Nuclear plant safety & performance: Elevating standards of quality assurance

Under its Nuclear Safety Standards (NUSS) programme, the IAEA has revised the standards for quality assurance of nuclear power plants

by Nestor Pieroni

Over the past five years, nuclear experts have worked to review and revise a wide body of documents that lay down quality assurance standards for the world's nuclear power plants. The work was done within the framework of the IAEA's Nuclear Safety Standards (NUSS) programme, which was set up in 1974 to lay down advisory standards useful to national authorities responsible for regulating the safety of nuclear plants. A comprehensive revision of the complete set of NUSS standards on quality assurance was approved and issued in 1996.

The result of the extensive and complex revision was the production of 15 NUSS documents: one Code and 14 supporting Safety Guides, which the IAEA issued in 1996 as a single publication, Safety Series No. 50-C/SG-Q. The revised standards offer a simplified set of basic requirements and implementation methods that facilitate for regulatory bodies the establishment of requirements and the measurement of their fulfillment; formulate clear responsibilities for responsible organizations for achieving improved quality and safety performance; and provide additional guidance on methods to fulfill the basic requirements.

This article highlights major elements of the revision process and key features of the revised quality assurance standards in selected areas.

Revision of quality assurance standards

Under the NUSS programme, more than 60 documents, including Codes and Safety Guides, have been published over the past two decades. The Codes establish the objectives and basic requirements that must be met to ensure adequate safety in the operation of land-based nuclear power plants. The Safety Guides describe acceptable methods of implementing particular parts of the relevant Codes. Although Codes and Safety Guides establish an essential basis for safety, they may require the incorporation of more detailed requirements in accordance with national practice. The NUSS programme covers five areas: governmental organization, siting, design, operation and quality assurance. Each area includes one Code and several supporting Safety Guides. Revisions and reissues of the Codes and Safety Guides are made as needed in order to take account of lessons learned and to incorporate new developments in technology and methods.

The development of the NUSS standards — whether the production of new documents or the revision of the existing ones — is accomplished by an elaborate and comprehensive process directed to achieve consensus among the IAEA's Member States. The resulting documents, therefore, reflect harmonized views and experience collected from around the world.

As in each of the NUSS areas, a specific Code on quality assurance and the corresponding Safety Guides were first developed during the period 1974-84. After the Chernobyl accident in 1986, the Code was revised with the intention to verify if lessons learned from that accident should be reflected in the document. The resulting revision was issued in 1988, though it was found that no essential change as a consequence of the accident was necessary. In fact, it was indicated that the Chernobyl case showed the consequences of *not* following the procedures and requirements normally implemented through an effective quality assurance programme such as recommended in the NUSS documents.

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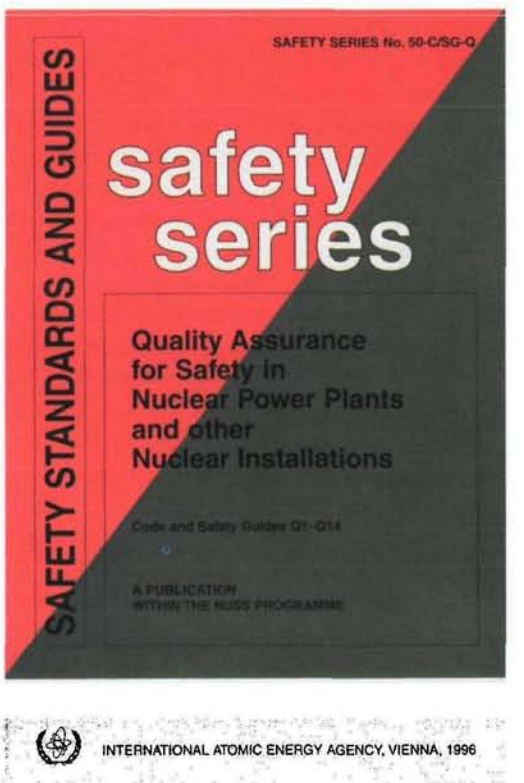
The review in the 1980s also showed that effective implementation of requirements encountered a number of difficulties depending on the particular country or organization. The IAEA thus tried to identify specific causes. Some typical issues that were identified include:

- interpreting quality assurance requirements as solely regulatory, as if they had no beneficial effect on work performance;
- viewing a good quality assurance programme as only demanding many written documents and procedures, i.e., it is only concerned with "paper work";
- assigning responsibility for quality only to the quality assurance unit;
- auditing for compliance with formal requirements without analyzing the final results;
- not recognizing that management and workers have the main responsibilities in the achievement of quality assurance results;
- being unaware of the importance of adequate qualification and motivation of personnel;
- not assessing the effectiveness of the quality assurance programme;
- not providing clear management support and commitment to the implementation of the quality assurance programme.

This situation largely prompted the need to revise NUSS documents on quality assurance, and the work was initiated in 1990. The revision process took almost five years because of the need to reach consensus, a requirement for the issuance of IAEA safety standards. Seventeen advisory and consultancy meetings were held, involving more than 70 experts. Altogether they represented 22 IAEA Member States and three international organizations, namely the European Community (EC), European Atomic Forum (Foratom), and the International Organization for Standardization (ISO). All the proposed revisions were submitted to IAEA Member States and international organizations for review before approval. A total of 3300 comments were received, an indication of the interest, vigorous participation, and effective support provided to the revision process.

Highlights of specific changes

As part of the revision process, the IAEA performed an analysis of the main reasons for variation in the performance of the world's nuclear power plants. A summary of the findings from this analysis includes the following key conclusions:



Above*: Japan's Genkai nuclear power plant.** ***(Credit: JAIF)

***Left:* Revised standards for quality assurance at nuclear plants were issued in 1996 in the IAEA's Safety Series.**

- practices that ensure operational safety are the same as those that improve overall plant performance;
- top management that supports disciplined operations is essential for achieving plant safety, and therefore reliability and economic performance objectives;

The focus on overall performance, including safety and other plant objectives, and the emphasis on the essential role of management were considered the driving elements that contributed to avoiding misinterpretations of, and failures to effectively implement, quality assurance requirements.

Main changes incorporated in the revision. The concept applied in the revision procedure sought to instill a performance-based approach to quality assurance, an approach that positively influences plant safety, reliability and economics. The overriding principle is that safety shall not be compromised for reasons of production or economics, or for any other reason. The approach emphasizes the key management responsibility and accountability for all aspects of quality of performance, including planning, organization, direction, control and support.

Since the approach looks for total quality, it helps to align people and activities towards the achievement of established requirements. To succeed, it is necessary to integrate the contributions that are made to quality and safety by the people managing it, those performing the work, and those assessing it.

The substance of the changes incorporated by the IAEA in the revision process emphasized the following:

- achievement of overall performance objectives;
- the responsibility of everyone regarding achievement of the objectives;
- the key role and commitment of managers;
- provision of additional guidance on quality assurance activities directed to assessment, siting, commissioning, decommissioning, research and development, non-conformance control and corrective actions, training and qualification, and instrumentation and control.

Simplified standards. In order to reflect the world experience evaluated by the IAEA, the revised documents enhance the essential responsibility of everyone in achieving performance objectives. The revised Code divides the responsibilities into three functional categories: management, performance and assessment. In correlation with these categories, ten basic requirements are established. They are the ones whose fulfillment has to be demonstrated by the responsible organization to the satisfaction of the regulatory body.

Some changes were made to provide guidance on the implementation of each basic requirement of the Code in each of the six licensing stages. Specifically, the content of the existing Safety Guides was rearranged and new Safety Guides were developed. The guidance contained in the Safety Guides, although not the only means of fulfilling the basic requirements of the Code, represents implementation methods that are generally accepted and have been proven by experience. The Code and Safety Guides integrate a complete and consistent set of guidance structured within a clear framework for safety regulation.

Global safety standards. The revised standards take into account international industry standards, such as ISO 9000 standards for quality management. There are fundamentally two application levels of standards set by NUSS and the ISO. The *establishment level* concerns the interface between the regulatory body and licensee/responsible organization (owner or operator of the nuclear power plant). The nuclear safety requirements are established by the regulatory body and their accomplishment must be demonstrated by the responsible organization. The NUSS documents provide the safety requirements and methods that may be applied at this level. The *implementation level* concerns the interface between responsible organizations and suppliers. The contractual agreements, including nuclear safety and other requirements, technical specifications, schedule, costs and other obligations, have to be arranged. The ISO standards (as well as other national or international industry standards) may be applied at this level. Additional measures are sometimes needed to complement the industry standards so as to meet the safety requirements for nuclear items and services.

Quality system respective to suppliers. The NUSS standards require that a quality assurance programme be established and implemented for all items and services affecting the safety of nuclear power plants. The supplier organization might have established a quality system as part of its way of doing business. If a quality system exists in the supplier organization, the establishment of the required quality assurance programme would be facilitated. However, the mere existence of a quality system is not enough to fulfill the safety requirements. The NUSS standards require a specific quality assurance programme for the nuclear items and/or services, irrespective of whether the organization has a quality system in place or not. It is the performance of the delivered products that is relevant and not (only) the implementation of the quality system of the supplier organization.

Quality certification. Since they are focused on performance and quality of the final product, the NUSS standards do not require reliance on any type of certification. Certification may lead to the undesirable consequence that priority is shifted to a mere compliance with procedures and documentation instead of conformance

with specifications. Concentration on documentation and procedures — which are certainly necessary — is not sufficient to ensure the effective implementation of a quality assurance programme. The NUSS quality assurance approach, by re-emphasizing product quality as the main goal, de-emphasizes reliance on certification programmes provided by third parties. It is the pursuit of quality rather than the pursuit of certificates that is intended.

Personal attitudes. As indicated earlier, the performance-based quality assurance approach does not place the responsibility, initiative and effort solely upon managers and supervisors. Emphasis is given to the essential role of managers, but it is also placed on the inescapable responsibility of everyone: managers as well as operators and verifiers. They all contribute to the final achievement of quality.

This entails the acceptance of personal responsibility for the assigned task. This responsibility is not diluted because of responsibilities assigned to others. Everyone understands that the assigned work has to be performed "right the first time". Each person feels the sense of responsibility, endeavours to correctly accomplish the work and enjoys the satisfaction of achieving the final aim if this is successful. If it is not successful, the person will try to improve his/her contributions, if this is possible, because he/she is not indifferent or passive, but part of the overall achievement.

The approach thus demands particular efforts, such as: deeper and frequent training, a permanent search for information, improved communication, strong discipline, creativity and permanent striving for improvements. The pursuit of quality ends up being an entirely voluntary and personal attitude.

Grading of quality assurance. The IAEA standards are primarily directed towards the safety of nuclear power plants and make no explicit statement regarding costs. This does not imply a disregard of the impact that costs have in nuclear power production, as they do in any other human activity.

In connection with the fulfillment of quality assurance requirements, part of the costs are related to the content and volume of documents and records, details of procedures, the type of verification and testing, and qualification skills. The NUSS quality assurance Code establishes the use of a graded approach, based on the relative importance to nuclear safety of each item, service or process. The approach reflects a planned and recognized difference in the application of specific quality assurance requirements.

Management — which is responsible for planning, direction and resource considerations — has to define the essential procedures, activities and documentation that must be controlled, on the basis of their relative importance to nuclear safety. Management further establishes the content of important records, the essential data that are to be maintained and the applicable scope of quality assurance verification activities. This assures that time and money are not wasted on activities not essential to the quality of the product or service, thereby preventing unnecessary and uncontrolled costs associated with nuclear quality assurance programmes.

Benefits to users

The revised Code holds the following benefits for users:

Regulatory bodies. The contents of the revised Code are arranged in a form that is much more suitable for incorporation in a national regulation than its predecessor. It contains only basic requirements that must be satisfied to ensure safety. Therefore the main text has been significantly condensed and contains only "shall" statements, meaning strict requirements.This facilitates the functions of the national regulatory body that desires to make the contents directly applicable to the activities under its jurisdiction. All the guidance on how to implement the ten basic requirements has been included in the corresponding Safety Guides.

Responsible organizations. The requirements to be fulfilled by the responsible organization also are more clearly formulated. This helps the function of the regulatory body because it provides precise elements against which work performed by the licensee can be subjected to regulatory inspections and follow up. Quality assurance further is integrated with normal plant management, making quality assurance an effective contributor to nuclear power plant safety and reliability. Since all personnel are involved actively, they remain committed to a process that supports and enhances their work results.

Additional guidance. New or revised specific recommendations are included to fulfill quality requirements regarding siting, commissioning, decommissioning, research and development, grading, instrumentation and

control, non-conformance control and corrective actions, training and qualification, and assessment.

Overall benefits. The standards serve to enhance plant safety, by focusing on the performance and the effectiveness of day-to-day work in all stages of the nuclear power plant.

A look ahead

In recent years, quality assurance activities have become intrinsic components of managing, performing and assessing work. As a consequence, these activities are progressively detached from the exclusive fulfillment of requirements from a particular quality assurance standard. They are instead incorporated as common practices. As a consequence, activities that would currently be identified as part of a quality assurance programme are not necessarily perceived in that way anymore.

In some organizations trying to enhance the quality of performance, a specific unit or department with specifically assigned responsibility for quality assurance does not appear in the organizational charts. This is because such responsibility is shared and accepted by every individual involved. These organizations have built up an environment that integrates people qualified and motivated for accepting and accomplishing responsibilities; systems and procedures tailored to the particular work; and hardware and installations operating in accordance with established specifications.

The successful organizations are characterized by an effective quality culture, manifesting itself by the following features:

- Management is consistently involved in plant activities, promotes staff accountability and sets high expectations for performance.
- Performance objectives are included in the organization's policy documents and procedures, integrated into staff training and work programmes, communicated to contractors prior to work commencement and reinforced by management staff in daily communications and meetings.
- Management dedicates permanent attention to performance data and their trend analysis, identification of performance deficiencies and associated root causes and development of performance improvement programmes with provision of adequate resources.
- Responsibility to achieve quality and to verify its achievements is assigned to those performing the task and their associated line management, who in all their activities make safety precede production objectives.

In accomplishing their policy and objectives, organizations with vigorous quality-raising initiatives have evolved beyond the fulfillment of requirements established in safety and industrial quality assurance standards. In fact, environments with this type of culture are progressively less dependent on the fulfillment of requirements established in quality assurance standards. This is because these requirements are automatically accomplished by the normal way of work performance.

If we allow our imagination to project into an ideal future where such a culture would be universally implemented, the need for quality assurance standards would be minimized. The successive revisions of present standards would be consistently streamlining the contents, because fewer and fewer requirements would need to be established.

The final goal in this ideal picture would be a future standard making all quality assurance requirements converge into just one single and unmistakable item. This could, for example, be plainly stated as "doing things right the first time and improving thereafter".

This vision does not intend to suggest that quality assurance standards will cease to be needed, particularly in the field of nuclear safety. It only invites us to look ahead, with the intention of progressing towards the creation of a quality culture that integrates quality assurance requirements as an indivisible component of every work performance. This will allow simpler standards and will contribute to an improvement of the present situation where sometimes proliferating, overlapping and contradictory requirements, methods, and terminology impair the understanding and achievement of the quality objectives.

The IAEA's revised NUSS standards on quality assurance for nuclear power plants offer a simplified set of basic requirements and implementation methods. They clearly convey the application of global nuclear safety requirements and provide guidance consistent with worldwide industry standards. They thus address the interests and concerns of regulatory bodies, operating organizations, and suppliers. In years ahead, the stronger development of a culture aimed at achieving a rising excellence of performance will allow formulation of even simpler and more effective quality assurance standards. ❐