STRENGTHENING FRAMEWORKS
EDUCATION & TRAINING IN NUCLEAR SAFETY

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Uncertainties about the future of nuclear power in many countries, the ageing of the workforce, and fewer new professionals entering the nuclear field have become matters of international concern. The situation is compounded by the reduction of higher education opportunities in the field of nuclear engineering, with the closing of nuclear engineering departments and research reactors in many universities, and of nuclear research facilities worldwide.

In 2000, the IAEA General Conference adopted a resolution (GC/44/13) on Education and Training in Radiation Protection, Nuclear Safety and Waste Management. It urged the Agency's Secretariat to "strengthen, within available financial resources, its current efforts".

In response, the IAEA started a systematic review of its education and training activities. A major objective has been assisting Member States to put into place sustainable programmes of education and training in nuclear safety, with a view to promoting safety and the application of IAEA safety standards.

TRAINING OPPORTUNITIES

Each year, over 60 IAEA training courses and workshops are organized in the field of nuclear safety. The main topics have been the safety of design and operation of nuclear power plants and research reactors, safety assessment methods and tools, and regulatory control.

Most commonly, training activities are implemented in the framework of technical cooperation projects and Extrabudgetary Nuclear Safety Programmes. In recent years, new training courses and distance learning modules have been introduced in the IAEA's safety training programme. The IAEA also has participated in an international task force organized by the Nuclear Energy Agency (NEA) of the Organization for Economic Cooperation and Development on nuclear education and training. *(See article, page 2.)*

Introduced in 1999 was a Basic Professional Training Course on Nuclear Safety. It was held for the first time in 1999 in Saclay, France, in cooperation with national authorities. A standard syllabus containing 22 modules was developed and a textbook of some 700 pages was drafted for the nine-week course. The course was attended by nuclear power plant operators, regulators and professionals from technical support organizations mostly from countries in Europe.

An evaluation of the course indicated that the knowledge acquired had an important impact on the technical competence and quality of work of participating professionals. In 2000, the course was offered in Spanish, in Brazil to Latin American countries and, in English, as a national training course in Romania, with six and four weeks duration, respectively. In 2001, the course was offered in Saclay, France, and at the Argonne Laboratory in the USA.

More specialized training includes a two-week course on regulatory control of nuclear power plants. It has been organized several times since 1994 in Europe and in Asia. A textbook of some 300 pages has been drafted for the course.

Two other specialized two-week courses are offered in the areas of safety assessment of nuclear power plants and operational safety. One course focuses on safety assessment and was given for the first time in June 2000 in Helsinki in cooperation with the IAEA and Finnish organizations. The course presents a broad overview of safety assessment, including the use of deterministic and probabilistic safety analysis. The second course covers operational safety including safety management, and was offered in 2000 in Karlsruhe, Germany in the

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form of a workshop. Work has started to prepare textbooks for both courses.

STRENGTHENING FRAMEWORKS

As the IAEA and its Member States examine ways to strengthen activities related to nuclear education and training, an improved framework is emerging. *(See box.)* It considers the wide experience gained by the IAEA to date; the needs of Member States; and the IAEA safety standards and trends in nuclear safety.

At the level of basic knowledge, training is intended to provide a broad overview of nuclear safety concepts and their application to nuclear power plants and research reactor 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 highly specialized professionals who lack a broader view of nuclear safety.

Recent experience indicates the need, in some cases, to provide academic education in fundamentals of nuclear engineering, including topics such as reactor physics and thermal hydraulics. This knowledge 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.

At the level of specialized knowledge, standard training courses are offered on regulatory control, safety assessment, and operational safety of nuclear power plants and research reactors. Target groups are technical staff of the regulatory bodies, technical support organizations, nuclear plant operators, research reactor operators and users, scientific personnel from research institutes, and educators. Training courses and workshops also will be offered by the IAEA in the area of fuel cycle installations after the relevant safety standards have been developed.

The framework further includes opportunities for practical on-the-job training. These are awarded by the IAEA in the form of fellowships, scientific visits, and participation in Agency safety review missions as observers.

An effective form of training is being delivered in connection with IAEA safety services. This approach has also been used in the areas of safety management and safety culture. Such training is of immediate benefit to activities related to safety self-assessments of nuclear power plants.

Training Materials. The implementation of the proposed programme requires a concerted effort from the IAEA and support from Member States.

For each training event, standard training material will be needed. Examples are the textbooks already drafted for the Basic Professional Training Course in Nuclear Safety and for Regulatory Control. Similar books need to be developed for other courses in the category of specialized training.

Needed to complement the textbooks and other relevant IAEA publications are standard sets of viewgraphs, preferably in the language of instruction, on IAEA nuclear safety standards and practices, for use by lecturers.

Training Schedules. Since the 1970s, Member States have consistently supported IAEA training activities in the area of nuclear safety. Nuclear Research Centers in several countries have periodically hosted IAEA training events. Such training centers will be requested to play a greater role in the future implementation of the proposed training programmes. This includes the provision of facilities, national lecturers, and support for preparation of standardized textbooks and lecture notes.

Distance Learning. Distance learning media cover a range of technologies, including correspondence courses, videotapes, video teleconferencing and Internet classes.

A typical distance learning package consists of a modular set of course notes, study guides and associated exercises based on specific topics from a syllabus. Participants complete the package in their place of work or at home. The training includes the completion of assessment tasks, which are then forwarded to a supervisor or tutor for marking and feedback. The role of the supervisor is important to the success of distance learning and frequent interactions between the participants and the supervisor may be necessary.

This method of training is an effective use of resources and permits the participants to study at their own pace. However, the success of the training depends on the self-motivation of the student to complete the work with minimum direct supervision.

FRAMEWORK FOR EDUCATION & TRAINING IN NUCLEAR SAFETY

LEVEL OF BASIC KNOWLEDGE

Basic Professional Training Course on Nuclear Safety

LEVEL OF SPECIALIZED KNOWLEDGE

Regulatory Control of Nuclear Power Plants	Safety Assessment of Nuclear Power Plants	Operational Safety of Nuclear Power Plants	Safety of Research Reactors

LEVEL OF SPECIFIC EXPERT KNOWLEDGE

-Regulatory Framework -Organization of the Regulatory Body -Authorization Process - Inspection and Enforcement - Regulatory Effectiveness	-Accident analysis methods -Probabilistic safety assessment -Accident management -Ageing management - Safety assessment of plant modifications	-Safety culture and management of safety -Interface between nuclear plant operator and regulator -Operational experiences and feedback -Operational practices	-Regulatory aspects and safety documentation -Safety analysis -Safety in operation and utilization - Management of ageing - Safe shutdown and decommissioning

PRACTICAL EXPERIENCE

Scientific visits, fellowships, observers in IAEA safety review missions

With the increased availability of personal computers around the world, many workers now have access to a computer in the workplace. This has stimulated the development of computer-based training packages consisting of interactive training modules with question and answer sections.

Under contract to the IAEA, the University of Illinois, USA, prepared a set of CD-ROMs with pre-recorded lectures in reactor physics and thermal hydraulics. The material is being used for self-study by a group of some 18 professionals from Asian countries who are participating in a series of training workshops on safety and accident analysis in 2001-2002. For this Internet instruction, a "Web Board" was created to facilitate the interaction of the students and lecturers, and for submission of the assigned homework. The training is in the framework of the extrabudgetary programme on the Safety of Nuclear Installations in South East Asia, Pacific and Far East Countries.

Modules for self-study in reactor physics and thermal hydraulics also have been developed. They are being tested for use via the Internet (via the IAEA's *NUSAFE* Web pages at http://www.iaea.org/ns) and distribution on CD-ROMs. A tutorial on fundamental safety principles also is available on the *NUSAFE* site.

FUTURE STEPS & DIRECTIONS

In late March 2001, the IAEA convened an Advisory Group on education and training in nuclear safety to enlist the views of experts from its Member States. The meeting's objective was review the Agency's programme and make suggestions for improvements in key areas. These included the scope and structure of activities; textbooks and other training materials; use of distance learning tools; the national and regional preparation of courses; and steps to foster the sustainability of education and training at the national level in Member States. Results will be submitted to the IAEA General Conference in September 2001.

Additionally, the International Nuclear Safety Advisory Group (INSAG) -- a body of senior officials from IAEA Member States which advising the Agency's Director General on matters of nuclear safety -- is preparing to issue a statement that emphasizes the importance of maintaining knowledge, training, and the research and development infrastructure. In highlighting the need for and benefits of nuclear education, research and development, the statement reinforces their essential roles in helping to ensure nuclear safety in Member States.

As the IAEA and its Member States move forward with plans to strengthen nuclear education and training activities, the benefits can be far-reaching. At the forefront are the enhancement of national capabilities and technical expertise in key areas of nuclear safety, and greater support for educating the next generation of nuclear engineers and safety professionals. ❐