Non-destructive testing training in Latin America and the Caribbean

Advanced inspection techniques and applications are introduced in a growing regional project

by C.K. Beswick and J.H. Zirnhelt

Effective non-destructive testing (NDT) is required to assure the safety of nuclear power plants while under construction and during service, former IAEA Director General S. Eklund noted in his keynote address to the International Conference on Non-destructive Evaluation in the Nuclear Industry, held in Salt Lake City in February 1978. Recognizing the critical importance of interpretation of test results to the success of any testing scheme, he pointed to the need for educational programmes in all countries embarking on nuclear power projects. Developing countries, in particular, he said, should be provided with clear recommendations on inspection methods and their applications.*

In the Latin America and Caribbean region, the IAEA's regional NDT project is addressing these concerns through training activities for more than 16 000 participants. As the availability of trained and experienced NDT personnel increases within the region, more advanced inspection techniques and applications are being introduced.

The result has been the development of a large cadre of competent technical personnel working within a regional network that reinforces national structures and contributes to national and regional self-sufficiency. The benefit has extended beyond the specific needs of the nuclear power industry; the contribution of NDT methods in the assurance of quality and in cost-effective maintenance inspection is a key factor in industrial development. The NDT project also has helped bridge the gap between research laboratories and industrial plants as scientists and technicians work together to apply state-of-the-art technology to real problems.

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* Eklund, S., "Confidence in Nuclear Safety and Non-Proliferation of Nuclear Weapons: A Prerequisite for Further Development of Nuclear Power", *Non-destructive Evaluation in the Nuclear Industry*, R. Natesh, ed., American Society for Metals, Metals Park, Ohio, 1978, 1-13.

The technology

In the nuclear industry, operational safety and reliability are of particular importance. The industry's concern with quality assurance and inspection significantly has influenced the awareness and development of test methods benefiting virtually every industry which relies on the fabrication process.

In the last 40 years, inspection methods collectively known as NDT have gone from being a handful of primitive techniques used in a small number of industries practiced by artists who only reluctantly shared their limited knowledge with their closest colleagues, to a widely known discipline that is an essential part of every industrial tool box.

NDT methods by their very nature allow components to be fully examined for properties or flaws without interfering with their usefulness or marketability. They have thus become indispensable in the quality control of industrial products and engineered structures during procurement, construction, and service.

Because of their widespread use to support quality assurance, economical production, and public safety, these methods form a critical part of every industrial infrastructure. In developing countries, effective use of NDT is particularly important to ensure the proper performance of products which may not easily be replaced and to verify the safe construction of large capital projects.

Project organization

From the start, the IAEA's regional NDT project has been steered towards its objectives by a co-ordinating committee composed of representatives of each of the participating countries. As executing agency for the project, IAEA maintains a co-ordination office with a project manager, a deputy, and two support staff. The Government of Argentina provides physical facilities and infrastructure support.

When a country joins the project, it appoints a national co-ordinator who becomes a member of the project's co-ordinating committee. National co-ordinators meet annually to review progress and to set out the work plan for the following year. The committee recognized the magnitude of the challenge before it in 1982; the members were aware that the project's success would rest heavily on the early decisions they were to make.

The project was intended to provide training to large numbers of personnel, while adapting its programmes to the needs of countries with diverse interests and levels of development. Variables included differences in national educational systems, industrial bases, exposure to advanced technology through major foreign investments, political structures, and recognized requirements.

While many of the governments designated the organizations which maintained contact with IAEA as their counterparts, and thus many of the national co-ordinators were nominated from their respective nuclear agencies, others chose universities, NDT societies, or national standards organizations to represent them. Several countries joined the project which were not members of IAEA, but were developing countries within the region.

It was also recognized that this training had to be carried out in a way that would be ultimately measurable and credible in the eyes of the industrialized world. National schemes of qualification and certification harmonized within the region would provide this target.

The multiple objectives of the project were addressed in the early meetings of the co-ordinating committee. The immediate objective was to provide training; however, the ultimate objective was national and regional self-sufficiency — the project must leave behind a structure that would provide for continuation of this self-sufficiency beyond the project's completion.

Since there were several international models for structuring qualification schemes, based on three levels of competence in each of five basic NDT methods, the national co-ordinators agreed on a bottom-up approach; training entry level personnel first, then providing supplementary training as the individuals gained experience. Train-the-trainers courses were offered to supplement technical training, recognizing that the broad industrial base and practical orientation meant that many trainers would have to come from the ranks of working technicians and not from universities or technical institutes.

Existing resources in the region were used as a base and were supplemented by experts from industrialized countries from outside the region. A regional working group for training and certification, made up of one representative from each country, selected by the IAEA from the technical specialists within the country, was convened and tasked with the development of course syllabi, equipment lists, and general technical documentation to support the project's activities.

In each country, the national co-ordinator organized a national co-ordinating committee to assist in implementing the project's objectives; steps were taken to ensure that these national committees included representation from all interested industrial sectors. National working groups were also established, assisting the regional working group member with accepted tasks to work on between meetings, and to provide technical advice to the national co-ordinating committee.

Resources

The project was primarily built on resources already available within the region and a high degree of horizontal co-operation. IAEA funded the project co-ordination

History of the project

In 1969, the Government of Argentina requested the assistance of the United Nations Development Programme (UNDP) in the establishment of a National Centre for Non-Destructive Testing and Quality Control Methods (INEND) to support the country's rapid change from an agriculture-based economy to an industry-based economy; in particular, to support its budding nuclear industry. UNDP and IAEA joined forces to conduct a survey mission in 1971, and in 1972, a project for the development of the centre was implemented. Through this project, some 15 international NDT experts visited Argentina, and 19 Argentine specialists studied in 10 other countries.

In addition to providing inspection services to the National Atomic Energy Commission (CNEA) and industry in general, INEND acted as a catalyst for the development of national standards related to NDT, including one for the qualification and certification of NDT personnel. INEND also began to offer training courses, and by 1979, had trained some 1300 individuals in NDT techniques.*

In this same period, the Organization of American States (OAS) had been sponsoring fellowships at CNEA through its Multinational Metallurgy Programme with the NDT portion being provided by INEND. Fellows from throughout Latin America returned to their home countries with an exposure to NDT and began to ask various UN agencies for assistance in developing their own NDT programmes.

In 1982, following 2 years of evaluating the need for a regional project, the IAEA, the United Nations Financing System for Science and Technology for Development (UNFSSTD), and the United Nations Industrial Development Organization (UNIDO), joined forces and six countries started the Regional Non-destructive Testing Project for Latin America and the Caribbean. By 1985, an additional 11 countries had joined, and in early 1988, Costa Rica became the eighteenth country to participate.

* Baez, J.N., H. Espejo, and A Leston, *Nuclear Power Experience*, Vol. 1, IAEA, Vienna (1983).

office and contributed the travel component in support of the intraregional activity. UNIDO provided funds which were used to cover the costs of regional courses with experts from outside the region, and provided several associate experts to work with the project office in the development of a computerized administration system.

The project has been supported by several donor countries. The Government of Italy (initially through UNFSSTD) has provided nearly 45% of the total project funding, contributing equipment, fellowships, experts, and travel funds for regional activities. In the early stages, these activities were usually model training courses in one of the basic NDT methods, but eventually the focus has been upon the application of NDT technology. Italy has also supported the meetings of the national co-ordinators and an international workshop to review the project's directions and achievements.

The Government of Canada contributed substantial funding through the Canadian International Development Agency (CIDA) and a non-governmental organization, the Canadian Society for Non-destructive Testing Foundation. This funding was particularly directed to train-the-trainers courses — model courses in the basic methods, equipment, and publications.

The Government of the Federal Republic of Germany provided funds to support the regional working group, fellowships, and experts, equipment, and travel funds for regional events generally directed to advanced and high-technology applications of NDT.

In addition to formal contributions, the project has had the benefit of a number of cost-free experts provided by private sector or non-governmental organizations in industrialized countries.

Project activities

The day-to-day functions of the project co-ordination office make extensive use of a computer system installed at the beginning of the project. This system was initially developed to maintain the comprehensive records generated by training activities for a large number of individuals from different countries and organizations.

Once the programme for the year is established by the co-ordinating committee, the project office co-ordinates arrangements for the experts, course materials, travel details for participants in a regional course, and negotiates schedules with the host countries. These arrangements must accommodate last minute changes in date, venue, or expert availability.

In addition to tracking arrangements for national and regional events scheduled for the future, the office conducts follow-up activities after the event with experts and hosts to obtain course results, and to prepare the necessary reports and statistics. Keeping abreast of the activities, the countries, and the participants has only been possible through the computerized management system.

Qualification and certification

The national co-ordinators decided at an early stage to develop a regional NDT operator qualification and certification scheme closely based on the existing scheme in Argentina. However, monitoring of developments on the international scene led them to agree to adopt a system being developed by Subcommittee 7 (''Personnel Qualification'') of the International Organization for Standardization (ISO) Technical Committee 135 (''Non-destructive Testing''). Since 1983, this group has been working to develop an international standard covering the same subject as that proposed by the project.

In early 1985, an IAEA-sponsored consultants meeting recommended that ISO work be monitored as well as strongly supported. As a result, the Agency sought ''liaison'' status on the subcommittee, and the project began to participate in its activities. History has shown this participation to be substantial and effective; successive drafts of the proposed standard have been critically reviewed by the regional working group, and IAEA's input has been recognized and appreciated.

A specific contribution was the inclusion, by reference, in the proposed standard of IAEA-TECDOC-407 *Training guidelines in non-destructive testing techniques*, a collection of course syllabi for the three levels of the five basic methods, prepared by the regional working group and used for all training activities in the region.

Project results

While the outcome of a project of this nature is intangible, there are nonetheless specific results which can gauge its impact. While the immediate task was to provide pertinent training, it was anticipated that the goal of regional self-sufficiency could only be sustained by the development of a regional network linking individual national networks in regular contact with international organizations.

The basic structure of the project contributed to the establishment of networks. National co-ordinating committees and working groups were set up, and many of these are now taking the legal format of national technical societies with universal representation. Eight countries report that they have established NDT societies which will eventually take over the role of liaison with the project. At the international level, these societies are being encouraged to join the world federation, the International Committee for Non-destructive Testing.

In the region, well-established networking at the political level through the co-ordination committee, and at the technical level through the regional working group, is constantly reinforced through individuals with special expertise from one country lecturing in national courses in other countries. The resulting contacts and

working relationships, formal and informal, provide a strong base for future interchange and co-operation.

International experts, usually from the donor countries, also contribute more than the specific course or seminar content. They offer participants a window into related technological development in another country, and the organizational and personal contact to pursue technical questions.

Countries have been encouraged to work through their respective national organizations to develop national standards for the qualification and certification of NDT personnel and to participate in the work of ISO. Through this activity, as well, valuable contacts are made within the country and internationally.

Regular contacts provided by these regional and national activities and biannual technical congresses, coupled with the formal structures developed for local administration of the project, have resulted in a strong interpersonal network that will provide the impetus to ensure the continuation of the activity funded by the project.

The model training courses, supplemented by the train-the-trainers courses, have given all but a few of the participating countries full capability to instruct their own courses at all levels in the basic NDT methods. Almost all of the participating countries have been able to provide experts to other countries on at least one method or application of NDT — a further indication of the degree to which native capabilities have been identified, nurtured, and developed.

The dual goals of national and regional self-sufficiency are well within reach, and the national co-ordinators are increasingly looking to the donor countries for application-specific instruction and for advanced testing technology.

In 1986, the Government of Italy provided each participating country with a personal computer and software related to NDT. Following a course in Mexico, each candidate went home to apply the material learned for training, simulation, and data analysis. This activity has been followed by seminars on the use of computers in NDT; thus, a great deal of the development work is coming from countries in the region.

The computers are now being linked to a communications system that will provide the physical network necessary to support the existing intellectual network.

The project aimed to provide each country with a basic set of equipment needed to conduct training courses. Countries were asked to list their needs in order of priority taking into consideration equipment already available from internal resources. A study tour in Italy was a valuable contribution which brought one person from each country to the factory of the manufacturer of each piece of equipment provided. Participants were able to strengthen their capacity for on-site maintenance, calibration, diagnosis, and repair; and to establish personal relationships between suppliers and users.

In less than 5 years, the project has carried out 180 training events involving 186 expert missions from within and outside the region. Some 969 individuals have been trained in regional courses or seminars; 2821 in national courses or seminars with experts provided by the project; and 12 600 more in national activities held without direct assistance but within the framework of the project and using the project's guidelines.

International impact

The surge of activity in NDT within the Latin America and Caribbean region has attracted the attention and respect of the industrialized world. The region's impact on and contribution to the work of the ISO subcommittee is well appreciated. Within the region itself, every country can quote specific benefits, savings, and increased capabilities directly due to its participation in the regional NDT project for Latin America and the Caribbean.

The national co-ordinators who decided in the early years of the project to establish the regional working group and to begin the training process from the bottom up took the right steps. Regional and national self-sufficiency are well within grasp, and the region is already contributing to international technical development.

The base is well-established for the quality assurance and in-service inspection programmes critical to the credibility of nuclear power programmes; the region's industrial development in general is being given a good push forward.