Group fellowship training in nuclear spectroscopy instrumentation maintenance at the Seibersdorf Laboratories

A new "in-service" training approach has proved effective

by Y. Xie and A. A. Abdel-Rassoul

The IAEA's Seibersdorf Laboratories, through its Instrumentation Unit, started accepting individuals for fellowship training on nuclear instrumentation maintenance and repair early in 1981. Since then, there has been a rapid and growing demand to train technicians and engineers from a number of developing countries. This reflects their existing needs to solve maintenance and repair problems for a big variety of malfunctioning electronic and laboratory instruments.

To throw light on the importance of continual maintenance and repair of nuclear instruments, it is worth noting that almost 55% of the IAEA's expenditures for technical assistance co-operation (which amounted to or about US $23.1 million out of a total of US $42 million during 1987) is spent each year to purchase major instruments required for more than 950 different projects.

In developing countries, several projects suffer or are discontinued due to missing auxiliary instruments, lack of spare parts, and the absence of efficient local maintenance and repair service capabilities. During the last 10 years, between 10–30% of all the instruments for technical assistance and co-operation projects that were distributed worldwide were out of order at some point in time — a serious limitation on the peaceful applications of nuclear energy in various countries. So far, intensive training of local technicians and engineers on maintenance and repair of nuclear instruments is the only effective solution to such problems. In fact, such training within the framework of the Agency's technical co-operation projects may be a better investment in the long-term for developing countries than generally recognized.

Mr Xie is Head of the Instrumentation Unit and Mr Abdel-Rassoul is Head of the Physics-Chemistry-Instrumentation Laboratory at the IAEA's Seibersdorf Laboratories.

Types of training

In instrumentation maintenance, three types of training are done: fellowship training; regular training courses; and group fellowship training.

In fellowship training, two or three individuals are accepted each year to get on-the-job experience in operation, maintenance, and repair of nuclear instruments, and to get acquainted with how to design and construct simple electronic equipment. This necessitates continual guidance and supervision for 6-to-12 months.

In regular training courses and workshops, up to 20 participants attend an 8-to-12 week course to study various techniques applicable to instrument repair through lectures, demonstrations, and limited exercises.

The "in-service" approach

The Agency's Laboratories at Seibersdorf started conducting group fellowship training on nuclear spectroscopy instrumentation maintenance in November 1987. As a first trial, two courses were successfully completed, each for a period of 6 months, and attended by a total of 10 participants selected from several countries in Africa, the Middle East, and East Asia. This new "in-service" training approach covers almost all aspects dealt with in regular training courses on nuclear instrumentation and through supervised on-the-job fellowships. It is characterized, in addition, by intensive training on maintenance and repair services that runs for longer periods of time. Results have been well received and appreciated by several institutions in developing countries.

More than 20 service technicians and electronic engineers have been nominated by their national authorities to attend the third course. Eight of them are attending the 6-month course, which concludes in March 1990.

A fellow from the Republic of Korea explains service maintenance problems during the second group fellowship training at Seibersdorf.

In group fellowship training, a maximum of eight candidates receive hands-on training for a period of 24 weeks, so as to become experienced in systematic troubleshooting of malfunctioning sophisticated nuclear systems and to be able to carry out various troubleshooting and repair services on modules, boards, blocks, and even electronic chips. An extension of 4-to-5 weeks for some participants is possible. Group fellowship training expands the training capabilities at Seibersdorf, since the number of fellows that can be trained is increased from two to eight each year while the training period itself can be decreased to about 6 months.

A fellow from Jordan gains experience in service and repair of an XRF system that is part of an IAEA technical co-operation project.

Nuclear spectroscopy instruments are important tools for nuclear research and applications. They are commonly used in nuclear engineering and technology, nuclear physics research and chemical analysis, environmental analysis, nuclear medicine, and various industrial applications. Several types of nuclear spectrometers are being sent to numerous laboratories in developing countries through technical co-operation projects. These are mostly sophisticated systems based on different radiation detectors, analogue and digital circuitry. In most cases, they use microprocessor or computer techniques involving software and hardware.

Maintenance service and repair of these systems is a major problem in many developing countries because suppliers do not set up service stations. Additionally, local technicians or engineers hesitate to open or touch the instruments for servicing or to make any modifications that might be needed for other applications.

Group fellowship training

In general, group fellowship training is characterized by several factors:

- It gives participants a better chance to put theoretical information into practice and to acquire hands-on experience. Individuals do not need to share their instruments because enough test equipment, tools, and nuclear measurement instruments are available.
- It promotes experience in systematic troubleshooting and repair of sophisticated nuclear spectroscopic measuring systems, and instills self-confidence in participants when handling and/or dealing with modern instruments.
- Test instruments are available to provide experience in testing defective parts of various types of radiation detectors, scalers, multichannel analysers, X-ray fluorescence (XRF) systems, microprocessors, and computer-based equipment. These represent most, if not all, types of nuclear instruments which participants will be asked to repair in home institutes.
- Trainees can increase their theoretical background through self-study by consulting introductory information, appropriate manuals, and library documentation, and by receiving continual guidance and supervision.
- Each individual is asked to define national needs for instrument repair and then receives sufficient experience through hands-on exercises to repair similar types of instruments.
- After the group course, extended training of a few months is possible to address instrumentation problems in some of the participants' home institutes.
- A "train-the-trainer" policy is achieved through presentations after each exercise or troubleshooting lesson, and comprehensive discussions are held on selected topics and on the experience acquired in the course.

In addition to conducting group fellowship training, teaching staff of the instrumentation unit are involved in research and development to keep them, and the fellows, abreast of the latest technology. Activities at Seibersdorf

allow both the teaching staff and trained fellows to become acquainted with different generations of instruments (over a 20-year span) that are still operable in developing countries.

From training to practice

Trained personnel play a key role in local maintenance and development work. The following are only examples:

- One fellow from Kenya worked on a maintenance project for an XRF generator during his training and was able to repair a similar defective generator in his home laboratory, which had not been in order after several expert missions.
- A fellow from Burma who had never opened an instrument before repaired a scaler (type SR-5), which is used for various nuclear measurements, without hesitation towards the end of his training. He had six pieces of old defective scalers of this type in his home institute and during his training project he obtained relevant circuit diagrams, maintenance tools, and spare parts to enable him to repair most of these units after his return.
- One fellow from Nigeria was appointed as a lecturer in a regional training course on maintenance and quality control of nuclear medicine instrumentation held in Zambia. Another fellow already has assisted in a national training course in Jordan on nuclear instrumentation.

Some talented fellows who have gained skill and expertise in certain fields of maintenance and repair of special nuclear instruments will be assigned for expert missions to help neighbouring countries in installation, calibration, repair and training, and in other areas.

The well-trained fellows are often faced with serious problems when returning to their home countries. Limited supplies of tools, maintenance instruments, service manuals and spare parts, and the complete absence of any help from suppliers or manufacturers, are a major cause of isolation. Lack of hard currency causes serious delay in getting the necessary spare parts in most cases. In addition, private centres for servicing non-nuclear instruments are potential competitors for their services. Several technical co-operation projects suffer from these factors and continual effort for training more technicians will compensate for the losses of skilled and experienced service staff.

One way to keep and to upgrade trained service technicians and engineers is through a new project called the Nuclear Instrumentation Network (NIN). The project will co-ordinate training, expert missions, and equipment assistance in a number of neighbouring countries. It aims to promote accumulation and updating of equipment and expertise, not only for nuclear instrumentation, but also for non-nuclear instruments, with the co-operation of other international organizations or potential suppliers. Candidates for group fellowship training will be selected for orientation training at Seibersdorf so as to be able to act as liaison officers and to play a key role in local repair and maintenance services and training of national staff. Close co-operation between Seibersdorf and the fellow's home institute can overcome isolation of fellows, who regularly will be provided with service manuals, spare parts, and maintenance kits. Moreover, they are then in continuous contact with suppliers or outside institutes throughout the network whenever assistance is needed.

Through the appropriate co-ordination of NIN and full support of the instrumentation unit at Seibersdorf, more trained fellows can become trainers in local activities at home to upgrade services in their own and neighbouring countries.

Programme for group fellowship training in nuclear spectroscopy instrumentation maintenance

General and introduction
- nuclear instrumentation systems
- characteristics and configuration
- maintenance instruments and tools

Ionizing radiations and detectors
- types of ionizing radiations
- radiation interaction with matter
- different types of radiation detectors

Operation of test instruments and tools
- accuracy and limitations
- proper operation and calibration
- specific maintenance tools and kits

Trace signal/shaping in nuclear spectroscopy
- signal amplification and shaping
- noise and resolution
- single-channel analysers/maintenance

Troubleshooting in microprocessor-based instruments
- logic circuits and relevant integrated circuits
- principles and applications of microprocessor in instrumentation
- diagnosis techniques among microprocessor, buses, memories, input/output ports, and relevant circuits

Multi-channel analysers (MCAs) and maintenance
- principle and circuit analysis at board, block and deeply chip levels
- troubleshooting practice on the monitor and central processing unit board of factory-made MCA
- systematic troubleshooting as a whole

Personal computer principles and maintenance
- system configuration and practice
- interfacing diagnosis
- diagnosis software for PC maintenance

Specific individual projects
- Such requests are presented at the start of group training and are directed at solving existing problems at a fellow's institute. The projects are done during the last month of training. Some examples of such projects are: "Personal computer applications for diagnosis, repair and preventive maintenance"; "neutron moisture gauges"; and "service maintenance and repair of XRF generators".

Note: The programme outlined here generally covers a period of about 24 weeks.