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SAFETY AND LICENSING PHILOSOPHY AND EXPERIENCE AT ONTARIO HYDRO NUCLEAR GENERATING STATIONS

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Abstract — *The safety and licensing philosophy adopted by Ontario Hydro in establishing the need for retrofit design modifications to CANDU nuclear generating stations in operation since the early 1970's is discussed. This philosophy was developed in response to regulatory requests to determine whether this need exists in view of the more extensive safety and licensing design features incorporated in recent CANDU nuclear generating stations compared to the earlier designs. These additional features generally reflect evolving safety knowledge and licensing requirements over time.*

The general safety and licensing retrofit philosophy developed by Ontario Hydro is based on a number of principles which recognize the basic design effectiveness and adequacy of the earlier nuclear generating stations as demonstrated by their safe and reliable operating experience to date. In addition, it is recognized that the retrofit review and assessment process must be carried out in an orderly and controlled manner according to areas of priority and that basic differences in the reference designs of the recent and earlier station designs must be acknowledged, as well as the licensing criteria and standards under which the original designs were licensed. These principles establish the practicality and extent of design retrofits, if deemed necessary.

Examples are given of the application of this retrofit philosophy to the Pickering "A" and Bruce "A" nuclear generating stations and the experience acquired to date in implementation of design modifications.

Note: *The views expressed in this paper are from a utility standpoint and do not necessarily reflect those nor imply concurrence of the regulatory authorities.*

INTRODUCTION

Ontario Hydro, the electrical utility owned by the Province of Ontario, has been operating nuclear power stations since 1962, when the 22 MWe Nuclear Power Demonstration Nuclear Generating Station (NPD NGS) of the CANDU design went into service. Since then, Ontario Hydro has concentrated on constructing and operating multi-unit CANDU stations as part of its nuclear generation program.[1]

TABLE 1

ONTARIO HYDRO
NUCLEAR GENERATION PROGRAM

Station	Unit	Net Capacity MWe	In-Service Date
NPD NGS	Single Unit Station	22	12/62
Pickering NGS "A"	1	515	7/71
	2	515	12/71
	3	515	6/72
	4	515	6/73
Pickering NGS "B"	5	516	5/83
	6	516	2/84
	7	516	1/85
	8	516	1/86
Bruce NGS "A"	1	754 (775)*	9/77
	2	754 (775)*	9/77
	3	754 (775)*	2/78
	4	754 (775)*	1/79
Bruce NGS "B"	5	830	3/83
	6	830	9/84
	7	830	4/86
	8	830	1/87
Darlington NGS "A"	1	881	5/88
	2	881	2/89
	3	881	9/91
	4	881	8/92
Total (In Operation and Under Construction)		14006	

*Figures in brackets include the electrical equivalent of steam production

This program, and its expansion with time expressed in terms of the unit in-service dates, is summarized in Table 1.

The approach to nuclear power safety in Canada is based on the fundamental principle that the licensee (owner/operator) bears the basic responsibility for safety, while the regulatory authority [the Atomic Energy Control Board (AECB)] primarily sets safety objectives and some performance requirements and audits their achievement (Reference 1). Within this framework, this paper discusses the approach taken by Ontario Hydro in developing a safety and licensing philosophy for determining the need for retrofit design modifications to the earlier nuclear generating stations in operation since the 1970's. This philosophy was developed in response to regulatory requests in view of the more extensive safety and licensing design features incorporated in current design CANDU nuclear generating stations, eg, Pickering NGS "B", Bruce NGS "B", compared to the earlier designs. These additional features generally reflect evolving safety knowledge and licensing requirements over time. Of interest to note is that some of the later stations share the same sites, and sometimes even some of the same facilities with the earlier stations, thus making the retrofit issue a rather complex one to deal with. In particular, the decision as to whether a retrofit design modification is required must be based on compelling reasons taking into account considerations of risk, operating experience, plant design and licensing.

PRINCIPLES OF SAFETY AND LICENSING RETROFIT PHILOSOPHY

The process which Ontario Hydro is following for reviewing and assessing the need for safety and licensing retrofit design modifications to earlier plants was developed from a number of basic principles. These principles can be stated as follows:

- Retrofit reviews must be treated in a prudent and responsible manner recognizing the basic design effectiveness and adequacy of existing plants, their operating experience, and design improvements implemented or committed since first in-service.
- The review and assessment process must be carried out in an orderly manner on a case-by-case basis recognizing inherent differences in reference designs as well as differences in licensing criteria and guidelines. In particular, the review should recognize the licensing standards in place when the plant was originally licensed.
- The areas for assessment should be prioritized based on a recognition of those areas with the greatest potential impact on operational safety.
- The need for retrofit design modifications must be based on compelling reasons involving cost/benefit and licensing considerations.
- Significant review findings should be discussed with regulatory authorities on an ongoing basis to ensure common understanding.
- Periodic revision of the Safety Report using current analysis methods will further ensure that licensing documentation is brought up-to-date in accordance with applicable licensing requirements and will further confirm the design adequacy from a safety standpoint.[2]

1 From 1968 to 1984, the 206 MWe single-unit Douglas Point Nuclear Generating Station was also operated on behalf of its owner, Atomic Energy of Canada Limited (AECL).

2 The AECB now requires that Safety Reports for nuclear generating stations be updated once every three years.

APPLICATION OF RETROFIT PHILOSOPHY

A systematic retrofit review and assessment process is currently being applied specifically to Bruce NGS "A" based on the underlying principles as outlined. This is not to suggest, however, that no previous reviews were ever carried out on operating stations for the purpose of determining design adequacy from a safety standpoint. On the contrary, a number of such reviews have been performed on an ad-hoc basis on all operating stations since their operating licenses were first received. These ad-hoc reviews were either generated internally or in response to regulatory requests, covering such issues as reliability of special safety systems, LOCA analyses, TMI-2 follow-up, post-LOCA design reviews, etc. In addition, Ontario Hydro routinely reviews significant events occurring at all operating stations for safety and other implications, eg, production reliability.

The reviews described above generally were carried out in accordance with the safety and licensing retrofit philosophy principles outlined previously. These reviews were initiated as a result of either operating experience (both CANDU and relevant non-CANDU experience) or new safety knowledge derived from R&D work and state-of-the-art analytical capability. The outcome of these reviews frequently have resulted in design modifications or procedural changes to operating stations. The operating records of Ontario Hydro CANDU stations attest to the effectiveness of this process in the maintenance of overall plant safety and reliability.

As identified in the discussion on principles, the need for retrofit design modifications must be based on compelling reasons involving cost/benefit and licensing considerations. The latter are determined by conditions at the time of the initial licensing, specifically, accepted ground rules, accident base cases and conservatism of assessment. The former influence in particular the actual choice of design modification and recognize practical constraints unique to operating stations such as ease of implementation, impact on production, dose considerations, maintenance and testing requirements, etc.

Finally, the process of implementation of the modifications, subject to regulatory concurrence, is generally carried out according to assigned priority level recognizing availability of resources, materials procurement schedules, and impact on continued power production.

BRUCE NGS "A"

Since 1983, a systematic review and assessment process to determine the need for retrofit design modifications to the Bruce "A" Nuclear Generating Station has been in progress based on the principles and criteria discussed previously. This review arose from a regulatory request in view of the number of design changes, many based on safety grounds, incorporated into the Bruce "B" Nuclear Generating Station reference design, and the extent and scope of the supporting safety analyses based on current methodology.

In response to this request, a selection of priority areas for detailed review was made based on:

- a systematic review of the reference design differences between major Bruce NGS "A" and Bruce NGS "B" systems such as special safety systems, the primary heat transport system and the secondary side,
- a systematic review of safety related design changes incorporated into the Bruce NGS "B" reference design and their applicability to Bruce NGS "A".

In parallel with the review effort, the Bruce NGS "A" Safety Report is being completely revised to reflect current analytical knowledge. This process will further ensure that the current plant design is adequate from a safety standpoint and address any other systems not included as part of the major system review identified above.

To date the review and assessment process has resulted in a number of committed design changes such as the provision of Instrumented Pressure Relief Valves in the containment system, provision of hydrogen ignitors to mitigate the consequences of loss-of-coolant accidents involving potential hydrogen release, and provision of an engineered Filtered Air Discharge System (FADS) to control radioactive releases post-LOCA. The latter system is based on a cost-benefit analysis of upgrading the existing FADS versus provision of a new system. In addition to these design modifications, a number of other changes have been identified concerning trip effectiveness and containment response, and generally involving minor hardware or procedural changes.

Although some issues are still under consideration by the regulatory authorities and are awaiting resolution, the review process has generally been satisfactory and orderly. The results to date generally confirm the basic design adequacy of the station and the majority of the Bruce NGS "B" safety related changes have been found to be unwarranted for retrofitting on Bruce NGS "A". Frequent discussions

with regulatory staff have also contributed to a common understanding and agreement on the need for essential safety design changes. The current schedule calls for completion of the review and assessment process during 1986.

PICKERING NGS "A"

In the case of the Pickering "A" Nuclear Generating Station no systematic reviews for retrofit considerations have been performed nor are they being considered, as in the case of Bruce NGS "A". The safe and reliable operating performance over the years, coupled with the type of ad-hoc reviews, analyses and routine reviews of significant operating events referred to earlier, suggest that such a process is not warranted. As a result of one such ad-hoc review, however, a major retrofit design modification of the emergency coolant injection system (ECIS) is currently in progress. This change was prompted by safety and licensing developments in other CANDU designs. The specific system modifications being implemented consist of upgrading of the existing low pressure ECIS to a high pressure ECIS, while basically retaining the existing recovery system consisting of the moderator system. The modified ECIS will result in improved system capability in dealing with LOCA situations, and provide other tangible safety benefits in terms of reduced operator interface in the short term following a LOCA, and in improved system reliability.

The choice of the modified ECIS design in Pickering NGS "A" clearly illustrates the principles of the retrofit philosophy when applied to operating stations. During cost/benefit analyses of various design options major factors leading to the chosen option included dose considerations to personnel during installation of the system, schedule constraints and impact on power production through interference with existing systems.

In addition to the above major retrofit work on the ECIS, a number of safety system modifications are also being implemented in Pickering NGS "A". These changes were identified as a result of safety assessments and reviews based on the principles and criteria discussed previously. As in the case of the ECIS modifications, the specific design changes to be implemented recognize the design and operating constraints of the existing station.

CONCLUSIONS

The safety and licensing retrofit philosophy discussed in this paper was developed in response to regulatory requests with regard to the applicability to operating nuclear generating stations of more extensive safety and licensing design features incorporated in current CANDU designs. The same basic principles and criteria, however, have been applied in the past when operating stations have been subjected to ad-hoc reviews and assessments on significant safety and licensing issues, and during routine reviews of significant operating events. These practices will continue in the future based on significant safety and licensing developments and operating experience.

Specific safety design modifications arising from these reviews have recognized the unique features and contraints associated with retrofitting operating stations in order to arrive at cost-effective, practical and reliable changes. This process has functioned effectively to date and has contributed to the maintenance of safe and reliable operating stations. The regulatory requirement for periodic updating of the Safety Reports will further ensure that the station designs remain adequate from a safety standpoint based on current safety knowledge.

REFERENCES

1. R.J. Atchison, F.C. Boyd and Z. Domaratzki, "Canadian Approach to Nuclear Power Safety", Nuclear Safety, Vol. 24, No. 4, July-August 1983.