INDUSTRY'S INDISPENSABLE TOOLS

TRAINING & CERTIFICATION FOR NON-DESTRUCTIVE TESTING

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Education of specialists engaged in non-destructive inspection -- including formal training, and certification -- is probably the greatest single factor affecting the quality of inspection. The objective of most non-destructive testing (NDT) methods is to detect internal defects with respect to their nature, size and location. This is a detailed process, subject to many variable factors, and demands specialized skills, training, and certification.

The factor common to all NDT methods is the operator, the person responsible for executing the tests and reporting the results. It is through the operator that the results of NDT tests are compiled for further consideration and decision about the fate of the tested part. In many cases, the operator holds the responsibility for passing judgement on the acceptance or rejection of the part. If the operator is not properly knowledgeable, trained and experienced, he or she might totally misjudge the results, with adverse and often costly consequences.

NDT based on radiography uses radiation sources. If a radiographer is ignorant or careless about the potential hazards, people unnecessarily can be placed at risk. It is therefore essential to properly train radiographers and ensure that they are officially certified to prevent malpractice or negligence regarding the safe use of radiation sources.

With the advent of new space-age materials and complex systems, engineers will be able to pursue structures and systems that require lower weight, greater strength, higher performance, less maintenance, and greater reliability to meet commercial and social challenges of the future. Each step of this development requires quality-control of NDT procedures and applications.

In recent years, more and more industry officials are becoming concerned about the education and training of NDT specialists. One concern is that NDT is not taught routinely to undergraduate science and engineering students. Another is the academic absence of the underlying NDT philosophy, which must become a part of a new engineering curriculum. That philosophy is centered on quality control and assurance -- essential components of any successful manufacturing, fabrication, or production process. Industry's emphasis on quality control and assurance is fueled by greater international competition in the marketplace and stricter consumer protection and product liability legislation.

Steps have been taken, and others are planned, within the NDT and international communities to address these concerns. This article reviews developments from the perspectives of both developed and developing countries, and describes efforts toward the international harmonization of training and certification practices.

TRENDS & DEVELOPMENTS

In the developed countries, NDT is extensively practiced, and there is a sound network of training officers and institutions. In most of these countries, NDT is taught in many universities, mainly as part of other disciplines within the educational curriculum, such as physics, electrical engineering, welding engineering, mechanical engineering, materials science, and quality control. NDT also is part of the programmes of colleges and vocational training schools. There are some institutions in the United States and United Kingdom that have exclusive degree programmes in NDT.

The training of NDT operators -- the specialists who actually do the job -- demands specialized training. This is

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usually done either by private NDT schools or institutions run by or in collaboration with professional NDT societies. These bodies have well qualified and experienced NDT trainers and a good collection of NDT test pieces with known defects. Their clear objective is to prepare the personnel for certification examinations which are separately organized.

The certification of NDT personnel is mostly done by professional societies in various countries or by regulatory or technical bodies. Different certification approaches, some of which involve employers of NDT personnel, are followed and applied in countries. The United States and Germany, for example, follow different approaches. Another approach, applied in the United Kingdom, has been adopted in Australia, New Zealand, South Africa, and a number of other countries.

A common element is that each country has a national standard on NDT training and certification that lays down the education and experience requirements of candidates for certification exams. These standards also contain the procedure for conducting the exams and the responsibilities of examiners and others involved.

Currently, a popular NDT training and certification approach is to use a centrally controlled, non-profit third party. Standards set by the International Standardization Organization (ISO) -- specifically the ISO 9712 standard -- basically promote this type of approach. In general, the personnel who actually perform the inspection are trained to the national equivalent of ISO 9712 Level 2 in the particular method being used. Supervisory personnel have skills equivalent to ISO 9712 Level 3.

IAEA-SUPPORTED INITIATIVES

In developing countries and regions of the world, great strides have been made for NDT training and certification over the past decades.

Cooperative efforts date back to the late 1960s, and include:

■ Latin America & Caribbean Project. From 1967-74, the Organization of American States (OAS) sponsored fellowships, and NDT formed a part of its courses. Students from throughout Latin America were thus exposed to the technology and application of NDT. After they returned to their own countries, they initiated requests to UN agencies including the IAEA for assistance in NDT.

The IAEA spent two years evaluating the need for a regional project. In 1982 -- with the support of the IAEA and the United Nations Development Programme (UNDP), United Nations Financing System for Science and Technology for Development (UNFSSTD), and United Nations Industrial Development Organization (UNIDO) -- six countries started the Regional Non-Destructive Testing Project for Latin America and the Caribbean. By 1985, an additional eleven countries had joined, and three countries, Italy, Canada, and Germany, had become active donors of equipment, expertise and funds.

While the sponsoring agencies and donor countries were contributing expertise, funds, and equipment, they all recognized the need for a yardstick to measure the adequacy of the training, and the need to harmonize training throughout the region. A Regional Working Group was formed to examine the issues of regional guidelines for training and qualification, developing a draft regional standard for qualification and certification of personnel based on the existing Argentine standard, and a set of training guidelines for three levels in each of the five basic training methods.

For its part, the IAEA convened a meeting of international experts in Vancouver in 1984 to consider harmonization issues. Following the meeting's recommendations, the IAEA decided to support the work of ISO/TC135/SC7 and to recommend its draft for use in all IAEA projects, closely monitoring developments and keeping open the option of developing its own document if progress appeared to be too slow. The IAEA also became an active member of ISO/TC135/SC7 and contributed strongly to its work.

These steps encouraged countries in Latin America and the Caribbean to apply the latest version of the ISO draft as a model for national standards being processed through their respective approval systems. (Countries in the Asia and Pacific regional project also agreed and, along with the donor countries of Japan and Australia, they began the process of harmonizing

their respective national standards to the ISO model.) As a particular contribution, the Latin America and Caribbean Regional Working Group's Training Guidelines were published by the IAEA as a technical document (IAEA-TECDOC-407, since updated in 1991 and issued as TECDOC-628) and included by reference in the ISO Draft Proposal.

The Latin American project led to the training of about 18,000 students, through courses either directly sponsored by the project or held within the participating countries following the project's guidelines. The project reached the point where all but a few of the 17 participating countries were self-sufficient to the point of meeting their own needs for courses in the five basic methods up to and including Level 2 of NDT training. Most of the 17 had national NDT societies, and had promulgated some sort of national standards for the qualification and certification of personnel.

■ Asia & Pacific Project. Encouraged by results of the Latin American project, the IAEA in 1981 incorporated an NDT sub-project in its Regional Cooperation Agreement (RCA) for Asia and the Pacific, which covered a much wider field of radiation technology including radiotracers, radiation processing, and nucleonic control systems. Seventeen countries of the region are members of the agreement while Japan and Australia are the donor countries.

Training under this project follows IAEA guidelines published in TECDOC-628 and specialized text books. Fifteen of the countries have established the national certifying bodies or equivalent technical training boards in accordance with the requirements of ISO 9712. Fourteen have formed professional NDT societies which are considered to be an essential organ for looking after the needs of NDT in each country even after the project is over.

Other projects along similar lines have recently been started for the African and West Asian countries.

Through these projects, about 85 developing countries are benefiting from the IAEA's NDT programme. The main focus is to develop core groups of personnel able to undertake training and certification of personnel and provide NDT services to industries. These results show the valuable role that the IAEA plays in promoting effective training and certification of NDT personnel through the use of international standards and the work of professional NDT societies.

INTERNATIONAL HARMONIZATION

The system through which countries each have their independent certification standards presents certain problems at the international level. This is especially the case for multi-national companies, which usually insist on having NDT personnel qualified to their own standards instead of accepting the certification standards of host countries. This is neither beneficial to the companies nor to the host countries. If standards of training and certification were uniform, this problem could be resolved.

Various types of certification present a problem to the movement of NDT personnel from one country to another. In such cases, NDT personnel have to obtain multiple approvals from different countries. The difference in certification standards sometimes leads to difficulties in reaching bilateral or international agreements, thus presenting trade barriers.

The NDT community has been working towards resolving such problems.

Following a number of actions at the national and regional levels, the ISO 9712 standard was updated in 1999 to smooth out the differences between NDT standards. It is now envisaged that the ISO 9712 standard and standard issued by the European Committee for Standardization (EN 473) in 1993 will be unified by the year 2002. It is hoped that such a unified standard will play an important role for harmonized training and certification of NDT personnel throughout the world, thereby ensuring a uniformity in NDT practices and the quality of the tested products.

In the USA, the American Society for Non-Destructive Testing (ASNT) has now started a Central Certification Programme. It includes certification according to ISO 9712 along with other international standards.

From 15-21 October 2000, the 15th World Conference on NDT was held in Rome, which included a seminar to present

NDT TRAINING GUIDES

The IAEA's publications in the field of NDT training and certification include:

- *Training Guidelines in Non-Destructive Testing,* IAEA TECDOC-407 (1987), and IAEA TECDOC-628 (1991)
- *Industrial Radiography -- Manual for the Syllabi Contained in IAEA TECDOC-628,* IAEA Training Course Series No. 3 (1992)
- *Non-Destructive Testing -- A Guidebook for Industrial Management and Quality Control Personnel,* IAEA Training Course Series No. 9 (1999)
- *Ultrasonic Testing of Materials at Level 2 -- Manual for Syllabi Contained in IAEA TECDOC-628,* IAEA Training Course Series No. 10 (1999)
- *Liquid Penetrant and Magnetic Particle Testing -- Manual for Syllabi Contained in IAEA TECDOC-628,* IAEA Training Course Series No. 11 (2000)

the salient features of the current version of ISO 9712. Efforts were made to achieve a consensus among all the important international certification bodies including those from Europe, USA, Japan and China, for the use of ISO 9712 as a universal standard for the qualification and certification of NDT personnel. These and other efforts will go a long way for achieving global harmonization in this field.

However, issuance of an ISO standard is not the final goal of international harmonization; it is the beginning. To achieve uniformity, the standard has to be implemented by each country. Important steps need to be taken in various areas:

- There should be well defined syllabi for various levels of certification. First, this should cover the basic six NDT methods as listed in ISO 9712. Secondly, they should include additional methods, such as leak testing, acoustic emission, and neutron radiography. This has been done by the IAEA in two technical documents (TECDOC-407 in 1987 and TECDOC-628 in 1991). It is envisaged that TECDOC-628 will be revised in 2001.
- The next important elements are the training materials and text books. The IAEA has started the process, and textbooks on liquid penetrant testing, magnetic particle testing, ultasonic testing, and radiographic testing have been issued. They follow the syllabus of TECDOC-628 and can be used for training of personnel at the first two levels. Plans are to similarly developed the textbooks for the other methods.
- The next important steps are related to the content of practical work for various levels of certification, and to the standard test pieces containing known defects which are used for training and examinations for certification. TECDOC-628 contains some guidelines about the practical content of various training courses for different levels and different NDT methods. Also on hand are guidelines about the content and procedure for conducting and assessing the practical examinations, though work remains to be done before their issuance.

Regarding test pieces, the IAEA has conducted many workshops on the methodology of production of standard test pieces. The main emphasis has been on welding. A guidebook on the subject has been compiled by a group of experts and will be published soon. There is a need to expand this exercise to other sectors of technology such as casting, forging, and the testing of concrete and ceramic materials. Also a guideline should be prepared as to what sort of standard test pieces are needed for specific sectors as outlined in ISO 9712, and review is required of standard test pieces available from various manufacturers.

- Another step towards harmonization concerns uniformity in the standard of examinations and examination questions. Various certifying bodies in the developed countries maintain a bank of questions for conducting certification examinations. The IAEA through experts' meetings has compiled such examination questions for Levels 1, 2 and 3, and is preparing them for publication to assist national certifying bodies, especially those in developing countries.
- NDT is used in many countries, many of which do not have English as the main language. This underlines the importance of translating textbooks, guidelines, and other documents, perhaps initially into the official languages of the UN.

NDT IN INDUSTRY

Most industries around the world -- ranging from automotive, aerospace, and rail transportation to electronics and oil production -- rely upon non-destructive testing to assure quality control and safety. NDT services include design studies, sensor and control systems, X-ray and gamma ray inspections, and ultrasound testing. The most widely applied NDT techniques are dye penetrant, eddy current testing, magnetic particle testing, radiography, and ultrasonic testing.

NDT inspectors and operators are specialists certified to exacting standards by national and international NDT boards. The IAEA qualification and certification system is based on standards of the International Standardization Organization, which sets three levels of competence:

- Level 1 -- may be authorized to set up equipment, do tests under written instructions under supervision of Level 2 or 3 personnel; can classify and report results under such supervision.
- Level 2 -- may be authorized to perform and direct testing according to established or recognized procedures.
- Level 3 -- may be authorized to direct any operation in the NDT methods for which certification has been received.

Trainees must progress from one level to the next and meet minimum experience requirements for each level and method. The length of time for education and certification depends on educational qualifications in science or engineering before NDT training begins.

- More emphasis will need to be placed on modern teaching methods, including video cameras and cassettes. For example, ASNT has already produced video cassettes for a number of NDT methods.
- Teachers and trainers play key roles in the harmonization process. The IAEA has issued "train-the-trainer" guidelines, and this approach needs to be further developed and incorporated by training and certifying bodies.
- The specific sectors for certification need to be defined in narrower and clearer terms. That would help ensure that personnel trained and certified in these well-defined sectors in one country would have same level of competence as in other countries.
- Greater efforts are needed to ensure that all regions are assisted in the harmonization process. Some of them, including the regions of Eastern Europe and the States of the former Soviet Union, are not involved in IAEA regional efforts, for example.
- There is a need to assess how far the requirements of ISO are being met by each country. Some standards for assessment and accreditation of NDT laboratories and training institutions already exist to assess the capabilities of these organizations.
- Closer collaboration still is needed between various national and international organizations which have an interest in the promotion and harmonization of training and certification of NDT personnel. The IAEA has taken the initiative of promoting collaboration by inviting representatives from these organizations to its regional coordination and Expert Advisory Group meetings, for example.
- The harmonization process must be formalized and documented. This can be achieved through agreements signed between the relevant bodies of countries on a bilateral or regional basis. A good example is the agreement signed between members of the European Federation of NDT Societies. To promote development of such agreements, the IAEA, through a regional project, convened a meeting recently to prepare a draft agreement among African countries.

Similar agreements are envisaged for other regions of the world in years ahead. Organizations participating in the process are expected to include the International Committee on Non-Destructive Testing. These and other cooperative steps will go a long way toward setting up a strong and sustainable network worldwide for uniform NDT practices, especially for the training and certification of operators responsible for conducting and interpreting the tests. ❐