Nuclear safety standards for quality assurance

by N. Raišić*

Standards developed under the Agency's Nuclear Safety Standards (NUSS) programme are receiving increasing attention. In a number of Member States they are endorsed as regulatory requirements; in others, some are used voluntarily by participants in nuclear power plant design, construction, and operation. In particular, documents dealing with Quality Assurance (QA) are used widely in both developing and industrialized countries – for example, in Argentina, Brazil, Egypt, France, Italy, and Pakistan. To encourage the use of the Agency's standards, and to assist in their implementation in developing Member States, various forms of technical assistance and co-operation have been established. These include NUSS implementation missions, the preparation and issue of Users' Manuals, and the orientation and training of personnel.

Probably the Agency's most efficient assistance lies in the organization of training courses and seminars for personnel engaged in the organization and performance of QA and Quality Control (QC) activities. Four interregional training courses on QA have been organized so far, namely in Argonne (1978), Madrid (1979), Karlsruhe (1980), and Saclay (1983); and two regional seminars on QA, for Asia and the Pacific and for Latin America, have been held. The purpose of these one-week training seminars was to give managerial staff working on nuclear power projects in the regions information and guidance on the requirements and recommendations of IAEA standards related to QA, and their implementation. Such seminars serve also as a good place for the exchange of information between participants on existing QA practices in Member States of the region.

The Training Seminar for Latin America** had in addition to this general purpose a specific objective, namely to review experience in the use of the Agency's QA documents, and to obtain the users' opinion on their adequacy and completeness. Two Member States in the region which have important nuclear power programmes, Argentina and Brazil, have endorsed the Agency's QA documents as their regulatory requirements and have accumulated some experience in their use. Nuclear power plants in Latin America have been designed and constructed by various foreign contractors having their own safety requirements and engineering standards. The standards used in nuclear power plant projects in Argentina are Canadian and German, in Brazil American and German, and in Mexico American; and QA requirements and practices adopted in Canada, the Federal Republic of Germany, and the USA differ. The evaluation of safety criteria, QA programme organization, and so on in such countries is therefore complex, and there are specific problems in ensuring uniformity in QA activities.

For greater consistency between safety and other requirements for different nuclear power plants these countries are tending to adopt the NUSS documents. The codes, guides, and standards developed under the Agency's auspices represent an international consensus acceptable to all Member States, including exporting countries. Some remaining difficulties have to be resolved in each country individually, taking into account its specific local situation. These difficulties relate mainly to some differences in QA philosophy and requirements between the IAEA QA Code and Guides and those of the supplier countries – for example, allocation of overall responsibility for QA programmes, selection of appropriate QA programme levels, inspection schemes including requirements for an independent inspection organization, and qualification of QA personnel.

The seminar discussed here was an appropriate place to review problems in the implementation of the QA documents, and to permit the correct interpretation of the specific requirements of the Latin American region. The tone of the seminar was set by a series of invited papers which interpreted the requirements and recommendations of the Agency's documents. Papers presented by participants, in particular a set from Brazil, reviewed specific situations and analysed the interpretation of QA requirements in the conditions prevailing in Latin America. A panel discussion held on the last day of the seminar focused on a few specific problems in implementing the Agency's QA documents in Member States, such as organization and allocation of responsibilities between QA programme participants, the rôle of regulatory inspections, the functions of independent inspection agencies, and technical aspects of verification activities during plant construction and operation.

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Responsibility and organization

The Agency's Code of Practice on QA requires that one organization, normally the plant owner, be responsible for establishing and implementing the overall QA programme. The work of preparing and executing this programme, or parts of it, may be delegated to other project participants, but the responsibility for programme effectiveness is always channelled to a single responsible organization. The practice in some Member States, in response to prevailing local conditions, is to allocate the responsibility for QA to different organizations at different stages of a nuclear power plant project. For example, the responsibility for the QA programme in Brazil, during the construction phase, rests with the design and construction organization, and during plant operation with a different organization. With such a partition of responsibilities for QA between various organizations at various stages of a programme, appropriate solutions to problems in overall co-ordination and in the organization of participants must be found.

The QA programme of a project participant normally comprises quality achieving and quality assuring functions. The former are performed by the organization itself. Assurance that the work is correctly performed is obtained by activities which include several levels of verification, starting with inspections and testing carried out by the organization itself and continuing to independent verifications by purchasing organizations including the plant owner. The organization of the overall programme proceeds through a hierarchical chain of purchasers, suppliers, sub-suppliers, and other lower tiers, each participant controlling its own work and verifying the effectiveness of that part of the QA programme which it delegates to other organizations.

When two or more organizations share responsibility for the overall QA programme, which also occurs in other Member States outside Latin America, the hierarchical chain of verification is modified. Additional independent verifications by a regulatory authority or independent inspection agency are carried out, the overall QA programme is co-ordinated by a special agency, and so on. In Brazil, an independent inspection organization has been established to cope with the existing QA programme organization and to contribute to the completeness of verifications, in particular during the construction and commissioning phases when the transfer of overall responsibility from the constructor to the operating organization is taking place.

The organization of the QA programme during the operation of a nuclear power plant requires special attention. In the past, QA during operation was largely neglected, tending to be identified with quality control (QC) oriented toward material and equipment. It was not until a number of outages at operating plants all over the world had been ascribed to deficiencies in QA programmes that QA increased in importance. At all operating power plants both in Argentina and in Brazil a major overhaul of QA programmes and of management control in general is under way, to bring them into line with the QA requirements of the IAEA Code and Safety Guide on QA during operation. At power plants with good operating experience, such as Atucha I in Argentina, it seems to have been difficult to recognize the need for a formal QA programme, although a number of significant improvements could be foreseen. Organizational arrangements for operating plants are such as to increase the independence of QA/QC functions from the on-site plant management. QA personnel are located both on- and off-site but should report preferably to off-site management. Independent assessment of the operational QA programme is considered essential. This is planned as part of the programme, or as a function performed by the regulatory organizations. A review of QA programme organization during both construction and operational phases of nuclear power plants in Latin America indicates a close relation between QA and regulatory controls. Given proper organization of both QA activities and regulatory reviews and assessments it has been possible to ensure the implementation of the requirements of the NUSS document, taking into account local conditions in each Member State.

Independent inspection organization

The Code and Guides on QA do not require an independent inspection organization to verify conformity of products and activities with established requirements. However, regulatory inspections, which are not formally a part of QA activities, include independent review and assessment of the applicant's QA programme. The existence and functioning of an independent inspection organization in the implementation of QA programmes is characteristic in the Federal Republic of Germany; normally, this practice is transferred to projects abroad, such as those in Argentina and Brazil. Argentina did not follow this example in the development of its own QA systems and practices, which give overall responsibility to the national utility, Dirección de Centrales Nucleares (DCN). Licensing functions including inspections and enforcements are carried out by the national regulatory body, Consejo Asesor para el Licenciamiento de las Instalaciones Nucleares (CALIN). The situation is identical in Mexico, where all regulatory functions are performed by the Comisión Nacional de Seguridad Nuclear (CNSN). In Brazil, as already mentioned, in addition to the inspection and enforcement functions of the national regulatory organization, the Comisão Nacional de Energia Nuclear (CNEN), an independent technical supervisory organization, the Instituto Brasileiro da Qualidade Nuclear (IBQN), contracted by the applicant and approved by CNEN, evaluates and approves suppliers of items and services, ensures that equipment complies with requirements, and carries out independent inspections during construction and commissioning with the right to accept or reject products and installations. Having accepted the Agency's QA

standards, with additional requirements for independent inspection, the Brazilian regulatory authorities are endeavouring to establish a system having the characteristics of both system-oriented QA, which is typical of the Agency's approach, and product-oriented QA, which is the main characteristic of the existing QA practice in the Federal Republic of Germany.

An attempt to improve QA effectiveness by introducing additional independent verification typifies not only Brazilian practice but the general trend in nuclear power activities both in Latin America and elsewhere. QA problems have been revealed at nuclear sites and at manufacturers' plants in the USA, Latin America, and Europe, and there is a tendency to improve the quality of plant by introducing stricter regulations, related to independent verification activities carried out by the regulatory authority itself, or by contracting independent inspectors to inspect and test equipment or to carry out QA audits. Discussions at the seminar showed that even countries which are not considering the establishment of an independent inspection agency are looking for new methods of improving quality by tightening regulatory QA reviews and inspections, laying down stricter technical specifications for equipment and so on. It was suggested that to obtain a more effective QA system the Agency should elaborate in some detail the interface between the QA activities to be performed by the plant owner, and the inspection and review functions of the regulatory organization.

Engineering requirements

An important element in implementing QA functions is the identification of engineering requirements and acceptance criteria for the inspection and testing of plant equipment both during manufacture and after installation on site. The Code specifies two types of requirement related to inspection and testing. First is programmatic control to ensure that the necessary inspections and tests are adequately accomplished, and second is the specification of the inspections and tests which should be performed, which are given only in general terms in the Safety Guides.

There seem to be no special difficulties in establishing and administering a system of control of inspections and testing during manufacture and construction. It seems that all current systems are consistent, irrespective of the national engineering standards followed. However, the second type of requirement is not specified in the Agency's Safety Standards in sufficient detail to ensure consistency and uniformity in inspection and testing activities, in particular proof-testing in manufacture, and post-installation testing. The national engineering standards of exporting countries are used, but the problem of ensuring uniformity in inspections and test requirements remains. It was suggested that the Agency should involve itself in the preparation of guidelines for the inspection and testing of important systems and components such as pressure vessels, pumps, heat exchangers, and so on. Such guidelines would address in particular the qualification testing of mechanical and electrical equipment, and proof-testing to verify adequacy of manufacture or installation. Close co-operation with other areas of the NUSS programme and possibly with the International Organization for Standardization will be necessary if such problems are to be solved on a multilateral basis.

Future rôle of the Agency

The Agency's rôle in the promotion of nuclear safety standards related to QA is not limited to the development of documents and to dispensing information about their content and place in national regulatory schemes. Reviews of experience in the implementation of QA documents showed that in a number of situations it will be necessary to interpret requirements and to adapt them to the existing situation in Member States. The Agency was urged to create a system for replying to queries raised in connection with implementation. Member States and individual organizations which use the documents in, for example, the formulation of regulatory requirements or contractual agreements, could obtain in this way an authoritative interpretation when questions arise.

The prepared and published QA documents represent minimum requirements and basic recommendations for the implementation of a QA programme in nuclear power projects. However, to provide more detailed guidance on specific QA activities, it was urged that the Agency should continue to collect good QA practices and issue them in the form of Users' Manuals or other types of publication. In particular, guidance is needed on the specification of inspections and tests to be performed during manufacture and installation, test acceptance criteria, checklists for inspections and audits, test procedures, etc. Also, for implementation of QA in site selection and investigation, commissioning and operation, additional guidance should be developed.

The need for qualified QA personnel in Latin American countries is increasing as national power programmes develop, and with growing national participation in all phases of nuclear power projects. The Agency was requested to assist in the training of personnel by supporting national training courses and seminars and organizing practical training of QA/QC personnel at nuclear power plants abroad.