Conference reports

Assuring quality and nuclear safety

Quality assurance can be thought of as a way of managing a nuclear power project to ensure that all project activities are accomplished in a planned, systematic, and controlled way. If such a system is operating well, there is a high degree of confidence that all project activities will be performed correctly and that failures, mistakes, and deficiencies in the design, construction and operation of the nuclear power plant will be avoided, or at least detected and rectified in time.

The way in which a Quality Assurance (QA) system is established is prescribed in a number of Member States by regulatory requirements and technical standards. In its nuclear safety standards development programme (NUSS programme), the IAEA has developed and published a Code of Practice on quality assurance for safety in nuclear power plants. This document contains minimum requirements on QA to be used by Member States in the context of their own nuclear safety regulations.

The objective of the symposium* was to review present practices in implementing QA in nuclear power projects in Member States, to identify existing similarities and differences, and to highlight those aspects of QA which are controversial and need to be harmonized. Particular attention was given to those QA requirements and practices in Member States which are specific to that country or are different from the requirements stipulated by the Code.

Since QA activities are interdisciplinary in nature and as they incorporate a broad spectrum of organizational, administrative, and technical functions, only a few topics were selected for review at the symposium. In this way, a broad discussion and exchange of experience was possible contributing to the improvement of the effectiveness of QA programmes and harmonizing of QA practices among Member States.

The symposium showed that in IAEA Member States there is a spectrum of practices which might be identified as formal QA. Two main concepts may be considered as extremes among the existing approaches:

The *system-oriented approach* places the emphasis on a prescribed QA methodology which requires the nuclear power plant owner and its contractors to plan, conduct, control, and document their work in a systematic way. Quality is achieved through controlled performance of all activities, and quality is verified at several levels, such as first-line inspections and testing, surveillance and monitoring of activities, and audits of the effectivenesss of the complete QA system. The role of the regulatory authority is to verify the plant owner's commitments made in a documented QA programme by carrying out programme audits and by sampling inspection of the work.

The *product-oriented approach* emphazises the extensive verification of product quality through inspections and testing. These are performed in a redundant way by manufacturers or constructors, by purchaser or plant owner, and by third-party inspections which are performed on behalf of the regulatory authority by an independent inspection organization. The adherence to a prescribed QA methodology is less formal in this approach, and achievement of quality is considered a separate management function not directly related to QA. The emphasis is on verifying the quality of equipment and services by an independent inspection organization.

Cost-effectiveness

In the papers and discussions at the symposium, it was shown that the QA concept developed by the Agency's Code is closer to the system-oriented approach, considering that this might be more appropriate for use by developing Member States which can have problems in staffing a competent and skilled independent inspection organization. On the other hand, the system-oriented approach may be more cost-effective because it avoids duplicating verification activities, and places the burden of achieving and verifying quality on the task-performing organizations, such as designers, manufacturers, constructors, and the plant owner itself.

A number of Member States have adopted officially, or are using unofficially, the IAEA Code and Safety Guides as reference documents for their QA requirements. Among them, one should mention those Member States which have established nuclear power programmes such as Argentina, Brazil, France, Italy, Japan, Netherlands, South Africa, Yugoslavia, etc. A number of Member States who are starting their nuclear power programmes are also considering adopting the IAEA QA standards. However, in those Member States which have their own QA standards different from the Code, there is consistency between the Code and the State's QA practices.

* International symposium on quality assurance for nuclear power plants, Paris, France, 11–15 May 1981.

Two important subjects came up in the discussion of various QA practices. The first is the function and role of independent verification in QA activities; and the second is the selection of QA functions appropriate to items which are important for safety.

- Verifying that quality requirements are met, is an integral part of any QA activity. However, such verification by a regulatory authority, or by a third party at the highest level, is not always considered a function of the QA system nor a part of standard QA verification activities. In the IAEA safety standards, regulatory inspections are covered by a safety guide in the Governmental Organization series, and do not fall within the concept of quality assurance. Consequently the Code of Practice on QA does not consider regulatory inspections. In some Member States, however, the verification by an independent inspection organization on behalf of the regulatory authority is an integral part of QA. The advantages and disadvantages of the various systems were reviewed, but it was not considered useful to recommend one approach or another. In all cases, the verifications should be consistent with the QA concept used, and the integration of the two approaches is probably not cost-effective and is therefore not recommended.

- Quality assurance activities have to be geared to the safety importance of items and services Techniques used to select appropriate QA programme levels vary from country to country and even from organization to organization. A multi-level system of graded QA programme requirements has been established in Canada for supply of items and services. In other countries, various techniques are used to identify QA functions. Common to all techniques is. the classification of items and services according to their importance for safety, a multi-level system of graded QA programme requirements which has to be established, and a methodology devised to assign in a consistent manner a QA programme level appropriate to each item and service. Reports and discussions in the symposium indicated that the harmonization of the selection of appropriate QA programme levels can become important in an international context. The development of a set of recommendations on multi-level QA programme selection and methodology for international application was considered highly desirable.

The problem of cost-effectiveness of QA emerged several times in the course of the symposium particularly in relation to redundant verifications, manpower requirements, and management of resources. There is a widespread conviction that QA programmes are cost-effective, although it is intrinsically difficult to quantify the advantages. Total QA costs directly payable by the plant owner (excluding manufacturing quality assurance and quality control (QC) which is a part of the equipment costs) come to between 2 to 2.5% of the total cost of the plant. A large part of these are costs of personnel which perform QA/QC functions. This means that proper management of human resources can result in significant savings.

Manpower management

An analysis of manpower needs, qualification and training requirements, were reviewed in two invited papers from the USA and the Federal Republic of Germany. Existing utility schemes for satisfying quality assurance requirements during design, construction, operation and decommissioning of a nuclear power plant were analysed. According to US practices, the number of QA personnel in the pre-construction phase (including the plant owner's and Architect-Engineering personnel) is 20 to 30 engineers and technicians. This number increases to over 50 during the construction period, with an additional 60 to 70 quality control staff to perform front-line inspections and testing. In the Federal Republic of Germany (which practises a typical product-oriented approach to QA) at the height of the construction-work the number of QA personnel of the main-contractor (performing also functions of the plant owner) is over 60 people. Personnel from the independent inspection organization numbers over 70 people.

This gives an even balance between the total number of QA/QC personnel in the USA and the Federal Republic of Germany during site construction, although the functions of the staff may be different. A considerable increase of QA personnel during plant operation has been identified in the USA as a consequence of the TMI accident. Present indications are that a utility may require as many as 30 QA/QC personnel, plus their auxiliary support-staff, at each reactor. This represents not only more activity in the traditional areas of QA, but also introduces new activities to provide confidence that the plant will operate safely.

Training problems

A special session of the symposium discussed the problems of introducing QA to a country embarking on a nuclear power programme for the first time. The experiences of Brazil, India, the Republic of Korea, and Spain were analysed. It is evident that the main difficulties are more the lack of skilled and competent manpower than the non-existence of QA standards. Therefore the emphasis in the discussion was on training and qualification of QA/QC personnel. In Brazil and the Republic of Korea, where manpower needs are especially large, there are big staff-training programmes in quality-assuring disciplines. Their experience shows that training in QA methodology and procedures is easier to implement than training in engineering aspects of QA/QC activities. Optimal methods of training QA/QC personnel in specific technical disciplines like civil, mechanical, etc. are not yet established. There are also problems in placing the trainees for on-the-job training in such activities on construction sites in industrialized countries.

The symposium concluded with a discussion of recommendations to the Agency related to the future programme in QA. These recommendations stress a need for the development of lower-level documents, such as manuals and procedures, for practical use. Specific emphasis was given to the Agency's programme in training QA personnel through all existing forms of technical assistance to developing countries. Finally it was considered that the Agency should assist Member States by organizing and implementing audits of the QA programme in various phases of a nuclear project. The audit team should consist of international QA experts, and the Agency's QA Code and Safety Guides should be used as the reference documents.

Low-level counting methods

Low-level measurements of radioactivity in the environment are increasingly useful for environmental protection, studies of processes in nature, and other fields like radiocarbon dating, or prospection for minerals and water. The last IAEA symposium on low-level counting methods was organized in Monaco in 1967 Since that time significant improvements in methods and instrumentation have been made, resulting in higher sensitivity for identifying and determining radionuclides existing in the environment. Therefore, a lot of new work was presented at this symposium*.

Radioactive material in the environment has several sources·

- Primordial radioisotopes of uranium-thorium series, potassium, etc. in the earth's crust;
- Continuous production by cosmic radiation;
- Production by nuclear explosions; and
- Release by nuclear installations.

These radionuclides become a part of different components of nature. By their radioactivity they label particular components on the local, regional, or global scale making it easy to study physical, chemical, and biological processes in the geo-, hydro- and biospheres. Low-level counting methods are especially important for nuclear waste disposal problems and uranium ore exploitation.

* International symposium on methods of low-level counting and spectrometry, organized by the IAEA in co-operation with the Hahn-Meitner Institut für Kernforschung in Berlin (West), 6–10 April 1981.

The papers presented and the discussions showed the great progress in recent years in the construction of low-background and high-sensitivity instruments used in laboratories or in the field. Detection limits for all radionuclides have been lowered by using specially selected construction materials which are low in radioactivity, anti-coincidence shields, and efficient detectors Special methods have been developed for isolation or enrichment of particular radionuclides in environmental samples. In the case of the actinides, low-level spectrometry is competitive with neutron activation analysis.

Among the new detectors discussed at the symposium was a multicrystal gamma-ray coincidence spectrometer with six NaI(Tl) scintillators whose improved precision has been demonstrated in measurement of Al-26 and Na-22 in meteorite samples. An extremely low background gamma-ray spectrometer was described in which an intrinsic germanium detector is surrounded by five NaI(Tl) crystals as anti-coincidence shielding and a

The programme of the symposium

Gamma-ray spectrometry,

Low-level alpha and beta particles counting;

Detection of actinides,

Tritium enrichment and counting;

Radiocarbon counting,

Accelerator-based techniques and other new methods for low-level measurements.