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TRANSFER OF CANADIAN NUCLEAR REGULATORY TECHNOLOGY

by

J.D. Harvie

Atomic Energy Control Board
P.O. Box 1046
Ottawa, Canada
K1P 5S9

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ABSTRACT

This paper discusses the Canadian approach to the regulation of nuclear power reactors, and its possible application to CANDU reactors in other countries. It describes the programs which are in place to transfer information on licensing matters to regulatory agencies in other countries, and to offer training on nuclear safety regulation as it is practised in Canada. Experience to date in the transfer of regulatory technology is discussed.

RÉSUMÉ

Le présent rapport fait état de la réglementation canadienne des réacteurs CANDU, et de son application dans les pays tiers utilisant ce réacteur. On y décrit entre autres les programmes d'information des agences étrangères sur les questions réglementaires et de formation sur la réglementation de la sécurité nucléaire au Canada. On décrit également l'expérience acquise sur le transfert de technologie réglementaire.

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1. INTRODUCTION

The Atomic Energy Control Board (AECB) is an agency of the Canadian federal government responsible for the regulation of all aspects of the development and application of nuclear energy. Within the AECB there is a group, entitled the Orientation Centre, which has the specific responsibility for the transfer of technology on regulatory matters to nations which purchase or consider purchasing CANDU reactors, with the objective of assisting overseas regulatory agencies to develop the ability to license reactors of Canadian origin.

The technology transfer is achieved largely through training programs, which include courses and on-the-job training in Canada, and seminars presented in other countries. In addition, the Orientation Centre, with technical support from other staff of the AECB, supplies information to foreign regulatory agencies on the Canadian approach to nuclear safety and on specific AECB licensing requirements. Furthermore, it may enter into agreements on the exchange of information on safety-related incidents or new regulatory requirements. While the AECB clearly does not make rulings on licensing situations overseas, its Orientation Centre is responsible for communicating to foreign regulatory agencies the AECB view on specific licensing questions which may arise on CANDU reactors in countries outside Canada.

2. REGULATION OF NUCLEAR REACTORS

2.1 Canadian Approach to Regulation

The Canadian philosophy on the safety of nuclear facilities is based on the underlying principle that the licensee (owner/operator) bears the primary responsibility for safety while the regulatory authority (AECB) primarily sets safety objectives and some performance requirements, and

audits their achievement. As a consequence, regulatory requirements have emphasized numerical safety goals and objectives and minimized specific design or operational rules. This approach is intended to achieve the fundamental objective of ensuring that adequate safety is achieved, while it permits flexibility and does not discourage innovation by designers by forcing adherence to very specific rules.

Licensing criteria for CANDU reactors in Canada have evolved with the development of the CANDU design. Since this design has several unique features relative to other reactor designs, it is not surprising that the licensing criteria are in many areas different from those in other countries. However, the basic objective, ensuring that nuclear power plants do not pose an undue risk during normal operation or postulated accident conditions, is the same.

2.2 Regulatory Requirements

This section summarizes the most important regulatory requirements which are in force in Canada. The historical evolution of these requirements, and a more detailed description of their content, can be found in reference 1. The process by which the requirements are applied in licensing reactors is described in reference 2.

For normal operation, there are legal dose limits both for atomic radiation workers and for members of the public. These limits are consistent with the recommendations of the International Commission on Radiological Protection (ICRP). Operation of the plant and releases of radioactive material must be such that these limits are not exceeded. In addition, a target level of 1% of the legal limit is applied to the emission limits derived from the limits on dose to members of the public.

Reactor process systems must be designed to appropriately high standards such that the frequency of process failures sufficiently serious to require intervention by the special safety systems (defined as serious process failures) does not exceed one per three years. Special safety systems are required in the design, to mitigate the consequences

of such serious process failures, should they occur. These consist of two shutdown systems, an emergency cooling system, and a containment. These systems must be independent both from each other and from the process systems, and must satisfy specified requirements for reliability, testability, etc. Details of these requirements can be found in references 3, 4, and 5.

Reference dose limits have been established for postulated failures of the reactor process systems, and also for dual failures in which a process system failure is assumed to occur when one of the special safety systems is unavailable. Safety analyses are required to demonstrate that these reference dose limits are not exceeded.

In addition, events involving failures of safety-support equipment (such as electrical power or cooling water supplies) must be evaluated to ensure that there is sufficiently adequate equipment to maintain the plant in a safe state following such failures. These evaluations must also demonstrate that common-mode effects which could cause multiple failures in plant equipment have been eliminated as far as possible in the design.

2.3 Documentation of Requirements

There are several types of documents which specify design and operating requirements. Some of these are produced by the AECB, in the form of regulatory documents. Such documents are first issued as "consultative documents" on which the nuclear industry or interested members of the public may comment, and are subsequently formalized as regulatory policy statements or regulatory guides. Compliance with such documents may be specified as a condition of a licence.

Some aspects of reactor design or operation are addressed in documents developed by the nuclear industry, in some cases with AECB participation, and published as national standards by the Canadian Standards Association (CSA). These standards may be developments of foreign or international (IAEA) codes and standards to address aspects

which are specific to the CANDU design. If the AECB considers such consensus to be appropriate, it may accept their use as sufficient assurance of adequate standards of safety, and AECB regulatory documents addressing such aspects are unnecessary. In some cases, the AECB may specify additional requirements which supplement those specified in the standards.

Finally, reactor designers may document requirements or commitments in the form of design guides. Such documents may be accepted by the AECB as a satisfactory method of achieving an acceptable design, although once again in some cases additional requirements are imposed.

While significant documentation exists on the licensing requirements for CANDU reactors, there are many aspects of CANDU design and operation for which specific documented licensing requirements do not exist. Rather, acceptable design has been achieved by precedent and by an iterative process by which the AECB has accepted or rejected various design proposals. This approach is consistent with the Canadian licensing approach discussed in section 2.1 above, in that it allows greater flexibility and does not discourage innovation by the designers by forcing adherence to very specific rules.

However, as a consequence of this approach, a comprehensive list of detailed licensing requirements, sufficient to ensure a licenseable plant, does not exist for CANDU reactors in Canada. It is important that potential purchasers of CANDU reactors, and licensing authorities in such countries, recognize this, and organize the licensing process accordingly.

2.4 Implementation of Requirements

The AECB assigns on-site project officers to each reactor complex to inspect and monitor the performance of the licensees and to ensure compliance with licensing requirements. These project officers are required to be very knowledgeable and experienced in all aspects of power reactor safety, and to have a thorough knowledge of the plant to which

they are assigned. They are stationed permanently at the reactor site during commissioning and operation of the plant. The duties of the project officers include coordination of reactor safety reviews, routine plant inspections, and follow-up of events which occur in operation. They also witness major commissioning tests and, where appropriate, give approvals which are required in accordance with conditions of the licence.

The on-site project officers are supported by groups of experts at head office who carry out detailed reviews of specific aspects of design and operation. These AECB staff members have a greater depth of expertise in specific engineering disciplines such as thermal hydraulics, reliability, and reactor physics. The detailed reviews performed in such areas complement the more general reviews of the on-site project officers.

The AECB is therefore in a position to make decisions on various aspects of reactor design and operation by careful judgement based on a fundamental understanding of reactor safety principles. This approach is in many areas considered preferable to simple verification of compliance to a "check-list".

2.5 Application to Other Countries

The sale of a nuclear power plant to a foreign country generally involves some agreement on safety criteria and licensing requirements. Such an agreement may contain detailed specification of the requirements to be satisfied on each aspect relevant to plant safety. An alternative approach is to make reference to a similar plant in the exporting country, and to specify a level of safety equivalent to that required to obtain a licence for the reference plant.

Regardless of the type of agreement, many licensing decisions specific to the plant itself must be made, for several reasons. Firstly, site-specific characteristics such as levels of seismicity, meteorology, population distribution and use of surrounding land are likely to be

different from those at any Canadian reactor. Furthermore, cooling water arrangements, and voltages and frequencies used in the electrical grid, have important implications on the design of the plant, and may also be different. The reliability of off-site power supplies, which is an important aspect of reactor safety, may not be the same as that at any reference plant.

These differences may make the "reference plant" approach more complex, or may preclude direct application of licensing decisions in the exporting country to a plant in another country. Equally, safety analyses for which the conclusions could be affected by such site-specific factors must be re-evaluated to take the differences into account.

In addition, the purchasing country generally wishes to maximize the use of locally-supplied material in the construction of the plant. If the materials used are not fully consistent with those used in the exporting country, or if the codes and standards used in the manufacturing process are different, the implications of these differences must be evaluated.

If a Canadian-designed reactor is built in another country, the licensing authority in that country must decide on the philosophy which is appropriate in assessing the safety of the plant. One approach would be to establish a complete set of safety criteria, independent of those in the exporting country, and to evaluate the safety of the plant against these criteria. Alternatively, it might choose to accept that the standards of safety which are applicable in Canada are satisfactory and evaluate only those aspects which result from differences between the plant being constructed and a reference plant in Canada.

From the discussion above, it is evident that the Canadian approach to reactor licensing and its implementation are considerably different from those in many other countries. As a consequence, application of the Canadian approach in other countries poses some unique problems. It is therefore very important that a potential purchaser of a CANDU reactor understands from the outset the Canadian approach and how it is implemen-

ted in Canada. Such an understanding is essential if appropriate decisions are to be taken to achieve a manageable licensing process.

For example, since the Canadian approach requires an understanding of basic safety principles, it might be preferable for a foreign regulatory agency to develop initially a relatively small staff of qualified people with the capability to make sound judgements based on fundamental safety considerations, rather than a large staff geared to the "check-list" approach. The staff could subsequently be augmented as necessary in accordance with the extent of review desired.

2.6 Transfer of Licensing Information

The Atomic Energy Control Board, through its Orientation Centre, supplies information to regulatory agencies in other countries on the Canadian approach to nuclear safety and its application in specific situations. While the responsibility for licensing decisions clearly rests with the licensing authority in the country where the plant is built, the AECB, if so requested, advises of similar decisions which have been taken in Canada, particularly on the reference Canadian reactor if one exists. In cases where a problem with a reactor in another country has not arisen at a Canadian plant, the AECB gives advice on the criteria which would be applied to make a decision if the situation arose in Canada.

Such advice may be given on request, or may involve regular meetings at which Orientation Centre staff, together with AECB staff working on reactor licensing matters in Canada, discuss with regulatory staff of other countries the requirements in general areas such as safety analysis or reactor commissioning.

3. INFORMATION EXCHANGE

The AECB enters into agreements on the exchange of information on safety-related incidents or new regulatory requirements. By this means, regulatory staff in both countries can learn about safety-related

occurrences which may have generic implications. While the transfer of information is initially from Canada to the country importing a CANDU reactor, eventually information is also transmitted to Canada on experience obtained in operation of reactors in the country entering into the agreement. Both countries thus benefit from the exchange of information.

4. TRAINING OF REGULATORY STAFF

The AECB, through its Orientation Centre, offers training courses on all aspects of regulation of CANDU nuclear generating stations for the personnel of nuclear regulatory agencies of other countries. These courses are intended to provide training on the Canadian approach to nuclear safety regulation and its practice, and to transfer the expertise to enable the regulatory agencies to regulate independently nuclear facilities of Canadian origin. While the programs can be designed to meet the specific needs of the trainees, three types of courses have been given in the past.

4.1 Comprehensive Training Programs

Comprehensive training programs are given in Canada and last up to one year. Trainees are given detailed instruction on CANDU design and operation, AECB licensing requirements, and CANDU safety analysis. On-the-job training is also included, for which the trainee works with AECB regulatory staff both in the head office in Ottawa and in the offices at reactor projects. Such training programs thus give the trainee both the theoretical knowledge required, and practical on-the-job exposure to its application in real situations at nuclear power plants.

The training programs have also included periods of attachment to other organizations associated with reactor safety, such as the Boiler and Pressure Vessels Branch of a provincial Department of Labour. Equally, periods of attachment to quality assurance groups in the design and/or construction teams have been arranged. Such arrangements recognize

that the role of the regulatory authority in other countries may be different, or have a different emphasis, from that of the AECB in Canada.

4.2 Short-term Orientation Programs

Short-term orientation programs are intended for experienced nuclear regulatory personnel who are familiar with CANDU technology. These are also given in Canada, and last for up to two months. The programs concentrate on on-the-job training and have the objective of training the personnel in Canadian regulatory requirements and the Canadian approach to regulating the design and operation of nuclear reactors. The objectives of these programs are similar to those of the comprehensive programs, but they are designed for people with more experience and are less comprehensive in scope.

4.3 Short-term Training Courses

Training courses are given in the country of the trainees, and are intended to reach a wider audience than the programs offered in Canada. Such courses have been given in the form of one-week intensive sessions on subjects such as reliability of safety systems, assessment of safety analyses, and compliance monitoring at operating reactors. While the courses are intended for a regulatory audience, in the past, researchers and utility staff have also attended. The courses include lectures, discussions, and workshops.

5. EXPERIENCE TO DATE

Information meetings, organized either on a formal or ad hoc basis, have been held with regulatory staff from such countries as Argentina, Korea, and Romania. Long-term training programs have been given to several people from Korea and to two from Turkey. Short-term orientation programs have been given to staff from a variety of countries. Seminars or workshops have been given in Korea on several occasions, and also in Turkey and Romania. A formal information exchange agreement exists

between the regulatory agencies of Canada and Korea. In addition, ad hoc advice and information have been given on many occasions to CANDU purchasers outside Canada.

6. CONCLUSION

The AECB, through its Orientation Centre, gives training to regulatory staff from other countries and supplies information on the Canadian regulatory approach and requirements. The methods discussed in this paper have been used successfully to transfer nuclear regulatory technology to various countries which have purchased, or considered purchasing, CANDU reactors.

REFERENCES

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3) "Requirements for Containment Systems for CANDU Nuclear Power Plants", AECB Consultative Document C-7/Rev. 1, May, 1982.

4) "Requirements for Shutdown Systems for CANDU Nuclear Power Plants", AECB Consultative Document C-8/Rev. 1, May, 1982.

5) "Requirements for Emergency Core Cooling Systems for CANDU Nuclear Power Plants", AECB Consultative Document C-9/Rev. 1, May, 1982.