NUCLEAR SAFETY PHILOSOPHY and DEVELOPMENT OF
THE N286 STANDARDS

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To begin, it would be appropriate to provide you with some background on the origin, mandate and duties of the Atomic Energy Control Board (AECB).

In 1946, Parliament passed the Atomic Energy Control Act, thus creating the AECB to implement and administer the Act. It was authorized to control atomic energy materials and equipment and to participate in measures for international control of atomic energy. Originally, the AECB was the reporting channel for the entire Canadian atomic energy programme including the original Chalk River Project. The Act of 1952 gave the responsibility for research development and the promotional aspects of the nuclear programme to the Atomic Energy of Canada Limited, and the amendment of 1954 formalized AECB's role to the regulatory aspect only. In short, the AECB today is charged with the regulation and control of all activities which bear in some way on the application of nuclear energy.

While perhaps the safety assessment and licensing of nuclear-electric power facilities is one of the most visible tasks of the Board, it is certainly not the only one. Other types of nuclear facility subject to the AECB licensing process, include fuel fabrication plants, heavy water plants, research reactors, particle accelerators, irradiators for hospitals, universities, medical equipment and industrial radiography, uranium and thorium mines, and radioactive waste management centres. The possession of radioisotopes, the export of nuclear-energy-related hardware or technology, are other activities for which prior permission from the AECB must be obtained. The AECB is also responsible for ensuring the implementation of Canada's nuclear materials safeguards policy at home and abroad. This involves strict inventory control of irradiated materials. At home, Board staff work with visiting International Atomic Energy Agency Safeguards Inspectors making sure that the full-scope stipulations of the UN 'Treaty on the Non-Proliferation of Nuclear Weapons' are being complied with. As technical advisors to the Department of External Affairs, Board staff play a leading role in the establishment of strict safeguards agreements with foreign countries purchasing Canadian nuclear material.
In the context of nuclear facility regulation, the Board's mandate is not limited only to the initial safety assessment of and the final granting of a licence for a facility. Rather, for example, the regulatory interest covers the siting, procurement, design, manufacture, construction and installation, commissioning, operation and decommissioning activities of each project.

The overall licensing process, therefore, becomes the means by which the AECB gains assurance that a nuclear facility will be sited, designed, constructed, commissioned and operated in compliance with safety criteria and requirements. Early communication from the applicant and ongoing surveillance by AECB staff over all safety-related activities in each phase of the project, from the initial conceptual design of the facility, through to its mature operation, is essential. Not only is the view of the end product of each of the applicant's activities important, but more particularly, the review of the process which produces these results. The intent is to identify points of contention at as early a stage as possible. In this manner situations which place the applicant under economic pressure to resist changes required by AECB staff for safety reasons, are avoided. This concept should sound familiar to those of you in the manufacturing sector.

Historically, the activities performed by AECB staff have been of an evaluation and verification nature. The step, therefore, to recognizing the need for applicant and licensee quality assurance programmes, was a small one for the AECB staff to take, so that now, in order that assurance that all of the requirements of the licensing process be satisfied, a comprehensive quality management programme is required from the owner. Early in the licensing process, therefore, the scope of the licence applicant's Quality Assurance Programme, including such things as his internal and external lines of communication, the identification of applicable standards, codes and safety guides and a matrix of the specific safety analyses to be performed, is reviewed.

The AECB requires that the licence applicant establish and implement an effective assurance programme that covers the entire life of the facility from initial design through to operation and decommissioning. The programme is made up usually of constituent programmes applied to design, procurement, manufacture, construction, commissioning and operation. It is the applicant's responsibility to ensure that an overall quality assurance programme covers both the integration of the constituent programmes and also the effective transition from one to the next. Influencing the satisfactory accomplishment of this responsibility, is the basic principle
of being able to assure coverage of an activity, even before that activity begins. The applicant must have already established the constituent quality assurance programme that applies, have it reviewed and approved by AECB staff and be in a position to implement it when it is needed.

To accomplish this, during the phase leading up to the issue of a construction licence, the applicant must, at an early stage, submit for AECB approval, a report describing the overall quality assurance programme, together with the details of those constituent programmes that must be in place prior to issue of a construction licence. An outline of the remaining constituent programmes must also be included. At the time of application for a construction licence, the programmes for design and 'long-lead' item manufacture, must already have been implemented and the programmes for procurement, manufacture and construction must be in place.

There can be no doubt, that a well-tuned quality assurance programme is essential to ensure that the highly complex structures, systems, and components, which constitute a nuclear power station, are subjected to a systematized management process through all phases of the project, if the station is to perform safely and to specification.

Take, for example, the activities taking place between the licensee and AECB staff as part of the design function. The initial challenge for the owners quality assurance programme is to demonstrate how regulatory requirements are to be met. It must describe, therefore, the management system, which has been organized to transform the basic safety criteria set by the AECB, into first of all a set of detailed instructions that communicate to the designers, the particular requirements and standards that must be met by safety-related systems. The outcome of this phase is a reference design which fixes the major parameters of the facility and identifies its component systems, major components and structures. The specific safety analysis required, must also be identified.

The design at this point must have been established so that the plant is both able to withstand and to mitigate, the postulated individual events and combinations of events. The applicant must demonstrate that the predicted ultimate consequence of these events falls within the criteria set by the AECB.

The detailed design process follows. Design specifications and design descriptions are prepared. Included in the design review is an AECB requirement for the designer to evaluate the proposed design and prepare estimates of the radiation exposure that will result from foreseen operating conditions and both routine and non-routine maintenance activities. The intent is
to demonstrate that the station has been designed to reduce such exposures to a level that is "as low as reasonably achievable, economic and social factors taken into account". In addition, the applicant must demonstrate that the facility design adequately provides for requirements arising from commissioning activities; testing during both commissioning and normal operation and in-service inspection.

Design reviews continue until the design and safety analysis programmes have reached the stage, such that any additional work that remains would not result in any further significant modifications. Once this point has been reached, the applicant is in a position to complete the safety analyses required to support his application for a construction licence. Although detailed design work may continue beyond this point in time, the scope of the remaining work will be limited to those areas that will not adversely affect the result of the safety analyses. An AECB decision on the suitability of the application for construction licence follows.

To this point, I have referred only to some design activities which individually are time-consuming, require long lead times, detailed planning, staffing, co-ordination both internally and externally, and the precise determination, identification and accomplishment of requirements in an orderly structured manner. The sheer magnitude of these tasks individually, not to mention their integration into an overall quality management programme, which assures, that a nuclear power station and its many structures, systems and components are designed, manufactured, constructed, tested and then operated safely, is formidable and in former times was never considered in the context of quality assurance. By the same token the safety assessment, licensing and compliance checking of nuclear power stations performed by the AECB staff were never referred in a quality assurance sense even though they are quality assurance activities i.e. they too represent planned and systematic actions necessary to provide adequate confidence that structures, systems and components will perform satisfactorily in service.

One might wonder why then, and with good reason, - in view of the high degree of safety and successful electricity production achieved with Canadian CANDU reactor power plants, - why the status quo, the former way of operating without formal quality assurance programmes, should be considered for changes. In the AECB's view, there are very good reasons for making changes.

The nuclear power programme in Canada has expanded in recent years. At the present time, a great deal of nuclear facility manufacturing and construction activity is in progress. As a result, all of us face an increased challenge if we are
to do our jobs in an orderly and consistent fashion. We cannot hope to meet this challenge properly, without rationalizing our approach to quality and quality assurance. Quality assurance has to become more visible, more identifiable and there are positive signs which indicate that this is happening. I can remember that, not too long ago, many individuals were breaking their legs jumping off the quality assurance band-wagon. Now, they are scraping their knees to get back on. The assurance of quality must become better organized and better co-ordinated; and it is. The assurance of quality in individual areas of activity must be conducted according to discrete programmes, which should then be integrated into a single overall quality assurance programme, so that a complete and coherent quality picture of each new station emerges. This concept is essential if the designer is to design not only what is safe but also what can be manufactured and installed and what, at the same time, can be inspected during manufacture and operation. It also means that the purchaser will develop histories on his suppliers, and alternate suppliers if need be, so that unqualified or undependable suppliers can be avoided. Expertise and quality results must be demanded not only from the welder and the fitter. They must also be demanded from the designer, the procurement engineer the constructor and the operator. Quality planning and quality results must be demanded and expected from everyone, performer and verifier, but especially from the performer. Correction of quality deficiencies as to cause, must also consider the contribution, (or lack of it) by supervisory and management staff, towards achieving stated goals. Their actions must be consistent with stated policy.

I'm sure that some of you have at one time or another heard mention of the "Pareto Principle". The Pareto Principle was coined by Juran when he erroneously identified Lorenz curves with Wilfredo Pareto. M.O. Lorenz drew up charts of the kind such as this, to show the maldistribution of wealth in the world. Applied to the control and assurance of quality, Juran stated that there is maldistribution of quality losses. The losses, quality problems, quality deficiencies call them what you will, are never uniformly distributed. Rather they are always maldistributed in such a way that a small percentage which we call "the vital few", always contributes a high percentage of the quality loss.

It is the AECB staff's view, that management commitment and the discharging of responsibility are in that "vital few" category.

Nuclear power station quality and the assurance thereof is vital to the safety of these plants. Anything less than a total commitment, or the non-recognition of individual, divisional or corporate responsibility by designers, manufacturers,
inspectors, constructors and owner-operators and even jurisdictions, the achievement of quality and the assurance of the quality of structures, systems, components, and administrative activities. on which the nuclear safety of these plants depend, is clearly unacceptable. We believe that nobody can afford a half-hearted or divided approach to quality.

So much for the general, regulatory argument for the need for demonstrable nuclear facility QA. But how should this requirement be met? What or where are the working level details and requirements?

This question has been addressed by the Canadian Nuclear Association's N286 Sub-Committee on "Nuclear Power Station Quality Assurance". This sub-committee of the main CNA "Codes, Standards and Practices Committee" is composed of members representing nuclear system designers, consulting engineers, constructors, commissioning engineers, equipment designers and manufacturers, electric power utilities and jurisdictions from the three provinces with nuclear power station commitments. To deal with the problem of nuclear power station QA the Sub-committee has initiated a QA standards-writing programme which resulted in the publication of the CSA Preliminary Standards N286, between November 1978 and May 1979.

The first tier standard N286.0 contains broadly-stated requirements for an overall quality assurance programme addressed specifically to the owner of the power plant (although they can just as well apply to the main contractual parties in the project). It specifies the requirements for establishing and implementing an overall QA programme to manage station safety. This standard cross references a series of supporting second tier standards which contain more detailed requirements for various constituent areas of activity associated with a nuclear power station, those areas being design, procurement, manufacturing, construction and operation.

The CSA N286 family of standards have been endorsed by the AECB staff for trial use and quality programmes are currently being evaluated and audited against the N286 requirements by the AECB staff. CSA issues preliminary standards after approval by the responsible Specification Committee, to provide a set of proposed requirements as the basis of further investigations and to obtain the field experience necessary. It is expected, therefore, that some modifications will result from their trial use before the final standard is balloted and issued.
To conclude, therefore, quality assurance has always had an important role in Canada's nuclear power station programme. Since 1975, the Atomic Energy Control Board formally requires that applicants for station licences establish, define, and implement effective quality assurance programmes for each phase of each project. The N286 series of standards should play an important role towards assuring designed, built-in and operating safety in nuclear facilities. It is essential that additional effort be directed towards ensuring that nuclear facilities, as they increase in number, continue to be safe. Effective and well implemented Quality Assurance Programmes can assist greatly in realizing that safety goal. These programmes will not work however, unless the activity performers can see that their immediate supervisors and those all the way through middle management to top management, are committed to assuring conformance to safety requirements, through effective quality assurance programmes. The buzz-words in achieving quality and safety are commitment and implementation. Management must initially make the commitment and then, both management and staff alike, must follow through with effective implementation.

Reference Documents:

AECB-1147 by R.A. Thomas
AECB-1139 by M. Joyce
(figs. 1,2,3 & 4 are from AECB-1139)
Informal Discussions with AECB Staff and Other Agencies Involved

(2.3) Meeting between AECB Staff and Applicant

(2.4) Meetings with Other Agencies to Co-ordinate Activities

(2.5) Applicant Prepares Site Evaluation Report

(2.6) Preliminary Review by AECB

Meetings Between AECB Staff, Applicant and Other Agencies Involved Continue as Required

(2.7) Public Meetings

(2.8) AECB Staff and Safety Advisory Committee Review Site Evaluation Report

(2.9) Review Continues together with Consideration of Outcome of Public Meetings

AECB Staff and Safety Advisory Committee Report to Board

Board Reviews and

Announcement by Applicant

Notes:
1) Numbers in Parentheses Refer to Section Numbers in the Text

FIGURE 2 SCHEMATIC OF ACTIVITIES LEADING TO SITE ACCEPTANCE

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