions for radiation protection.

3.37. Training of workers in protection and safety should be a well established part of the overall programme on radiation protection. The training should be tailored to the

particular radiation application and the type of work performed and should be designed so that a worker develops the necessary skills to work safely. The training programme should ensure that all workers receive adequate and up to date information on the health risks associated with their occupational exposure, whether normal exposure, potential exposure or exposure in an emergency, and on the significance of actions to be taken for protection and safety. It should also include local rules, safety and warning systems, and emergency procedures. Each training subject should be covered to the appropriate depth for a specific radiation application and the potential hazards associated with it. Workers should also be made aware of the presence of other hazardous agents in the workplace which may affect the safety of sources, such as inflammable items or corrosive agents. Female workers who are likely to enter controlled or supervised areas should be provided with appropriate information on the potential risks to an embryo or foetus due to exposure to radiation. They should also be made aware of the importance of notifying their employer as soon as pregnancy is suspected. Training should always include on the job training. Those workers who are not working directly with ionizing radiation, but are nevertheless working in the vicinity of radiation sources (including, for example, cleaning and maintenance staff), should be informed of the potential hazards associated with radiation sources and trained in the basic protection and safety procedures, especially the recognition of warning signs and signals.

3.38. The amount and type of work experience necessary will depend on the specific radiation application. However, workers should work under the supervision of the person responsible for the area, either a qualified operator or a radiation protection officer.

3.39. The necessary personal attributes of workers depend on the tasks undertaken, but may include communication skills, skills relating to the human–machine interface and analytical skills.

3.40. Assessment of qualification and authorization should depend on national regulations.

Qualified operators

3.41. Qualified operators is a worker who has the responsibility for the day to day use of radiation sources. Qualified operators should be trained in the operation of the equipment and should have a high level of expertise in their area of work. Examples of typical working environments of qualified operators are described below.

— Qualified operators in industrial radiography should be radiographers trained to the appropriate standard as specified in Ref. [13], in an equivalent standard or

by the corresponding national industrial society, for example the American Society for Non-destructive Testing. These standards should also specify a minimum level of training in radiation protection. Qualified industrial radiographers should be trained in a range of techniques for carrying out radiography in a range of workplaces and may also be trained in the accurate interpretation of the radiographs produced. They should be trained in potential hazards associated with radiation, safe working procedures and emergency plans.

— Qualified operators of a paper thickness gauging system, for example, should be trained in the specific working procedures associated with the routine operation of the gauge, including the threading of the line and replacement of gauge foils. They should also be trained in actions to take in the event of, for example, a mechanical failure, damage to the gauge head or fire.

— Qualified operators in diagnostic radiology should be diagnostic radiographers. They should be trained in proper examination procedures and should be aware of the levels of radiation dose to patients that are associated with specific procedures. Quality assurance associated with the operation of X ray equipment and with imaging procedures should be an essential component of an operator's training.

3.42. Educational requirements for qualified operators will vary considerably depending on the application. For many applications, a secondary educational level should be the minimum requirement.

3.43. Training in protection and safety should be tailored to a particular application and should be designed so that a worker develops the necessary skills to work safely. Minimum training should cover the safe use of radiation sources in a specific practice and an understanding of local rules and procedures, including safety and warning systems and emergency procedures, with account also taken of any potential hazardous agents in the workplace such as inflammable items or corrosive agents that may affect safety conditions.

3.44. On the job training is essential. A qualified operator should have had several years of supervised working experience in a specific practice before being recognized as qualified.

3.45. Qualified operators should have communication skills, analytical skills and skills relating to the human–machine interface in order to perform their work effectively and safely. It should be considered whether those in supervisory functions should be required to have leadership skills.

3.46. Qualifications relating to radiation protection should be assessed by the radiation protection officer of the facility, a training centre or an independent specialized organization.

3.47. Qualified operators are normally appointed by the employer and it should be considered whether they should be required to be authorized by the regulatory body.

Health professionals

3.48. A health professional is "An individual who has been accredited through appropriate national procedures to practice a profession related to health" (Ref. [4], Glossary). For health professionals there are also specific requirements for qualification in protection and safety. Some examples of health professionals are described below.

— A medical practitioner is "An individual who: (a) has been accredited through appropriate national procedures as a health professional; (b) fulfils the national requirements on training and experience for prescribing procedures involving medical exposure; and (c) is a registrant or a licensee, or a worker who has been designated by a registered or licensed employer for the purpose of prescribing procedures involving medical exposure" (Ref. [4], Glossary). An example of a medical practitioner is a hospital radiologist who is responsible for conducting diagnostic X ray procedures and making diagnoses. They should be aware of the levels of radiation dose associated with the procedures, and should be responsible for the selection of examination procedures and techniques used to obtain diagnostic information. In carrying out this work, radiologists should take account of relevant information from previous examinations in order to minimize the radiation exposure of the patient.
— A medical physicist is a highly trained person whose areas of responsibility include dosimetry, radiation safety, quality control and equipment selection. For example, a medical physicist in radiotherapy [14] should have gained an advanced university degree in the physical sciences or engineering, and should have undergone at least one year of academic and clinical training in radiation oncology and additional training in brachytherapeutic physics and radiology.
— Nurses who could be subject to radiation exposure while assisting in radiographic procedures or looking after patients undergoing procedures in nuclear medicine or brachytherapy should be trained in protection and safety.
— Ancillary technical staff includes, for example, diagnostic radiographers, technologists in radiation therapy and nurses in radiation oncology. They should undergo training in protection and safety appropriate to their speciality

of work. The level of training should be closely related to the field of application.

— Occupational physicians carry out the health surveillance of occupationally exposed workers and may also carry out general consultancy work in the community. They should be aware of the risks associated with radiation exposure and its biomedical effects, both stochastic and deterministic, and should be able to diagnose radiation induced injuries and prescribe an appropriate course of treatment [15, 16].

3.49. Health professionals should have had the minimum educational level required by national regulations or by the relevant professional associations.

3.50. Health professionals should receive comprehensive training in radiation protection relevant to their area of expertise. An appropriate level of formal training could be that described, for example, in the relevant sections of Ref. [11], emphasizing the biological effects of ionizing radiation, together with specialized training in their field of work. They should be familiar with current developments in the diagnosis and treatment of radiation injuries (see, for example, relevant IAEA technical publications [15, 16]). The duration and depth of the specialized training will depend on the level of responsibility and the complexity of the job of the health professional.

3.51. Health professionals should have had general experience in their field before specializing in the medical application of ionizing radiation.

3.52. The necessary personal attributes are those established by national procedures or by the relevant professional associations.

3.53. Assessment of health professionals' qualifications should be made and recognition granted by professional health associations. Depending on national regulations, this may require the participation of the regulatory body.

Staff of regulatory bodies

3.54. Staff of the body designated or recognized by a government for regulatory purposes in connection with protection and safety should have a good knowledge of radiation protection and adequate expertise in safety, and should also be familiar with relevant international standards and practices in other countries. Staff should be capable of assisting in the development of appropriate national subsidiary legislation and guidance, carrying out technical reviews and/or safety assessments of users and practices, and providing essential input to licensing, performing inspections and carrying out enforcement actions.

3.55. A secondary educational level should be the minimum requirement for staff in technical positions, although education to a tertiary level (see footnote 4) is appropriate for specific positions within the regulatory body. For example, an inspector of nuclear installations should have a tertiary educational level, whereas, in some countries, an inspector of industrial gauging systems need not.

3.56. The level and depth of training will also vary considerably according to the duties performed and the potential hazards associated with the sources in the regulated facilities. Personnel involved in the assessment of safety and inspections at regulated facilities should undergo extensive training; however, inspectors of industrial gauging systems, for example, may need only basic training in radiation protection. Thorough knowledge of national legislation and the regulatory framework is needed in addition to training in the safety of radiation sources. Inspectors should also be trained in radiation monitoring and inspection techniques.

3.57. It should be considered that, depending on the duties of the staff of regulatory bodies, considerable work experience may be necessary. All regulatory body staff should have acquired sufficient operational and regulatory experience to enable them effectively to verify that regulations are being implemented and complied with.

3.58. The personal attributes of staff of a regulatory body should include communication skills, leadership skills, analytical skills and multitask management skills.

3.59. Assessment of inspectors' qualifications should be required.

Emergency response personnel

3.60. Emergency response personnel include local officials such as police, fire fighters, civil defence personnel, medical personnel and paramedical personnel of national and regional organizations responsible for the planning for and response to nuclear or radiological emergencies. Although not normally occupationally exposed, they may have to carry out their duties in areas where there is a potential for radiation exposure.

3.61. Depending on their tasks and responsibilities, emergency response personnel may have educational levels ranging from basic to tertiary. For example, a basic educational level may suffice for fire brigade and police personnel, whereas emergency response team co-ordinators at a nuclear installation should have a tertiary educational level.

3.62. In addition to the necessary specific training relating to emergency response, training needs will range from basic instruction in radiation hazards to training in assessment of and response to a nuclear or radiological emergency, radiation monitoring procedures, decision making processes and co-ordination between emergency response teams. Training should include practical drills with the participation of emergency response teams. Lessons learned from past emergencies should be taken into account.

3.63. Work experience that should be required is that inherent to the respective professions.

3.64. The personal attributes of the personnel of emergency response teams should include communication skills, leadership skills, analytical skills and multitask management skills, and the ability to work under stress, depending on the function to be performed in an emergency response.

3.65. Assessment of qualifications should be performed as part of the selection and/or recruitment process for emergency response personnel.

4. A NATIONAL STRATEGY FOR BUILDING COMPETENCE IN PROTECTION AND SAFETY

GENERAL CONCEPT

4.1. Regulatory bodies, having established minimum qualifications for different job categories and procedures for assessment of qualification, authorization of individuals and accreditation of training courses and centres, should enforce the relevant regulations and verify that employers, licensees or registrants comply with the applicable requirements.

4.2. Prevailing conditions may necessitate a national strategy for building competence in protection and safety. The development of such a strategy will depend on the current and planned practices in the country, the available infrastructure and the country's human and material resources.

4.3. While implementation of a national strategy for building competence in protection and safety should normally be outside the responsibilities of the regulatory

body, circumstances may warrant the direct participation of the regulatory body in the training and qualification of the licensees' personnel in protection and safety.

4.4. In this case, the participation of the regulatory body in the training and qualification of the licensees' personnel in protection and safety should be considered a transitional arrangement. The regulatory body should not participate to an extent that could compromise its function as an independent national authority for the control of the use of radiation sources.

4.5. A national strategy for building competence consists of interrelated phases (Fig. 1):

— Analysis of training needs;
— Design of a national training programme in a realistic time frame;
— Development and implementation of a national training programme;
— Evaluation of the effectiveness of the national strategy and its individual components.

4.6. The national strategy for building competence is a structured and systematic strategy that can be applied efficiently and consistently. It also affords management control through the monitoring of each of its phases.

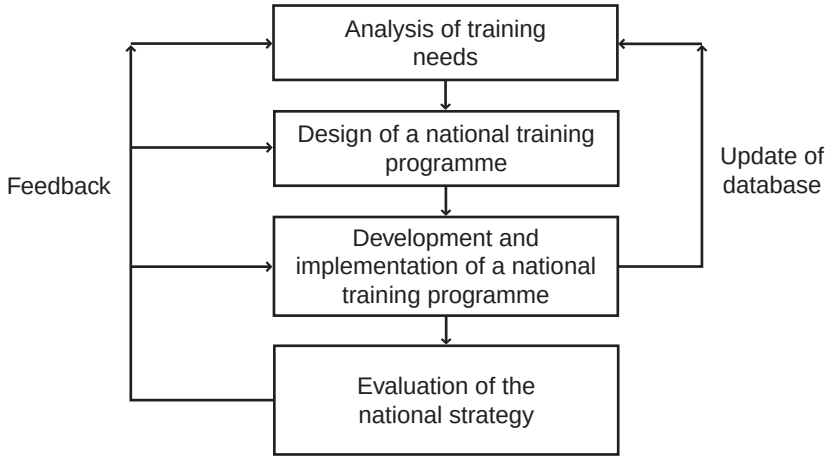

FIG. 1. Overview of an integrated national strategy for building competence in protection and safety.

4.7. Feedback of information from the evaluation phase to each preceding phase and between phases allows the strategy to be modified and improved in a timely manner. These features facilitate meeting the regulatory requirements for attaining and maintaining an appropriate level of competence of personnel. Table I sets out the objectives, the parties responsible for their implementation, the necessary inputs and the expected outputs for each phase of the strategy.

4.8. Employers should consider adapting this process for part of their own development programmes for human resources within their organizations.

ANALYSIS OF TRAINING NEEDS

4.9. The objective of the analysis phase is to identify and prioritize the training needs within a country. The projected development in the use of radiation sources should be considered in order to anticipate the needs for training that will arise from the introduction of new practices. The rate of change of staff in posts should be taken into account in considering future needs for training.

4.10. Current levels of competence can be identified from:

— Records of qualified and authorized personnel (a database should be available),
— Reports from inspections and authorizations,
— Information from employers and employees.

4.11. The necessary levels of competence are based on the qualifications described in Section 3. The following information is necessary for the analysis of training needs:

— Identification of personnel in need of training by comparison of current levels of competence with necessary levels and analysis of their job performance or new job descriptions;
— Feedback from inspection reports;
— Trends in the use of radiation sources in the country;
— Changes in training objectives on the basis of lessons learned from analyses of accidents and feedback from emergency response drills;
— Changes in equipment, procedures, technical specifications and regulatory requirements;
— Improved training techniques;
— Training of new personnel;
— Any relevant information from other countries or from international organizations;

— Information from feedback from previous training processes.

4.12. Information should be obtained from training centres on the availability of training resources within the country. The availability of training resources from international organizations should also be considered where necessary.

4.13. The regulatory body, employers, training centres and third parties, such as professional bodies, scientific societies, or regional or international organizations, should provide the information necessary to identify the needs, and the necessary resources, for the training. Training agreements could be usefully developed between organizations that have only occasional need for providing training and accredited training centres. The need for training and the availability of training should be compared to identify any shortfall.

DESIGN OF A NATIONAL TRAINING PROGRAMME

4.14. A national training programme should be designed on the basis of an analysis of training needs. Once a national training programme has been designed, the national capabilities should be assessed and it should be decided whether the country can implement the entire programme or part of it with its own resources, and whether it needs additional external resources. External resources may be available through bilateral or multilateral agreements or from international organizations.

4.15. A national training programme should include the following components:

— Preparation of a training schedule, which includes:

- Training objectives,
- Training topics,
- Selection criteria for trainees,
- Selection criteria for instructors,
- Procedures for assessing trainees' performance.

— Estimation of the resources required (e.g. lecturers, equipment and facilities).
— Selection and accreditation of centres and/or courses.
— Identification of the availability of new training (nationally or internationally) to remedy any shortfall identified in the analysis of needs.

4.16. Training centres and/or courses providing training in protection and safety should comply with the applicable national regulations and may be accredited by the

regulatory body or by an independent body recognized by the regulatory body. The regulatory body should consider whether it is necessary to accredit training centres at this stage.

4.17. External support may consist of sending trainees abroad for training or recruiting lecturers from abroad. Typical cases in which a country should seek external support are:

— In the application of a technique not previously used in the country that involves radiation sources,
— In the use of equipment not previously used in the country that contains a radiation source,
— The absence of an accredited training course in the country for a specific subject,
— If it is not cost effective to provide the training within the country,
— If the training cannot be provided in the necessary time frame,
— For the exchange of information.

DEVELOPMENT AND IMPLEMENTATION OF A NATIONAL TRAINING PROGRAMME

4.18. In the development and implementation phase of a national training programme, all training activities should be developed and implemented by training centres or training providers to achieve the training objectives. The development phase should produce the appropriate training material and all arrangements for the training, which might include theoretical and practical training in the form of lectures, workshops, tutorials, seminars or practical training exercises, and/or on the job training of appropriate duration [10]. The material to be prepared should include a suitable timetable, lecture plan, lecture notes, practical workshop instructions and assignments, scenarios for exercises and drills, and training assessment tools such as examinations.

4.19. Once the material has been fully developed, suitable trainers should be appointed and the training activity should be commenced. Active participation by the students should be encouraged.

4.20. Trainees' performance in the training process should be assessed, for example by means of examinations, during and after each training period. It should be determined whether the trainee has successfully completed the training. The information fed back from the assessment of trainees' performance and from the

training organization should be used to assess the effectiveness of training and to improve the training programme as necessary. Assessment of trainees is aimed at:

— Ensuring that training objectives are met;
— Providing feedback to trainees on their improvements;
— Providing feedback to trainers and training centres for improving training methods, if needed;
— Providing feedback to employers on new competence levels;
— Providing input for qualification and authorization of trainees whenever necessary.

4.21. An individual's training certificate should formally recognize the successful completion of training. If the training is provided by a training centre abroad, a means should be established for recognition of the certification in the home country.

4.22. Where necessary, qualification or authorization should be assessed as soon as possible to allow a person to start work in a new position without delay.

EVALUATION OF THE STRATEGY FOR BUILDING COMPETENCE

4.23. The results of an evaluation of the strategy for building competence in protection and safety should be used as feedback for a review of the various phases of the existing strategy and for the design of future national training programmes (see paras 4.14–4.17).

4.24. Performance indicators should be identified and used in the evaluation of competence building programmes. The evaluation should cover the impact of the programme, the overall process and its content. The following examples of indicators should be applied as appropriate:

— Number of training courses, types and levels;
— Number of people undergoing initial and refresher training;
— Percentage of successful completions of training by trainees;
— Feedback from employers on the basis of a formal and documented appraisal of the performance of trainees after training;
— Feedback from trainees about the quality and effectiveness of training;
— Comparison of inspection reports before and after training;
— Comparison of data on individual and collective doses before and after training;
— Comparison of accident reports before and after training;
— New levels of competence reached by trainees.

4.25. Where evaluation indicates ineffectiveness of a training programme, possible causes could be:

— Incorrect definition of training needs;
— Lack of appropriate infrastructure for implementation of the training;
— Incorrect definition of the educational level, training and experience required to enter the training activity;
— Incorrect selection and assessment of trainees;
— Incorrect selection of instructors or inadequate training delivery;
— Lack of fruitful communication between instructors and trainees.

4.26. The cause(s) should be determined and steps taken to rectify matters in future programmes.

4.27. Table I summarizes the phases for establishing a national strategy for building competence in protection and safety. This strategy, systematically implemented, is a dynamic process for helping to meet present and future training needs.

TABLE I. SUMMARY OF A NATIONAL STRATEGY FOR BUILDING COMPETENCE IN PROTECTION AND SAFETY

Phase	Objectives	Organization and/or personnel involved	Input[a]	Output
1. Analysis of training needs	Identification of current competence levels	Regulatory body or other governmental bodies Employers Professional associations	Database of qualified and authorized personnel Reports from inspections and authorization processes Information from employers Information from employees	Current competence levels identified
	Identification of available training resources	Regulatory body or other governmental bodies Employers Training centres Professional associations	Information from national training centres Information from training centres abroad	Database of existing training centres and relevant courses (national and those abroad)
	Identification and prioritization of training needs	Regulatory body or other governmental bodies Employers Training centres Professional associations	Competences Requirements for qualification and training Anticipated changes in practices and/or technical procedures Information on personnel in need of training and on the rate of turnover of staff in particular posts Accident analysis and industry experience Trends in the use of radioactive materials in the country Improved training techniques	Training needs identified and prioritized Identification of shortfall in the availability of training nationally

TABLE I. (cont.)

Phase	Objectives	Organization and/or personnel involved	Input[a]	Output
2. Design of a national training programme	Preparation of a national training programme	Regulatory body Employers Training centres Professional associations	Prioritized training needs Database of training centres and relevant training courses Identified shortfall in availability of training	Training event schedule prepared Objectives defined for each training event Resources needed identified Training centres and/or courses accredited Selection criteria for trainees and trainers determined Assessment procedures for trainees' performance determined
3. Development and implementation of a national training programme	Development of training activities	Training centres Employers Professional associations	Training schedule Training objectives List of available resources Assessment procedures Certification requirements	Training material developed Timetables prepared Trainers and trainees identified Assessment tasks and/or examinations prepared
	Implementation of all scheduled training activities	Training centres Employers Trainees	Planned and prepared training activities and arrangements as in the above phases	All scheduled training activities completed Increased levels of competence of employees

TABLE I. (cont.)

Phase	Objectives	Organization and/or personnel involved	Input[a]	Output
3. (cont.)	Assessment of qualification and authorization	Regulatory body Professional associations Employers	Trainees' results Qualification and authorization procedures	Qualification (when necessary) Authorization (when necessary) Updated database of qualified and authorized personnel
4. Evaluation of a competence building strategy	Verification of successful training activities	Regulatory body Employers Trainees Professional associations Training centres	Percentage of successful candidates Feedback from employers on performance appraisal Feedback from trainees Accident reports (as appropriate) Data on individual and collective doses (as appropriate) Inspection reports	Successful training activities noted Needs for improvement identified and fed back to the appropriate phase
	Verification of successful national competence building strategy	Regulatory body or other governmental bodies Employers Professional associations Training centres	Number of people receiving training Number of successful training courses New competence levels	Competence levels of the workforce increased Needs for improvements identified and fed back to the appropriate phase

[a] Improvements indentified in the evaluation phase should be used as input for the phase concerned.

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