Nuclear instrumentation training

by J. Dolnicar*

There is one problem common to many projects in the field of nuclear science and technology: the sophisticated instrumentation is delicate, sensitive to the environment, and it breaks down frequently. This might be a relatively small obstacle in European countries: a representative of the manufacturer or a service laboratory is not far away. In many developing countries, the difficulties are more severe: very few producers of nuclear equipment maintain service laboratories in such places; many countries are considered non-serviceable areas; spare parts are not available, or it takes a very long time to receive them from abroad. Therefore when a country is introducing nuclear techniques, it has to analyse carefully how the necessary equipment will be maintained and serviced. In this regard, many developing countries have reached the same conclusion: an indigenous capability should be developed. This implies two actions: the needed professional staff must be properly trained; and the material basis (laboratories, testing instruments, spare parts, and components) has to be established.

For many years, the Agency has had a modest programme focused on nuclear instrumentation, and the co-operation with several developing countries is showing its first results.

Any programme is efficient if it is addressed to and implemented by the right personnel. Who are the customers for nuclear instrumentation in developing countries? Research institutions, universities, laboratories for nuclear medicine, radiation protection services, uranium prospection teams. In contrast to the heavily industrialized countries, nuclear techniques are only exceptionally in daily use in industries in developing countries. The type of use defines the category of instrumentation, and this in turn determines the optimal approach to the problem of equipment maintenance and servicing. It would appear necessary to analyse closely the customers for nuclear techniques and the type of instruments they are using, before establishing a direct programme to remedy the unsatisfactory present situation. The Agency has done several studies of this type; the most detailed and informative was one related to nuclear medical equipment (see *IAEA Bulletin* Supplement 1982, page 32). As a consequence of the experience gained by the authorities in developing countries, and by the Agency's Secretariat, a number of projects related to nuclear electronics and instrumentation have been implemented.

The oldest and the most evolved action by the Agency is the organization of a yearly course on nuclear electronics. When it was started 18 years ago, with a six-month course in Sri Lanka, it was mainly oriented towards theory, consisting of only two hours of laboratory work to every eight hours of lectures. From there, it went a long way: it has been held once in Brazil; then eight times in Turin, Italy. In 1978, it moved for three years to Dublin, Ireland, and in 1981 landed in Berlin (West). On this road it has undergone many changes:

- The practical laboratory exercises became the focal point of the course, consuming more than 65% of the time.
- The teaching methodology has been developed, resulting in a well-balanced curriculum providing, in the relatively short period of 13 weeks, the maximum amount of knowledge and experience to the participants.
- The rapid progress in electronics, and particularly the appearance of microprocessors, requires a continuous updating and upgrading of the course. In recent years, regular consultants' meetings have discussed, modified, and improved the technical contents and the methodological aspects.

Over the years, the Agency's inter-regional nuclear electronics courses have trained close to 300 engineers and scientists from developing countries. At the same time, a team of lecturers has been created. There is now a corps of well-known experts who find it a challenging and interesting task to share their experience with the students. Prof. U. Ciancaglini (Argentina), Prof. W. Kessel (FRG), Prof. P.F. Manfredi (Italy), Prof. J. Pahor (Yugoslavia) are among those who have created the course, and who also occasionally serve as the Agency's experts in the field. The best students from a course are invited to serve as assistants on the course in the following years, and so themselves become teachers. In this manner, a number of electronics experts have emerged who continue to be associated with the Agency's programmes: Messrs. S. Akdurak (Turkey), W. Cudny (Poland), D. Camin (Argentina), and J. Preston (Jamaica), are only a few among the new generation of nuclear electronics personnel emerging from the Agency's training courses.

With the improvement of its curriculum, the Agency's course on nuclear electronics has become rather advanced. Nowadays, only those participants with an academic

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background can follow the programme. On the other hand, it was realized that good technicians are essential for an instrumentation or electronics laboratory. This triggered off regional courses on a lower level, suitable for senior technicians, held every year in a different part of the world. This series started in Malaysia in 1977, was continued in Costa Rica in 1979, Morocco in 1981, and Peru in 1982. As in the advanced training course, the Agency's Secretariat and the teaching team had first to learn how to transfer as much as possible of the electronics and instrumentation knowledge to the participants in a short time – eight weeks. From course to course, the efficiency of this training is increasing.

The efforts invested in the Agency's courses on nuclear instrumentation, and the experience gained in how to organize training in this field, could also well be applied on the national level. In fact, even in advanced countries, nuclear electronics is not taught as a separate course at the universities, but is mastered in the on-the-job training, or in special courses organized by research institutes. Accordingly, there is no extensive experience of how to train staff in the field. Literature is scant: the best books (Nicholson; Korwalski) are rather old, and not designed to provide didactically optimized texts. Even worse is the situation with laboratory manuals: they just do not exist.

Thus, the courses designed by the Agency can serve as a model for local training in the field of nuclear electronics. The first two examples have shown excellent results. In 1982, the IAEA co-operated with the Governments of Viet Nam and Senegal in organizing national courses on nuclear electronics. The participants were selected and sponsored by the national authorities; the Agency contributed the teaching staff and some equipment. The results indicate that, in a given country, a well-organized training course certainly produces a strong impact. In the two above-mentioned countries, the laboratory where the course was held became a local centre for nuclear instrumentation, and good links were established between this and other laboratories where nuclear instruments were used and have to be maintained.

Realizing how important practical training in electronics is, the experts who are associated with the Agency's programme on nuclear electronics training recommended in 1981 that a set of teaching aids should be developed. This would allow a more efficient illustration of the principles of nuclear electronics, while at the same time forcing the students to work with real circuits and use test instruments intensively. Several exercises, with appropriate hardware, have been developed already. In 1983, this project received the support of the Government of the Federal Republic of Germany. It is expected that more well-balanced experiments will be available soon, covering all the main topics including the application of microprocessors. This set of exercises, combined with a Laboratory Manual, should be of interest to many countries, universities, and research laboratories concerned with training in nuclear instrumentation, even in advanced countries. In 1984 a comprehensive and practical manual will be published containing selected laboratory exercises, and covering the specifically "nuclear" topics in electronics.

Another promising approach to the training of national staff, for maintenance and servicing of nuclear devices, was initiated by the Agency in the field of nuclear medical instrumentation, and resulted in a programme with wider objectives. A report on this will be presented in the next issue of the *IAEA Bulletin*.

Apart from its training courses, the Agency awards individual fellowships through its technical co-operation programme. The Fellows selected for this kind of training are, as a rule, concerned with advanced aspects of nuclear electronics and the application of microprocessors. Frequently, the Agency's courses serve as a selection forum: the best students are considered for further training under the fellowship scheme. Such a selection ensures that suitable candidates are accepted as IAEA Fellows for training abroad, and reduces the undesirable phenomenon which is particularly prevalent in the electronics field: well-trained engineers and technicians are recruited by commercial companies, and leave the nuclear electronics laboratories for better-paid jobs. In a training course, the teaching staff can evaluate how committed a participant is to his work, how loyal he is to his laboratory, and make appropriate recommendations. The fellowship programme can profit by the selection established in a training course.

Having enough well-trained staff is not enough, however. The second essential requirement for properly organized nuclear electronics in a developing country is suitably equipped laboratories. In co-operation with the Agency, many countries have established such laboratories which are attached to the nuclear research centres of science faculties at universities. The main objective of a nuclear electronics laboratory is to provide the expertise and facilities for maintenance and repair of nuclear instrumentation, for the whole country or for a region. From a large selection of well-established centres for nuclear electronics, a few are mentioned below: Kwabeniya Nuclear Research Centre operates a laboratory servicing nuclear equipment in Ghana; the Instituto Peruano de Energía Nuclear in Lima has a strong electronics group and is expanding its laboratories; the electronics laboratory at the Dalat Research Centre supports all the nuclear instruments in the south of Viet Nam. In these institutions, the Agency's co-operation has permitted the local staff to set up a good scheme, and engage the local resources for the operation of an electronics laboratory. The United Nations Development Programme (UNDP) occasionally assists projects related to nuclear electronics and instrumentation: in Senegal, the Institute of Applied Nuclear Technology was created with the assistance of UNDP, which supplied the equipment for a nuclear electronics laboratory.

The experience gained in establishing and operating nuclear laboratories shows that their activities should not

be limited to maintenance and repair. Many simple nuclear devices can be designed and contructed locally, at a fraction of the price of the equivalent commercial units. The Agency tries to encourage and assist the electronics engineers and technicians in such endeavours, and has even started a programme to design a set of modular instruments that can be produced locally in many developing countries. To avoid any possible conflict with commercial manufacturers of nuclear electronics and to keep the costs at a minimum, the widely-applied industrial standard, based on the Eurocard* modular system, was adopted. It is not used by companies that manufacture and sell nuclear electronic equipment. The first instrument, a single-channel gamma spectrometer using a NaI detector, will be developed by mid-1983. The full documentation will be available to any laboratory in the developing countries; the assembling of this instrument will have an educational and an economic effect.

Another topic attracting the attention of developing countries and of the IAEA is the rapid breakthrough in professional microcomputers. As a result of rapid progress in computer technology, small computers with the capability of large machines are available today at acceptable prices. The use of such desk computers in nuclear science and technology is of special interest to the scientists in developing countries where previously the chances of obtaining a large computer for scientific work were infinitesimal. However, the problem of training appears again, both for those who should be taught how to use the microprocessor in an optimal manner, and for the electronics engineers who will again have the problem of maintenance on their hands. Co-operation with the Agency can also provide some valuable assistance in this field; among other activities, the Agency is planning an inter-regional programme specifically for efficient training in the field.

* In electronics, *Eurocard* refers to a standard size of printed circuit board (dimensions 100 x 160 mm). Many industrial electronics units and microcomputers use this norm.