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GUIDELINES FOR THE IAEA NUCLEAR SAFETY EDUCATION AND TRAINING REVIEW SERVICE

CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

The uncertainties about the future of nuclear power in many countries, the consequential lack of interest on the part of new professionals to engage in the nuclear field, and the ageing of the existing work force is a major current concern in the international nuclear community. The situation is even of greater concern because higher education opportunities in the field of nuclear engineering are greatly reduced, with the elimination of nuclear engineering departments and research reactors in many universities and the loss of nuclear research facilities generally.

The IAEA has statutory functions to "foster the exchange of scientific and technical information" and "encourage the exchange and training of scientists and experts". In line with these functions the IAEA has been offering training opportunities to professionals from Member States. These include a wide range of training courses and workshops in topics relevant to the safety of nuclear installations.

In response to a resolution [GC(44)/RES/13] of the General Conference of September 2000, the IAEA convened an Advisory Group (AG) to review efforts to date and to advise on the overall strategy, structure, scope and means of implementation of an IAEA Programme of Education and Training in Nuclear Safety. The strategy adopted is in Appendix A.

The AG recommended, inter alia, that the IAEA should provide, upon request, advice to Member States in carrying out a broad evaluation of national training needs and assistance in developing and implementing the required training, and that the Agency provide a specific advisory service to deliver this advice.

The primary purpose of this publication is to provide guidance for planning and conducting a nuclear safety related education and training review. Guidance is provided for IAEA staff and external experts in planning, conducting, and reporting on the review mission. Because a self-assessment of education and training programmes in the requesting Member State is an essential part of the review, guidance is also provided for this preparatory activity.

For the purpose of this document, education and training encompasses academic and professional training activities in the basic knowledge in nuclear safety, including fundamentals of nuclear engineering and reactor physics, as well as the specialized knowledge required for staff of nuclear power plant and research reactor operators and for regulators and their technical support organizations.

In addition to its use in providing advice to the requesting Member State on its nuclear safety education and training programme, the report of a review mission under these guidelines will provide information to the IAEA staff needed in performing the "Integrated Safety Evaluation for Nuclear Installations" in the Member State. Education and training in nuclear safety is one of the major areas addressed in the integrated safety evaluation.

1.2. OBJECTIVES OF REVIEW

The objective of the IAEA Nuclear Safety Education and Training Review service is to assist Member States to develop and to maintain a sustainable and adequate education and training programme in nuclear safety consistent with IAEA safety standards and international good practices with due recognition to national conditions. It is intended that the review service will address three key areas relative to the education and training safety programme of a Member State:

Area 1- The basis and framework for nuclear safety education and training;
Area 2 - Competencies and training in nuclear safety; and
Area 3 - Maintenance and improvement of competencies and training.

In order to address these three areas, a review will consider the education and training in safety at all levels in the Member State, including the national system of universities and technical institutes, the system of professional training, and the provisions for job-specific training. Organizations that would be consulted in the review include those whose primary function is providing education and training, such as universities, technical institutes, and training organizations, as well as those that are primarily users of trained personnel. The internal training programmes of these recipient organizations, such as regulatory bodies, plant owners and operators and technical support organizations, will also be taken into account.

For the organizations providing education and training, the principal topics to be reviewed will include their perspective on the needs for education and training in nuclear safety, the programmes being offered, including the existing facilities and instructional materials, the qualifications of the faculty and trainers, and provisions for continuous upgrading and renewal of the courses and instructions. For the recipient organizations, the same basic topics will be addressed, with additional consideration of the emphasis placed on upgrading education in the organization and provisions for on-the-job training and mentoring of staff.

An important part of the review process will be consideration by the review team of a self-assessment of the nuclear safety education and training programme of each organization, which should be conducted by the Member State as part of its preparation for the review. Guidelines on conduct of a self-assessment are given in Chapter 5 of this document.

1.3. PHASES OF REVIEW

An education and training review mission has three main phases: preparation for the mission, conduct of the mission, and follow-up. Regardless of the scope of the mission, realization of a successful mission requires equal care in the execution of all three phases.

Preparation for the mission requires information about the whole national system of education and training, and from organizations providing and receiving nuclear safety education and training in the Member State. It also requires a self-assessment of the nuclear safety education and training programmes of the relevant organizations. Details on the

information to be submitted by the Member State prior to the mission is provided in section 2.6.

Typically the review mission includes an entrance meeting between the IAEA review team and national counterparts, reviews according to the agreed schedule, daily IAEA team meetings for exchange of information and consistent formulation of findings, conclusions and recommendations, daily meetings with national counterparts and an exit meeting. While details of the review mission will vary depending on the mission scope, it may involve review of the self-assessment and other written material provided with the self-assessment; interviews with national experts, including operators and regulators; visits to universities and training centres and preparation of the mission report. The results of the review are discussed with the national counterparts during the course of the mission to ensure that they reflect properly the existing situation.

A follow-up mission or activity is organized one to two years after the mission to verify the level of implementation of mission recommendations. The main purpose is to assist in the implementation phase by providing specific guidance and advice in the areas that are most difficult for the Member State's organizations.

1.4. REFERENCE BASIS FOR REVIEW

The reference basis for the review of national education and training programmes are:

- **IAEA Safety Standards**
- **IAEA OSART reports**
- **IAEA INSARR reports**
- **IAEA IRRT reports**
- **Other IAEA safety publications** - these may include INSAG reports, TECDOCs, and other IAEA reports on current safety developments and good practices, .

2. PREPARATION FOR THE REVIEW MISSION

2.1. DEFINING THE DETAILED SCOPE OF THE REVIEW

One main characteristic of the Nuclear Safety Education and Training Review Service is to provide an evaluation of the education and training system of a Member State from a global perspective. This implies the review of the activities and programmes of education and training in a wide variety of organizations going from the governmental level to the operating organization level. Despite this broad coverage of the service, the scope of a review may be limited by limiting the number of operating organizations being reviewed (mainly in countries with a large number of facilities) and/or the type of nuclear installations considered.

The scope agreed will define the number of experts to be recruited by the IAEA as reviewers. The scope should be clearly established and properly reflected in the mission agenda. The agreed scope will also govern the scope of the background material to be

submitted to the IAEA prior to the mission, in particular, the national self-assessment expected from the Member State for the review.

2.2. TEAM COMPOSITION

The IAEA review team should be composed of an IAEA team leader and of 1-4 external reviewers. Team members should not be from countries or organizations contractually involved in training activities in the host country in order to avoid potential conflicts of interest. Team members should provide a broad range of views and experience on topics to be reviewed.

In agreement with the host country, one observer may be invited to participate in a review mission. Observers should be chosen taking into account future reviews scheduled.

2.3. IAEA TEAM LEADER RESPONSIBILITIES

The IAEA team leader will establish all required liaison contacts with the national counterpart designated by the Member State requesting the review.

Once the scope is defined, the team leader will recruit the experts needed and develop the agenda for the mission. The team leader will provide the national counterpart with the logistical requirements for the review mission and technical visits as appropriate.

The background material requested (see section 2.6) and its timely transmission to the IAEA team before the mission is of paramount importance for a successful review. The background material to be reviewed in advance should be received at the IAEA at least two months prior to the mission. The team leader will review the material submitted by the national counterpart for completeness and adequacy and distribute the material to the review team members at least one month prior to the mission. If appropriate, the team leader will also assign specific areas of review to each team member.

The team leader performs an in-house review of available information from the activities and reviews previously conducted by the IAEA for the country. This will facilitate focusing the team attention in the areas where improvement is needed and ensure consistency with previous findings and recommendations of the IAEA. The team leader provides guidance to each team member on the mission-relevant IAEA publications.

2.4. NATIONAL COUNTERPART RESPONSIBILITIES

The national counterpart is in charge of preparing the logistics for the mission including:

- defining the detailed scope of the training review and preparation of the daily review mission schedule in co-operation with the IAEA team leader;
- arranging for preparation and transmittal of the required advance materials to the IAEA, including the self-assessment (see Section 2.6) according to the previously agreed scope and schedule, two months in advance of the review mission;

- establishing the logistic arrangements for the mission including hotel rooms with adequate conditions for work (e.g. desk and light, electrical connection for a portable computer), meeting rooms, access to the training centres, local transportation, and secretarial services;
- co-ordinating the participation of the national organizations and national experts engaged in nuclear safety education and training in the review mission.

2.5. IAEA REVIEW TEAM MEMBER RESPONSIBILITIES

IAEA review team members are responsible for familiarizing themselves with the background material in advance of the mission, especially the areas related to their review assignments.

Each team member is responsible for the review activities in the specific field assigned to him according to the daily schedule provided by the team leader. In addition, team members participate in daily team meetings, present their daily findings orally and in writing and offer their comments and experiences when the findings of other team members are discussed.

Each team member is also responsible for the preparation, writing and reviewing of the sections of the review mission report dealing with the subject under his/her responsibility. He will also be asked to review the report on other closely related subjects to ensure consistency and good integration. Completion and review of the mission report after the mission is also a task to be performed by the team members.

2.6. ADVANCE MATERIALS REQUIRED

Complete, concise, and timely transmitted written material is an essential part of the nuclear safety education and training review mission. Not only do the various documents serve to inform the review team members and establish a basis for the review, but it is expected that preparation of the required documents will be based on a thorough self-assessment of education and training resources and needs in the Member States. In this way, both the Member State and the IAEA team will be prepared to conduct an efficient review.

The details of content and timing of submittal of advance material are to be agreed between the IAEA team leader and the national counterpart as a part of the definition of the scope and objectives of the mission. The advance material should be submitted in the English language.

Materials shall be provided covering the following topics:

1. Summary of the national nuclear programme and future plans

    - Relevant information is normally already available to the IAEA from previous IAEA missions to the country and in the country nuclear safety profile. This information may need to be updated to reflect the current status.

2. Summary of the national framework for Nuclear Safety Education and Training

    - National legislation, policies, rules and regulations relevant to nuclear safety;

- National legislation, policies, rules and regulations that govern the higher educational institutions, especially as they relate to providing and maintaining nuclear education and training.

3. Summary of the national educational system

   - Overview of the national educational system, covering universities, technical schools and professional training organizations, as they relate to the nuclear programme.
   - Description of educational programme offerings, especially those offerings related to safety:
     – course descriptions and syllabi;
     – size of programme - numbers of faculty and students;
     – research arrangements;
     – facilities and equipment;
     – facility development plans.

4. Summary of the national nuclear training system (universities and training centres)

   - Description of training capabilities and offerings related to safety:
     – course descriptions and syllabi;
     – size of programme - number of trainers and trainees;
     – facilities and equipment;
     – trainer development arrangements.

5. Description of each organization being reviewed, its functions, its current staffing, and the qualifications and experience of the staff, and the rationale behind its selection as an organization to be reviewed.

6. Training programme of the organizations being reviewed.

7. Reports of the self-assessment of each organization being reviewed following the guidelines provided in Chapter 5.

3. CONDUCT OF THE REVIEW MISSION

Typically the duration of a training review mission is 5 days which includes ½ day for an overview presentation by the host country experts, 3.5 days of meetings between the IAEA team and national counterparts and visits to training centres; during this period the mission report is also prepared and discussed with the national experts. In the last day, the exit meeting is held. If there is a large number of separate training centres or organizations some additional days may be required.

An internal meeting of the IAEA team members is normally held during the evening before the start of the mission (typically on Sunday evening). During the meeting, the team leader reviews the detailed schedule of the mission and duties of each team member as well

as a summary of the pre-evaluation results. Team members also have the possibility to discuss the advance material and their preliminary findings.

The mission begins with an entry meeting with the national counterparts. Participants are introduced and the objectives and scope of the mission as well as mission programme and schedules are presented. The national counterparts provide a general presentation on the first four topics of the advance materials (see Section 2.6). The IAEA team leader introduces the team members, the review methods and the reference material. Administrative arrangements are also discussed. Next, the IAEA team members meet their national counterparts to agree on the detailed review programme and the necessary arrangements.

The conduct of the mission is carried out according to the agreed schedule. The review includes the following activities:

- In-depth review of advance material to resolve issues requiring further clarification and to further discuss potential weaknesses;
- Review of polices, procedures, and training materials;
- Interviews with counterpart personnel;
- Direct training centre and facility observations and evaluations;
- Discussion of evaluation results, preliminary conclusions, suggestions, and recommendations;
- Preparation of draft report to the national counterparts.

The members of the IAEA review team are expected to thoroughly cover their respective topics and materials in enough detail and depth to reach independent conclusions about the adequacy of training arrangements. Therefore, the review team should be familiar with the IAEA guidance and results of any prior assessments.

Each aspect of the conduct of the mission requires documentation. A detailed list of all written material reviewed should be maintained, especially those items which form the bases of judgements made and conclusions drawn. In addition to identification of the reviewed items, a summary of the level of detail of the review of each item should be provided. Documentation of meetings and interviews should be maintained for inclusion of salient items in the draft report. The documentation should identify all national professionals with whom discussions were held, specifically identifying their respective contributions. This information is collected in the form of daily summaries of conclusions.

The IAEA team has daily meetings at the end of the day to discuss mission findings and compare the results with other findings.

The IAEA team members formulate on the basis of their significant findings, conclusions and recommendations to be included in the draft report. The team leader and the national counterpart meet also on a daily basis to discuss the findings made from the previous day and provide clarifying or dissenting views. Similarly, good practices should be documented. Conclusions are to be clearly stated. Recommendations are to be unambiguously formulated, clearly stated and based on the identified weaknesses. They should be formulated such as to allow the recipient to find the best solution for the problem. The draft mission report is prepared during the mission on the basis of daily reports including the conclusions,

recommendations and good practices identified. The report follows the outline presented in section 4.

An exit meeting is held during the last day of mission. Participants in the meeting are the IAEA team members and their national counterparts, senior management of the organizations involved in the review, other parties concerned. During the meeting significant findings, conclusions, and recommendations are presented by the IAEA review team.

4. MISSION REPORT

The mission report serves as the formal documentation of the results of the education and training review mission. It includes the following key information:

- The findings of facts relative to the education and training programme of the Member State.
- Conclusions of the review team concerning the conformance of the education and training programme to IAEA standards and international good practices.
- Recommendations for actions to remedy weaknesses and to strengthen the national education and training programme.
- Recognition of noteworthy good practices.

Results of the mission are discussed between the IAEA team leader and the national counterpart at the daily progress meetings as well as meetings between the IAEA team members and their counterparts. At these meetings, any misunderstandings are identified and clarified.

To the extent possible, draft report will be prepared during the mission and presented to the national counterparts at the exit meeting before the review team leaves the country. At least, the sections on findings, conclusions and recommendations should be available in draft for presentation at the exit meeting.

After the performance of the mission the draft report will be finalized by the IAEA and submitted to the host country for comments. Upon receiving the comments the IAEA completes the final report and submits it to the Member State through the official communication channels.

The complete outline of the mission report follows:

SUMMARY

The summary should provide an overview of the objectives and scope of the mission, and its findings, conclusions and recommendations.

INTRODUCTION: BACKGROUND AND OBJECTIVES

The Introduction should clearly state the objectives and scope of the mission. Agency documents that form the basis for the review should be identified. Background material provided by the Member State should be cited, and key points summarized.

CONDUCT OF THE MISSION

This section provides the details of the mission. Its content should include a brief discussion of the methods used in the mission (e.g. extent of review of written background material, interviews with national counterparts, site and facility visits). A day-by-day accounting of technical work of each team member, including meeting subjects, participants and location should be provided.

REVIEW SESSION FINDINGS

Findings are statements of facts relative to the subjects covered in the course of the mission. An appropriate format for the findings section would include a general introductory section followed by, for each issue subject covered:

(i) Summary of the question investigated;
(ii) Background including a summary of previous reviews (open items, recommended actions, training centre visits, etc.), if any;
(iii) Citation of the reference material, studies and results presented to the IAEA review team during the mission;
(iv) Citation of IAEA and other reference documents related to the findings; and
(v) Summary of discussions and remarks including the positions of the national counterparts as they relate to the subject under consideration.

The findings should be clearly numbered for ease of future reference.

CONCLUSIONS

In the conclusions section, the IAEA review team states their opinion as to whether the training arrangements meet the criteria to which the review is being performed.

RECOMMENDATIONS

The recommendations of the review team for actions deemed necessary to meet the review criteria are presented here.

GOOD PRACTICES

Good practices presents items which are considered noteworthy as good examples for others.

5. ELEMENTS OF SELF-ASSESSMENT

A thorough self-assessment of the Member State's programme of education and training in nuclear safety is an essential part of the preparation for the review mission. Preparation of the advance material for the mission, which will include both information items and assessment items, will help the Member State to identify and understand its own needs, resources, and gaps in its education and training programme, provide the Review Team with essential knowledge and understanding, and provide a basis for efficient conduct of the Review Mission. Information items are requested to assist the Review Team, but are not the subject of the Review, which will address the assessment items.

Briefly stated, the self-assessment should address four fundamental questions:

1. What is needed?
2. What is available and adequate to meet the needs?
3. What is not available or needs improvement in order to meet the needs?
4. How can the deficiencies be remedied?

While these questions may be stated in many different ways, they are fundamental to the process of self-assessment.

For the Nuclear Safety Education and Training Review, the Member State's information submittal and self-assessment should consider its entire nuclear-related enterprise, including the relevant bodies responsible for nuclear policy and for education and training policy at the national level, the relevant academic organizations (universities and technical institutes), the regulatory body, and organizations operating NPPs or research reactors. For each organization (or group of organizations), the information submittal and self-assessment should address these basic areas:

1. The basis and framework for nuclear safety education and training;
2. Competencies and training in nuclear safety; and
3. Maintenance and improvement of competencies and training.

Within each of these areas, the fundamental questions stated above should be addressed.

Basis and Framework

This area addresses the legal, policy, strategy, planning and organizational matters that impact the education and training needs, the system for meeting the needs, availability of resources for education and training, and qualification and utilization of these resources.

For the education and training institutions, the regulatory body, and the operating organizations, information should be provided on the internal policies, strategies, planning, and organizational matters that provide the basis and framework for the education and training programmes in the organization.

For each organization, the self-assessment should address:

- The legal basis, policies, standards, requirements, procedures, facilities, and resources required to conduct a nuclear safety education and training programme;
- Adequacy of the existing legal basis, policies, standards, requirements, procedures, facilities, and resources to conduct a nuclear safety education and training programme for the organization;
- Improvements and changes needed to provide an adequate education and training programme in nuclear safety.

Competencies and Training

This area addresses the competencies required and the training necessary to provide these competencies, primarily in the operating organizations and in the regulatory body.

A self-assessment on this area includes the following items:

- The competences needed in the organization to perform its safety-related functions;
- Whether or not the education and training required to provide the required competencies is available in the Member State, and whether or not the available resources are used efficiently by the organization;
- Measures taken to achieve the required competencies if in-country resources are inadequate, for example IAEA training events or bilateral education and training arrangements;
- Efficient use and dissemination of externally acquired competencies and training materials (multiplier effect).

In each of the self-assessments, consider the three basic questions of self-assessment, which may be recast as follows:

1. What safety-related academic and professional training is required to meet the current and projected future needs?
2. Are the required subjects taught and the required training available in the academic institutions, professional training organizations, or within the organization, and are these resources efficiently used?
3. What improvements in the education and training framework are necessary to meet the identified deficiencies?
4. How can the needed improvements be achieved?

Maintenance and Improvement

This area addresses the need for continuous maintenance and improvement of the competencies needed for nuclear safety. Rather than focusing on identifying competencies and the means to acquire the needed competencies, this area focuses on maintaining, reviewing and upgrading the competencies.

The self-assessment should include:

- Internal training (formal and on-the-job) programs and monitoring programs for staff members;
- Safety-related training policies for staff members;
- Internal programs for maintaining awareness of relevant R&D results, feedback of relevant operating experience and new challenges to the current staff;
- Programs for tracking the education and training status of staff members;
- Programs for dissemination of the education and training acquired by staff members to colleagues and other organizations (i.e., through lectures and seminars, distribution of training materials, and utilization of the staff member as a trainer).

As in the preceding areas, the discussion should focus on the fundamental questions; for this area, they may be summarized as:

1. What programs are needed to ensure continuous maintenance and improvement of safety-related competencies?
2. What programs exist and are in use?
3. What improvements are needed to achieve the desired level of maintenance and continuous improvement of safety-related competencies?
4. How can the improvements be achieved?

Appendices B, C, D, E and F provide detailed guidance on the topics to be considered in the three areas for the National System, Universities, Professional Training Institutes, and other Training Organizations, for the Regulatory Body and its Technical Support Organizations (TSO), and for the organizations operating NPPs and research reactors.

APPENDIX A

INTEGRATED STRATEGY FOR EDUCATION AND TRAINING IN NUCLEAR SAFETY

STRATEGY

As a first step for the development of a Programme of Education and Training, a strategy is proposed: It recognizes that there is a need for a long term, sustainable programme of Education and Training in Nuclear Safety in MSs and that a gap exists between the Nuclear Safety knowledge required in MS, and the capabilities of IAEA to deliver training. Therefore, complementary to its training courses, the IAEA needs to concentrate its efforts on assisting MS to establish national sustainable education and training programmes that are in line with international safety standards. An essential element of this effort is the development by the IAEA of model type training leading to train the trainers who will ultimately implement the national programmes in a harmonized way.

The strategy is described in terms of a vision, objectives, outputs and activities required to implementation. It can also serve as a basis for education and training in areas other than nuclear safety.

VISION

Adequate nuclear safety infrastructure including a sustainable programme of Education and Training in Nuclear Safety is in place worldwide and safety is ensured in all practices, consistent with the requirements of the IAEA Safety Standards and other relevant nuclear safety standards.

OBJECTIVES

1. A “Sustainable Education and Training System” should be in place in Member States to develop and maintain competence in nuclear safety, consistent with IAEA safety standards and best practices.

2. An “Education and Training Support Programme” should be further developed by the IAEA in co-operation with Member States, and as appropriate, other international organizations, to extend and augment the existing IAEA training programme and support the above objective.

OUTPUTS

1. A Training Support Programme in nuclear safety, including a standardized and harmonized approach for training developed by the IAEA and in use by Member States.

2. National and regional training centres, established to support sustainable national nuclear safety infrastructures.

3. Training material for use by lecturers and students developed by the IAEA in English for the Basic professional educational course and the main specialized courses. Member States commitment to translate material to other languages.

ACTIVITIES

The main activities to reach the objectives stated above include:

- Assist Member States in identifying their needs in education and training support;
- define appropriate training requirements to achieve specific nuclear safety competency;
- develop standards and other safety related documents on education and training;
- develop standardized training material;
- support the establishment or further development of national training centres for the provision of regional/national education and training programmes;
- develop exemplary train the trainers programmes;
- exchange information through meetings to harmonize and facilitate co-operation;
- perform quality assessments and peer reviews of regional/national programmes, courses, use of standardized material, to assure adherence to the IAEA Safety Standards; and
- develop and support the use of distance learning training programmes.

PROPOSED FRAMEWORK

A systematic approach is proposed to support planning and implementation of IAEA activities related to training in nuclear safety. The approach should consider :

- the needs of Member States;
- the wide experience gained by the IAEA to date;
- the IAEA safety standards and current trends in nuclear safety.

The programme calls for a double track approach: (a) focusing on IAEA's exemplary training for basic and specialized knowledge aimed at professional staff and for training the trainers; (b) the commitment of Member States to establishing their own sustainable training programmes in line with (a) above.

The framework proposed for the IAEA Education and Training Programme in Nuclear Safety is shown in Fig. 1. The axes of the figure show the areas of competency on which training is to be focused (horizontal) and the level of detail to be pursued by the training (vertical). Also indicated on the horizontal axis are the target groups to which training in a particular area should be primarily directed.

The areas of competency are identified according to the structure of the IAEA Safety Standards to emphasize the fact that all the training provided by the IAEA is based on its own standards and recognized international practices. The same approach is to be adopted by MSs providing nuclear safety training.

At the level of basic knowledge, training is intended to provide a broad overview of nuclear safety concepts and their application to NPP and RR design and operation. Its nature and scope are primarily oriented to junior professionals recently involved in nuclear safety related activities. It is also appropriate for some highly specialized professionals who lack a broader view of nuclear safety. The Basic Professional Training Course described earlier in section 2 is the main course offered at this level. This course in its form and content is unique and fulfills a recognized gap in the education and training of nuclear safety worldwide.

Recent experience indicates the need to provide some academic education in fundamentals of nuclear engineering, including basic topics such as reactor physics and thermal hydraulics. This training is essential to those engaged in the nuclear safety field and is increasingly difficult to obtain due to the phasing out of nuclear engineering programmes in many universities worldwide. The use of distance learning tools for self-study is attractive and work is already underway at the IAEA. This topic is further discussed in section 4.

At the level of specialized knowledge, standard training courses are offered on regulatory control, safety assessment, and operational safety of NPPs and RRs. Target groups are technical staff of the regulatory bodies, technical support organizations, NPP operators, RR operators and users, scientific personnel from research institutes, and educators. The syllabus of such courses is provided in a separate document. Textbooks for some of these courses have been drafted and need to be further developed.

At a more specific expert level, workshops are generally preferred as they provide more appropriate conditions for an effective exchange of information and experience among practitioners. Some topical courses and workshops at this level are also indicated in Fig. 1.

The framework for education and training is complemented by opportunities for practical on-the-job training awarded as Scientific Visits and Fellowships by the IAEA on a case by case basis. This form of training, normally away from the home country, depends on acceptance by the host country and is considered in cases where the other training opportunities have been exhausted.

A complementary and highly effective form of delivering training and exchange of experience among practitioners is that of offering workshops in the frame of the IAEA safety services. This approach has been particularly used in connection to operational safety services in the areas of safety management and safety culture. Training delivered in the frame of IAEA safety services is of immediate use for NPPs to perform self-assessment. Currently, training courses for operational safety are an integral part of the operational safety services such as the Operational Safety Review Team (OSART) and associated seminars and workshops.

Areas of competency	Regulatory control	Siting & Design of NPPs	Operation of NPPs	Research Reactors Design, Operation & Utilization	Non-Reactor Fuel Cycle Facilities
Primary audience	Regulatory body staff	Technical Support Organizations	Operators and Utility Staff	Research organizations and educators	Regulatory Body Staff, Facility Operators and Technical Support Organizations
Basic knowledge (standard training courses)	Basic Professional Training Course on Nuclear Safety				
	Fundamentals of Nuclear Engineering				
Specialized knowledge (standard training courses)	Regulatory Control of NPPs	Safety Assessment of NPPs	Operational Safety of NPPs*	Safety of Research Reactors	to be defined after IAEA publishes the relevant safety standards.
Specific expert knowledge (examples of tailored topical courses or workshops)	- Authorization Process - Review and Assessment - Inspection and Enforcement - Development of Regulations and Guides - Regulatory Effectiveness	- Accident analysis methods - Probabilistic safety assessment - Accident management - Ageing management - Safety assessment of modifications	- Safety culture and management of safety NPP operator regulator interface - Operational experiences and feedback - Operational practices	- Reg. aspects and safety documentation - Safety analysis - Safety in operation and utilization - Management of ageing - Safe shutdown and decommissioning	to be defined after IAEA publishes the relevant safety standards.
On the job training, Practical experience	Scientific Visits, Fellowships, observers in IAEA safety missions				

FIG. 1. Framework for Education and Training in Nuclear Safety

*Currently, training courses for operational safety are an integral part of the operational safety services and associated seminars and workshops.

APPENDIX B

GUIDELINES FOR A NATIONAL LEVEL SELF-ASSESSMENT OF THE SYSTEM FOR EDUCATION AND TRAINING IN NUCLEAR SAFETY

A self-assessment of the national system for education and training in nuclear safety should be carried out by the governmental body having responsibility for the national nuclear enterprise, in cooperation with the body having responsibility for education and human resource development. This self-assessment should consider the current situation for utilization of nuclear energy in all of its forms, as well as the national vision and plans for future utilization. The principal focus should be on current and future needs for human resources and the arrangements needed to develop these resources. Important considerations include the national laws, policies, regulations, and strategies related to nuclear safety, the organizations involved, assignment of responsibilities, and the needs for government funding and support. It is important that this self-assessment be conducted at the national level, considering the national requirements and the whole system for meeting the requirements for education and training in nuclear safety. The structure of the self-assessment is shown in Figure B-1. Guidelines for self-assessments of particular components of the system are provided in Appendices C through F.

Area 1: Basis and Framework for Nuclear Safety Education and Training

At a national level, the basis and framework for nuclear safety education and training lies in the current laws, regulations, and policies governing the nuclear enterprise, along with the national vision and plans for future utilization of nuclear energy in all of its forms. In addition, the basis and framework includes the laws, regulations, and policies governing the national educational system.

Question 1: What is needed?

Given the current situation and the national vision and plans for future utilization of nuclear energy, what human resources are needed and what laws, regulations, policies, and institutional arrangements are needed to provide the required education and training capabilities?

Consider:

- The current national framework of laws, regulations and policies for education and training in nuclear science and engineering generally, and nuclear safety in particular.
- The national vision and plans for utilization of nuclear energy.
- The needs for new legal and governmental infrastructure, laws, regulations, governmental organs and operating organizations, and the needs for staffing these organizations.

- The mechanisms necessary for funding new or upgraded education and training capabilities.

These considerations should lead directly to the remaining three questions.

Question 2: What is available and adequate to meet the needs?

Consider:

- The existing framework of laws, regulations, and policies and its adequacy to meet current needs for education and training in nuclear safety.
- The adequacy of the existing framework when considered in light of the national vision and plans for utilization of nuclear energy in the future.

Question 3: What is not available or needs improvement to meet the needs?

Consider:

- The improvements necessary in the national system of laws, regulations and policies to meet the current national needs for education and training in nuclear safety.
- The improvements needed to fulfill the national vision and plans for utilization of nuclear energy in the future.

Question 4: How can the deficiencies be remedied?

Consider whether new laws or regulations are needed, whether new or revised policies are required, or are other measures needed to provide the required basis and framework for education and training in nuclear safety.

Area 2: Competencies and Training in Nuclear Safety

Question 1: What is needed?

Consider, at a national level, the required skills and the numbers of people having these skills to staff government organs, academic institutions and professional training organizations, the regulatory body, and operating organizations, in light of the current situation and the national vision and plans.

Question 2: What is available and adequate to meet the needs?

Consider the current capability of the education and training system to produce people with the required skills in the required numbers. Consider also the means available at a national level to attract new personnel into the field of nuclear safety.

Question 3: What is not available or needs improvement in order to meet the needs?

Consider the gaps between requirements for personnel and the capability of the current system to provide these resources.

Question 4: How can the deficiencies be remedied?

Consider the modifications to the current system or the nature of the new system that are needed to produce the human resources needed.

Area 3: Maintenance and Improvement of Competencies and Training

In this area, consider the same questions as in Area 2, but from the perspective of maintenance and improvement in the long term.

Page 5 **Nuclear Power Plants**

Page 4 **Research Reactors**

Page 3 **Regulatory Body**

Page 2 **Universities**

Page 1 **National System**	**What is needed ?**	**What is available and adequate ?**	**What is not available or needs improvement ?**	**How can deficiencies be remedied ?**
Area 1 **Basis and Framework**	• ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... •	• ... • .... • ... ...
Area 2 **Competencies and Training**	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ... • ... •	• ... • ... •	• ... • ... • ... • ... • ...
Area 3 **Maintenance and Improvement**	• ... • ... • ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ...	• ... • ... •	• ... • ... • ...

Figure B-1

Structure of a Self-assessment of Education and Training in Nuclear Safety

APPENDIX C

SELF-ASSESSMENT GUIDELINES FOR UNIVERSITIES, PROFESSIONAL TRAINING INSTITUTES, AND OTHER TRAINING ORGANIZATIONS

This Appendix provides guidelines for a self-assessment of the academic educational institutions, the professional training institutes, and other independent training organizations engaged in nuclear safety education and training in a Member State. It does not include internal training activities in the regulatory body or reactor operating organizations, which are covered in other appendices. The structure of the self-assessment is shown in Figure C-1.

Area 1: Basis and Framework for Nuclear Safety Education and Training

Question 1: What is needed? Given the national laws, policies, regulations, strategies and plans related to education and training in nuclear safety, what academic and professional training capability is needed to provide the required human resources?

Consider:

- The role that the academic educational institutions, the professional training institutes and other independent training organizations are ready and positioned to play in the national system of education and training in nuclear safety.
- The tasks, responsibilities and funds assigned to the various organizations;
- The impact of policies, strategies and plans with respect to current and future use of nuclear power plants and research reactors;
- The impact of existing and new laws, policies, rules and regulations with respect to the regulatory body;
- The need for qualified faculty, facilities, equipment, and a suitable funding structure to support the required nuclear safety education and training programme.

Question 2: What is available and adequate to meet the needs? What is the existing framework for nuclear safety academic education and professional training, and is it adequate to meet the needs?

Consider:

- The current status of nuclear engineering and related education and training in the Member State (existence of programmes, qualified faculty, teaching and research facilities, training materials, etc.), and national policies related to maintaining and improving that status;
- The adequacy of the education and training capabilities to meet the future needs assessed under question 1, above. In particular, which parts of the education and training establishment (universities and professional training institutes) can meet the current and projected future needs; and

- Are suitable policies in place to maintain the existing capabilities?

Question 3: What is not available or needs improvement to meet the needs? What improvements in the existing framework for nuclear safety academic education and professional training are needed?

Consider:

- Deficiencies in the current status of nuclear engineering and related education in the Member State;
- Policies, practices that discourage maintaining or improving the current status; and
- Constraints, such as insufficient financial support, that lead to deficiencies.

Question 4: How can the deficiencies be remedied?

Consider ways in which the identified deficiencies can be remedied or improvements can be achieved. This part of the self-assessment will provide the review team with the opinions of the Member State's personnel performing the self-assessment on means to improve the deficiencies.

Area 2: Competencies and Training in Nuclear Safety

Question 1: What is needed?

Consider the competencies required of the faculty and trainers in the universities, professional training institutions, and other training organizations, in particular, subject matter expertise in topics related to nuclear safety in light of current and future needs of the nuclear enterprise.

Question 2: What is available and adequate to meet the needs?

Consider the competencies and interests of the current faculty and trainers, along with the research and teaching facilities related to make use of these competencies.

Question 3: What is not available or needs improvement in order to meet the needs?

Consider the gaps between the identified needs for competencies and those identified as available, in particular, needs for new or expanded faculty and trainer expertise in light of current and future needs of the nuclear enterprise.

Question 4: How can the deficiencies be remedied?

Consider means by which the identified deficiencies can be remedied, such as by recruiting additional faculty having the required expertise, providing additional training to current faculty through national or international programmes, and other means.

Area 3: Maintenance and Improvement of Competencies and Training

Question 1: What is needed?

Consider the needs for maintaining and improving the competencies of the faculty and trainers, the teaching and research facilities, and the training material in the academic and professional training institutions.

Question 2: What is available and adequate to meet the needs?

Consider the available means for maintaining and improving the competencies of faculty and trainers, and the relevant facilities and materials, such as additional training through international arrangements.

Question 3: What is not available or needs improvement in order to meet the needs?

Consider the gaps between the needs and the available means to maintain and improve the competencies of faculty and trainers, and the relevant facilities and materials.

Question 4: How can be deficiencies be remedied?

Consider the means available to maintain and improve the competencies of faculty and trainers, and the relevant facilities and materials. In particular, consider the use of external resources such as IAEA training events, or bilateral arrangements for study abroad. Consider also ways in which existing resources in the Member State can be more effectively used to maintain and improve competencies.

Consider whether the education and training system can provide a flow of people having the required competencies for current needs or for future expansion. Can it expand to provide the competencies that are not now available, or is some other approach preferred?

Page 1 **National System**

Page 5 **Nuclear Power Plants**

Page 4 **Research Reactors**

Page 3 **Regulatory Body**

Page 2 **Universities**	**What is needed ?**	**What is available and adequate ?**	**What is not available or needs improvement ?**	**How can deficiencies be remedied ?**
Area 1 **Basis and Framework**	• ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... •	• ... • .... • ... ...
Area 2 **Competencies and Training**	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ... •	• ... • ... •	• ... • ... • ... • ... • ...
Area 3 **Maintenance and Improvement**	• ... • ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ...	• ... • ... •	• ... • ... • ...

Figure C-1

Structure of a Self-assessment of Education and Training in Nuclear Safety

APPENDIX D

SELF-ASSESSMENT GUIDELINES FOR THE REGULATORY BODY AND ITS TECHNICAL SUPPORT ORGANIZATIONS

This Appendix provides guidelines for a self-assessment of the education and training in regulatory body and its technical support organizations, if applicable. It focuses on the basis and framework for education and training within the regulatory body as outlined in applicable laws, regulations, and policies, on the competencies and training required for regulatory staff members, and provisions for maintaining and improving the staff competencies. The principal Agency documents underlying this appendix are references 2 and 5. The structure of the self-assessment is shown in Figure D-1.

Area 1: Basis and Framework for Nuclear Safety Education and Training

Question 1: What is needed? Given the laws, policies, and regulations that govern regulation of the nuclear enterprise, what education and training policies and practices are needed to provide the required competencies in nuclear safety?

Consider:

- Education, training, qualification and re-qualification required by the legal and sub-legal framework.
- Short-, medium-, and long-term education, training, qualification and re-qualification policy/strategy aiming at the development of:
  - individual competencies and careers
  - institutional capabilities
  - institutional safety culture
- The approach to in-house training and co-operation with external organizations providing education and training.
- Education, training, qualification and re-qualification required of staff members of contracted technical assessment organizations and experts.
- Financial and physical resources provided for education and training.

Questions 2,3, and 4: The consideration of what is available and of adequate quality, what is not available and needs improvement, and how deficiencies can be remedied follow directly from the consideration under Question 1.

Area 2: Competencies and Training in Nuclear Safety

Question 1: What is needed? For the regulatory body and its technical support organizations, the details of the required competencies can be found in Ref. 5. For convenience, a brief summary of the required competencies, and the associated

knowledge, skills, and attitudes (KSAs) is provided below. In the self-assessment, the regulatory body should consider the extent to which the listed competencies are needed in the national situation, and what education and training is needed to provide the needed competencies.

Competencies related to legal basis and regulatory processes

This list includes competencies associated with both the legal basis and the regulatory process under which the regulatory body operates. Legal basis competencies include those related to nuclear and other relevant legislation, decrees and regulations of the central government and local jurisdictions. Regulatory process competencies comprise KSAs related to regulatory policies, procedures and other regulatory guidance documents as well as licensing documents that the staff members employ to carry out their duties.

These competencies and the associated KSAs include:

- Legal basis competency
  The ability to read, comprehend, interpret and use relevant documents that establish the legal requirements for obtaining a license, and the powers of the regulatory staff and the limits to these powers.

- Regulatory process competency
  The performance of work in accordance with rules, regulations and established regulatory protocol to achieve the relevant regulatory objectives.

- Regulatory guidance documents competency
  The capacity to produce regulations and guidance documents including policies and procedures containing practical steps on how regulatory requirements could be satisfied by the licensees and be adjudicated by the regulatory staff.

- License and licensing documents competency
  The capacity to ensure that the license and the associated licensing documents are in compliance in form and contents with the regulatory requirements. This competency is related to a concept used by some regulatory bodies known as the safety case or safety envelope, which is normally defined by a license and the associated licensing documentation.

- Enforcement process competency
  The provision of a supportable recommendation of enforcement action in accordance with regulatory body policy.

Competencies related to technical disciplines

This section addresses competencies associated with technology in various fields and areas that are needed by the regulatory body to carry out its overall responsibilities.

- Basic technology competency

Comprehension of science and engineering fundamentals in a particular field equivalent to a university degree.

Examples are:

- Nuclear engineering
- Nuclear physics
- Chemical engineering
- Material science
- Mechanical engineering
- Civil engineering
- Earth sciences
- Environmental engineering
- Computer science
- Electrical engineering.

- Applied technology competency

  Additional comprehension and demonstrated ability to apply engineering and science concepts in relation to the nuclear industry. Some typical applied technology areas for which many regulatory bodies provide technical training for regulatory body staff are listed below. Regulatory bodies commonly provide such training to generalists to broaden their competencies in specific areas. Regulatory bodies sometimes also provide such training to specialists in areas other than their specialty to broaden their perspectives of how their specialty area relates to other areas for which the regulatory body has jurisdiction.

  Examples are:

  - Reactor technology;
  - Fuel cycle technology;
  - Engineering techniques or technical issues;
  - Radiation protection as applied to nuclear facilities and to industrial uses of radioactive sources;
  - Nuclear safety technology including safety and risk analysis.

- Specialized technology competency

  Comprehension and demonstrated ability to address and resolve issues in a specialized field.

  Some typical scientific fields or specialized areas that are common to many regulatory bodies are listed below. It should be noted that this is a sample list only and that a particular regulatory body may require competencies in other science and engineering areas:

  - Instrumentation and control;
  - Criticality analysis;
  - Nuclear material control;
  - Software reliability;
  - Fire protection;

- Human performance engineering/human factors;
- Fracture mechanics;
- Corrosion chemistry;
- Thermal hydraulics;
- Health physics.

Competencies related to regulatory practices

- Safety-focused analytical techniques competency
  The objective analysis and integration of information using a safety focus to develop a supportable regulatory conclusion.
- Inspection techniques competency
  The independent gathering of information through objective review, observation, and open communications and determining acceptability of information by comparing it to established criteria.
- Auditing techniques competency
  The review of documents and/or programs for conformity to established standards and procedures and making recommendations based on the results.
- Investigation techniques competency
  The pursuit of the cause of events arising from notifications, incidents or information obtained during inspections and/or evaluations and gathering evidence in order to make regulatory decisions.

Competencies related to personal and interpersonal effectiveness.

This section addresses competencies associated with the personal and interpersonal effectiveness of regulatory body personal while carrying out regulatory activities either individually or as part of teams.

- Analytical thinking, problem solving and decision making competency
  Approaching problems objectively, gathering and integrating information, and developing a comprehensive understanding to reach conclusions
- Personnel effectiveness competency: Information technology + Planning and organization of work + Self management competencies.
  Using technology to create, gather, manipulate, communicate, and/or share information. Effective and efficient coordination of tasks to achieve a desired objective. Working independently, exercising judgment and exhibiting flexibility in the completion of activities especially during difficult or challenging situation
- Communication competency
  Engaging in effective dialogue, representation and interaction with others through committed listening, speaking, writing or delivery of presentations. Understanding the true interests of people and delivering meaningful understandable messages
- Teamwork competency

Working in collaboration with others to achieve common objectives.

- Management competency: Leadership + Negotiation + Project management competencies.
  Exemplifying by practice tolerance, objectivity, openness and fairness in dealing with colleagues and subordinates. Dealing with stakeholders to achieve a consensus view over a strategy or programme of actions to achieve safety improvements. Completing a set of complex tasks in a coordinated manner to preset time, scope and budget

Question 2, 3, and 4: The considerations of what is available and of adequate quality, what is not available and needs improvement, and how deficiencies can be remedied should be addressed after the required competencies have been identified and the education and training needed to achieve these competencies has been defined.

Area 3: Maintenance and Improvement of Competencies and Training

Consider the needs for maintaining and improving the competencies needed for the regulatory as defined in the preceding areas. Evaluate the education and training programme of the regulatory body with respect to maintaining and improving competencies using the four basic questions as a guide.

Page 2 **Universities**

Page 1 **National system**

Page 5 **Nuclear Power Plants**

Page 4 **Research Reactor**

Page 3 **Regulatory Body**	**What is needed ?**	**What is available and adequate ?**	**What is not available or needs improvement ?**	**How can deficiencies be remedied ?**
Area 1 **Basis and Framework**	• ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... •	• ... • .... • ... ...
Area 2 **Competencies and Training**	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ... •	• ... • ... •	• ... • ... • ... • ... • ...
Area 3 **Maintenance and Improvement**	• ... • ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ...	• ... • ... •	• ... • ... • ...

Figure D-1

Structure of a Self-assessment of Education and Training in Nuclear Safety

APPENDIX E

SELF-ASSESSMENT GUIDELINES FOR RESEARCH REACTOR OPERATING ORGANIZATIONS

This appendix provides guidelines for a self-assessment of the education and training programme in nuclear safety in a research reactor operating organization. If follows the format of assessment consisting of three areas:

1. The basis and framework for education and training;
2. The required competencies and the training required to provide these competencies;
3. Provisions for maintenance and improvement of the competencies within the organization.

In each area, the four fundamental questions are to be addressed:

1. What is the need?
2. What is available and of adequate quality?
3. What is not available or needs improvement? and
4. How can the needed improvements be achieved?

The principal Agency document underlying this appendix is Reference 10. The structure of the self-assessment is shown in Figure E-1.

The material provided relates primarily to fundamental question 1. Once the needs are established, the other questions can be addressed in a straightforward manner.

Area 1: Basis and Framework for Nuclear Safety Education and Training

In assessing the framework for training activities in a research reactor organization, the following elements are to be considered:

- Laws and regulations that establish initial requirements for licensing of operating personnel, as well as for requalification;
- Existence of well established internal training and re-training policies and programmes for operating personnel, users and support staff;
- Existence and structure of the internal training organization and administration;
- Existence of well defined requirements for initial training and certification;
- Existence of requirements for qualification of instructors

Address the four basic questions for these elements.

Area 2: Competencies and Training in Nuclear Safety

In assessing the competencies and training required for research reactor operating personnel, the following areas are to be considered in answering the four fundamental questions of the self-asessment.

(a) Refresher courses: Refresher courses in such areas as mathematics, physics, chemistry and basic engineering are sometimes needed to ensure that personnel entering a training programme have the prerequisite knowledge necessary to successfully complete the training programme.

(b) Reactor theory and related subjects: These subjects cover the prerequisites for the understanding of reactor theory and technology and may include:

- Fundamentals of nuclear physics
- Fundamentals of reactor theory, including fission process, neutron multiplication, source effects, control rod effects, criticality indications, reactivity coefficients and poison effects
- Reactor kinetics and dynamics
- Fundamental concepts of nuclear safety
- Radiological safety principles and procedures
- Radiation monitoring methods and survey equipment
- Principles of shielding
- Heat transfer, thermodynamics and fluid mechanics
- Materials technology.

(c) Reactor technology: This area should include all subjects necessary for the understanding of reactor design and operation and the purpose of its different systems. These subjects generally include:

- General design features of the core including core structures, fuel elements and control rods
- General design features of the reactor including:
  - Reactor instrumentation systems
  - Reactor control systems
  - Safety systems
  - Reactor cooling systems
  - Ventilation systems
  - Auxiliary systems
  - Containment/confinement design features; and
  - Experimental facilities.

(d) Facility specific systems: This area should include a detailed description of all the systems in the reactor facility and related services, their functions and modes of operation including:

- Experimental facilities
- Isotope production facilities
- Beam tube utilization
- Neutron radiography facilities.

(e) Operating principles: This area covers specific reactor characteristics and required knowledge for safe reactor operation and include:

- Facility operating characteristics during steady state and transient conditions
- Operational limits and conditions
- Core management and reactivity control
- Monitoring and control of core safety limits
- Coolant chemistry and control
- Fuel handling facilities and procedures
- Procedures for normal and abnormal operating conditions
- Emergency plans and procedures
- Handling and disposal of radioactive materials and effluents.

(f) Administrative requirements: This area covers additional administrative measures to ensure the safe management of the facility and include:

- Nuclear material accountability
- Nuclear criticality safety
- Maintenance requirements and scheduling
- Operational procedures
- Administrative procedures
- Facility access control
- Radiation protection
- Fire protection
- Security
- Staffing requirements
- Requalification requirement
- Operational records retention
- Reporting requirements.

(g) Rules and Regulations:

- Relevant national legislations
- Licenses and conditions of licenses
- Regulatory bodies and authorities
- Relevant regulatory requirements
- Relevant codes and standards.

More guidance on E&T programmes for research reactor operators is found on the draft Safety Guide entitled "*The Operating Organization and the Recruitment, Training and Qualifications of Personnel for Research Reactors*", Reference 10.

Area 3: Maintenance and Improvement of Competencies and Training

The four fundamental questions should be addressed relative to the guidelines following.

Continuing training based on a systematic approach is essential to ensure that the knowledge, skills and attitudes of research reactor personnel are maintained and for upgrading, when necessary, their level of qualification and competence to improve the career development potential of selected candidates. All personnel whose functions are important to the safe operation of the facility should participate in the programme.

A continuing training programme should be delivered over a period normally not exceeding one year and should be followed by successive continuing training programmes on a regular basis. The programme should include selected topics from the initial training related to tasks important for the safe operation of the reactor, tasks that are infrequently performed or tasks that are difficult to perform. An example of topics for a continuing training programme could include the following:

- Nuclear theory and principles of reactor operation
- Reactor design and operating characteristics
- Instrumentation and control systems
- Reactor protection systems
- Reactor experimental and auxiliary systems
- Operating procedures for normal, abnormal and emergency conditions
- Radiation protection control and safety
- Operational limits and conditions for operation
- Emergency plan, including drills and exercises
- Security plan.

In addition to the above training topics, continuing training programmes should cover knowledge and skills required as a result of:

- Changes in reactor systems and equipment
- Changes in operating and emergency procedures
- Changes in licence or in documents referred to in the licence
- Facility experience and operating events gained inhouse and elsewhere
- Weaknesses detected in the performance of a person
- Individual requests.

Re-qualification examinations should be administered periodically by the regulatory body or by the facility to ensure that operating personnel have maintained the knowledge and skills required by the position. The typical interval between successive re-qualification examinations varies between one and five years. Operating personnel who have been absent from active duties for several consecutive months should be required to successfully complete appropriate re-qualification examination before reassuming the duties of the position.

When an individual is being considered for advancement from reactor operator to senior reactor operator, consideration should be given to his experience, leadership and communication skills. He should also receive the training required to develop the knowledge and skills he needs to possess to competently perform the duties of the new position. The additional training courses should include the following subjects:

- Facility operating limitations and their bases
- Conditions and limitations in the facility license imposed by regulations
- Alterations in core configuration
- Emergency plan
- Emergency procedures
- Management training.

When an individual is being considered for advancement from senior reactor operator to shift supervisor, he should receive the training mentioned above. In addition this individual should be trained in handling abnormal occurrences and in management and communication skills.

Page 3 **Regulatory Body**

Page 2 **Universities**

Page 1 **National System**

Page 5 **Nuclear Power Plant**

Page 4 **Research Reactors**	**What is needed ?**	**What is available and adequate ?**	**What is not available or needs improvement ?**	**How can deficiencies be remedied ?**
Area 1 **Basis and Framework**	• ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... •	• ... • .... • ... ...
Area 2 **Competencies and Training**	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ... •	• ... • ... •	• ... • ... • ... • ... • ...
Area 3 **Maintenance and Improvement**	• ... • ... • ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ...	• ... • ... •	• ... • ... • ...

Figure E-1

Structure of a Self-assessment of Education and Training in Nuclear Safety

APPENDIX F

SELF-ASSESSMENT GUIDELINES FOR NUCLEAR POWER PLANT OPERATING ORGANIZATIONS

This appendix provides guidelines for a self-assessment of the education and training programme in nuclear safety for an organization operating one or more nuclear power plants. It follows the format of assessment consisting of three areas:

1. The basis and framework for education and training;
2. The required competencies and the training required to provide those competencies; and
3. Provisions for maintenance and improvement of the competences within the organization.

In each area, the four fundamental questions are to be addressed:

1. What is needed;
2. What is available and of adequate quality;
3. What is not available or needs improvement;
4. How can the needed improvements be achieved?

The content of this appendix is primarily taken from Reference 4. The guidelines are not to be confused with the OSART guidelines (TECDOC-744) because an OSART mission goes in to deep details that are not the focus of the Education and Training Review Service. The content is primarily a listing of topics to be considered in a self-assessment of fundamental question 1. The other questions can be addressed in turn in a straight forward manner once the needs are identified. The structure of the self-assessment is shown in Figure F-1.

Area 1: Basis and Framework for Nuclear Safety Education and Training

What basis and framework for training related to nuclear safety of nuclear power plant is needed and what already exist?

- The operating organization:
  - is responsible for training its own staff and ensuring that contractors' staff are suitably trained and experienced so that all work is carried out safely.
  - is required to make sure that all personnel who are assigned to duties that can affect safety have a sufficient understanding of the plant and its safety features and sufficient competence, in areas such as management and supervisory skills, to ensure safe operation of the plant.

- needs to ensure that staff competence is sustained by regular training and review,
- needs to develop programmes used to ensure the continuous availability of competent staff to meet the needs of the organization, with account taken of retirements and promotions.
- should formulate an overall training policy. This policy is the commitment by the operating organization and plant management to the training of personnel and an acknowledgement of the critical role that training plays in the safe, reliable operation and maintenance of the plant.

- The training policy:
  - should be known, understood and supported by all persons concerned. Plant department managers and the plant training manager should be involved in developing the training policy and implementing procedures, as a way of facilitating their acceptance of the policy.
  - should be taught to the personnel in the on-site training unit. The personnel should also be properly trained in matters concerning the policies of the operating organization, in particular safety management and safety culture, regulatory requirements and quality assurance. Training provided by external organizations should be evaluated to ensure that it meets the needs at the plant and that its quality is consistent with the standards of the on-site training unit.

- The training programmes:
  - should include an orientation for all new employees starting work at a plant. The programme should introduce the worker to the organization and their working environment in a systematic and consistent manner. General personnel training programmes should give new employees a basic understanding of their responsibilities and of safe work practices, the importance of quality programmes and of following procedures, and the practical means of protecting themselves from the hazards associated with their work.
  - should include, for most positions at a nuclear power plant, on-the-job training, to ensure that trainees obtain the necessary job related knowledge and skills in their actual working environment.
  - should include training in new technologies which are introduced to improve practices and results in operation and maintenance. Suitable staff should be trained in root cause analysis and the assessment of human factors.
  - should stress the need for an understanding of safety issues, should include consideration of the possible consequences for safety of errors and should deal specifically with ways in which such errors may be avoided, or corrected if committed.
  - should provide for managers and technical specialists, control room operators and senior technicians a thorough understanding of the basic principles of

nuclear technology, nuclear safety and radiation protection, of the design intents and assumptions, and of the theoretical basis for plant activities, together with the necessary on the job training.

- should have for other operators and technicians and for craftspersons a more practical orientation, with explanations of the theoretical and safety related aspects.

Area 2: Competencies and Training in Nuclear Safety

What competencies related to NPPs are needed and what training is needed to provide these competencies?

- Managers and supervisory personnels should have competencies that include:
  - the concept of safety culture, including making successful presentations of safety related messages to subordinates.
  - mastery of their particular technical skills through long experience and basic training in the nuclear field.
  - a thorough understanding of all the relevant standards, rules and regulations.
  - a good overall knowledge of the plant and its systems.
  - specific training for their emergency duties if individuals are in positions of responsibility for emergency preparedness and response.
- Senior operations and management staff should have competencies that include:
  - the special problems of managing a nuclear power plant with its exceptional demand for safety and the need for familiarity with emergency procedures.
  - gaining the benefits of feedback of operational experience and root cause analysis of events that are generic or that occur at the plant.
- All operators should be competent in:
  - relevant areas of technology to the levels necessary for the tasks to be performed.
  - the theoretical and practical knowledge of plant systems and their functions, layout and operation.
  - routines for normal operation of the plant and in the response of the plant to changes that could cause accidents if not counteracted.
  - diagnostic skills, operating procedures for normal operation and for anticipated operational occurrences and, as far as practicable, severe accident conditions. These competencies should be practiced at the simulator, so that operators can recognize the negative consequences of errors or of violations of procedures.
- Control room operators should be competent in:

- plant diagnostics, control actions, administrative tasks and human factors such as attitudes and human–machine and human–human (teamwork) interfaces.

- Shift supervisors should be competent in:
  - supervisory techniques and communication skills, and should have, in general, more broadly based skills than those of other operators.
- Field operators should have competencies:
  - commensurate with their duties and responsibilities, have detailed knowledge of the operational features of the plant and hands-on experience, and have knowledge covering both the control rooms and the plant as a whole.
- Maintenance personnel should have competences in:
  - the potential consequences for safety of technical or procedural errors.
  - review of experience of faults and hazards caused by errors in maintenance procedures and practices at the plant, or at other plants and in other industries.
  - the plant layout and the general features and purposes of plant systems as well as quality assurance and quality control, maintenance procedures and practices including surveillance and inspection, and special maintenance skills.
  - safety culture in all aspects of their work.
  - operator of the equipment on which they are assigned to work and a control should be established. They should be qualified based on training given by the component manufacturer, training on equipment mock-ups or on-the-job training under the supervision of experienced staff.
- Personnel involved in chemistry, radiation protection, nuclear engineering or other technical functions should have competencies:
  - as appropriate to their jobs and responsibilities.
- Craftspersons should:
  - undergo general employee training (GET) and overall plant training.
  - be trained especially to impart and develop the basic and specific skills required for work on the installed equipment.
- Training instructors, on and off the site, should:
  - have the appropriate knowledge, skills and attitudes in their assigned areas of responsibility.
  - thoroughly understand all aspects of the contents of the training programmes and the relationship between these contents and overall plant operation.
  - be technically competent and show credibility with the trainees and other plant personnel.

- ideally have an academic background in an education related subject, in addition to a degree in an appropriate discipline in their area(s) of responsibility.

- All staff of the training unit, as well as simulator and technical support engineers, technicians and instructors, should have competencies:
  - commensurate with their duties and responsibilities. In all cases the training should be subject to some form of quality control.

Area 3: Maintenance and Improvement of Competencies and Training

Are required competencies related to nuclear safety of NPP continuously maintained and improved?

- The organization's internal training system should be reviewed. The review should cover all stages of the training system, the analysis of training needs, and the design, development and implementation of the training programmes. Training records should also be reviewed. Such a review should be undertaken by persons other than those directly responsible for the training. Plant managers should be directly involved in the evaluation of training programmes. Close co-operation should be maintained in the training evaluation process between the plant management, individual departments and the training unit.

- The training plan should:
  - be periodically reviewed and modified as necessary. The review should cover the adequacy and effectiveness of the training with respect to the actual performance of employees in their jobs. The review should also examine training needs, training programmes, training facilities and the training materials necessary to deal with changes to regulations, modifications to the facility and lessons learned from experience in the industry.
  - be independently reviewed by external an organization. This external review should be considered complementary to the internal evaluation in giving a different perspective to the evaluation of training programmes. The results of the external review should be integrated with the results of the internal evaluation, to identify necessary changes and improvements in the training programmes.

- Instructors should have the time necessary to maintain their technical and instructional competence, by secondment or attachment to an operating plant on a regular basis, and by continuing training.

- The training programmes should :
  - be reviewed and modified taking into account the operating experience. Examples of sources of information on the effectiveness of training programmes and on factors influencing training needs are, for example, new plant equipment, new or revised procedures, new regulatory requirements, feedback from employees, supervisors, trainees, instructors, programme evaluations, etc.

- An action plan should be developed and implemented on the basis of the results of evaluations, to improve and correct the training programmes. This may lead to improvements in the conduct of training or to changes in the training programmes.
- The career development of managerial staff should:
  - include involvement with external groups, networks and bodies at the national and international level, with a view to increased co-operation for the mutual benefit of participants.
  - reflect the individual's attitude towards safety.

Page 4 **Research Reactors**

Page 3 **Regulatory Body**

Page 2 **Universities**

Page 1 **National System**

Page 5 **Nuclear Power Plant**	**What is needed ?**	**What is available and adequate ?**	**What is not available or needs improvement ?**	**How can deficiencies be remedied ?**
Area 1 **Basis and Framework**	• ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... •	• ... • .... • ... ...
Area 2 **Competencies and Training**	• ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ... • ... • ... •	• ... • ... •	• ... • ... • ... • ... • ...
Area 3 **Maintenance and Improvement**	• ... • ... • ... • ... • ... • ... • ... • ... • ...	• ... • ... • ... • ... • ...	• ... • ... •	• ... • ... • ...

Figure F-1

Structure of a Self-assessment of Education and Training in Nuclear Safety

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