REVIEW OF PICKERING 'A' AS-BUILT DESIGN AGAINST CURRENT REGULATIONS AND STANDARDS

H.S. Johal, E.S.Y. Tin, (AECL, Mississauga, Ontario).

1. INTRODUCTION

The four units at Pickering 'A' first started up between 1971 and 1973, and the design effort was undertaken in the 1960s. The Pickering 'A' units were designed to comply with the requirements that existed at that time. It is noted that there is no regulatory back-fit policy in Canada and, therefore, these units are not required to comply with the design requirements in current codes and standards.

This review of Pickering 'A' as-built design against the current regulations and standards was initiated as a result of a request from the AECB: AECB stated "... *we believe that completing some form of Periodic Safety Review will be a desirable, if not essential, step before allowing Pickering NGS 'A' and Bruce NGS 'A' to restart*".

The AECB letter referenced the guidance available from the IAEA Safety Series Guide entitled "Periodic Review of Operational Nuclear Power Plants" (Reference 1). Subsequently, the AECB re-iterated their request, stating:

" ...we expect that a comprehensive safety assessment will be completed to support the restart including a review of the findings of the Pickering 'A' Risk Assessment. This should be based on either current standards, or original requirements where these can be shown to be satisfactory. In cases where current standards cannot be met and the original requirements are not satisfactory, a systematic review should be carried out to identify practical upgrades."

In November 1999, Ontario Power Generation (OPG) provided to the AECB a comparison of the requirements in IAEA 50-SG-O12, against various initiatives already planned or underway for Pickering 'A'. In addition, OPG made the following commitment.

"...A review of compliance of plant design with current standards and regulations will be done, as follows:

- *Review each relevant standard that has been issued after Pickering 'A' has been started up.*
- *Decide what changes, if any, are required to allow Pickering 'A' to meet the intent of the new standard to the extent practical and economical.*
- *Implement those changes"*

This paper describes methodology to review plant design against current standards, and regulations, including treatment of non-compliances.

2. METHODOLOGY

This section describes an overview of the methodology to select the standards for review, the review process and the guidelines for dispositioning non-compliances.

2.1 Identifying the Codes, Standards, and Regulations to be Reviewed

2.1.1 General

There are a large number of codes, standards, and regulations which are used in the CANDU industry. Some are mandatory while many others are used on an elective basis to maintain a consistent level of quality and performance. The codes, standards, and regulations which are most appropriate for such a review are those which are considered mandatory from a nuclear safety perspective, and which are considered to have a direct and immediate effect on installed design features. Codes, standards, and regulations related to other aspects such as analysis methodology, quality assurance, and operations are not part of this review; basis for this exception is that the documents related to plant operations and analysis are submitted periodically to the AECB on an ongoing basis.

2.1.2 AECB Regulatory Documents

The two AECB document series of interest are Regulatory Documents and Consultative Documents. AECB Regulatory Documents which pertain to CANDU aspects, clearly are required for licensing a new plant today.

Consultative Documents are issued for public and industry comment and, after suitable revision as necessary, are intended for eventual use as Regulatory Documents. They are generally not licensing requirements, except in cases where one may be used on a trial basis for licensing a particular station. It is inappropriate to include Consultative Documents in such a review unless there is some specific insight to be gained which could have a direct impact on installed design features.
A complete list of AECB Regulatory Documents and Consultative Documents can be found in the AECB's March 1999 Catalogue of Publication. This was reviewed and a list was prepared of all the Regulatory Documents and the Consultative Documents pertaining to CANDU nuclear generating stations.

All of these CANDU-related AECB Regulatory Documents and Consultative Documents were then classified into one of the following categories:

1) Direct and Immediate Effect on Installed Design Features;
2) Pertains Mostly to Design Support Analysis;
3) Pertains Mostly to Quality Assurance Aspects;

4) Pertains mostly to Operations aspects, or other aspects not having a direct or immediate effect on installed design features.

As mentioned earlier, the appropriate scope for this review was taken to be the classification number 1. In general, all documents classified as having "a direct, immediate effect on installed design features" were chosen for review with some exceptions. For example, review was not conducted against AECB Regulatory Document R-10, since there is no additional insight to be gained beyond the review against AECB Regulatory Document R-8.

2.1.3 Codes and Standards

A complete list of codes and standards typically used in the CANDU industry was prepared. This list contains over 700 codes and standards. While all of them are used to one extent or another, there is a varying degree to which each should be considered mandatory for licensing purposes. For example:

- Some standards, such as the CSA "N" series, are clearly mandatory from a nuclear safety and licensing perspective;
- Some codes, such as the National Building Code, are clearly mandatory from a conventional safety perspective;
- Some applications require that an acceptable code or standard be used, but not necessarily the one mentioned (many applications have acceptable alternatives). Example: some IEEE standards;
- Some standards are used exclusively on an elective basis to maintain a consistent level of quality and performance, rather than for licensing reasons. Example: CGSB standards.

In short, a simple classification of each of the more than 700 codes and standards as mandatory/not mandatory, may be inappropriate or misleading. For the purposes of this review, it was considered appropriate to only consider those which receive special attention due to their relevance to nuclear safety and licensing; these are essentially the CSA 'N' series.

This shortened the list of over 700 codes and standards down to about 40 standards, the next step was to apply the same classification selected for the AECB Regulatory Documents, i.e. ones with direct and immediate effect on installed design features.

Accordingly, Pickering 'A' has been reviewed against a select list of CSA Standards with some exceptions. For example, CSA CAN3-N289.1-80, "General Requirements for Seismic Qualification of CANDU Nuclear Power Plants" was not included because recent completion of the Pickering 'A' Seismic Assessment makes such a review unnecessary.

Table 1 lists the regulatory documents and the CSA Standards selected for this review.

2.2 Review Process

In general, a clause-by-clause review of each document has been conducted. However, a more general review on a topic basis was carried out if a particular topic has not been treated in detail in the Pickering A design. Review results for each document have been prepared in tabular format with a compliance statement for each clause or topic. Compliance or non-compliance for each requirement is stated.

The purpose of this review was to evaluate the design against current requirements. As the goal was to identify safety requirements that were not known at the time these units were designed, compliance discussion for each requirement is based on finding existence of requirement in plant documents, or current commitment to implement the requirement, and if such evidence is not available, on reviewing the as-built design to determine if the requirement was implemented. In cases where the requirements were specified in plant documentation, it was not considered necessary to review implementation of requirement.

Each completed review has been prepared as a stand-alone chapter, with an introduction and summary of any recommendations, and all chapters are compiled into one document with introductory remarks and summary of recommendations.

In general, the compliance discussion for each clause falls into the following categories:

- Compliance:
  - direct - straightforward compliance with the code/standard/regulation;
  - indirect - compliance with intent of the code/standard/regulation ("equivalent compliance").

- Non Compliance (indicates possible shortcomings in system design or operation):
  - acceptable- technical judgment has determined that this aspect is acceptable;
  - this aspect of the system is not acceptable, and system design and/or operation improvements are deemed appropriate.

This evaluation approach generally follows the guidance offered in Section 7 of the IAEA Safety Series document 50-SG-O12 (Reference 1).

2.3 Treatment of Non-Compliances

The design is either compliant or non-compliant with each requirement. Each non-compliance is reviewed on a case-by-case basis to determine the course of action. Three different treatments are being applied to these non-compliances.

The first type is considered acceptable based on technical arguments; technical arguments are explained in the text and are based on precedents, similar design from other plants, past operating experience, available analysis/assessment, issues dispositioned by AECB.

For the second type, practical design or procedural changes are being made to comply with the requirement.

The third type can be assessed using IAEA criteria given in 50-SG-012 (see next section). Here one or more of six criteria can be used to evaluate the non-compliance. This could be done by assessing design options to achieve various levels of compliance. The cost and benefit of each option would then be calculated. The cost of implementation including design, equipment, installation, maintenance, and cost of replacement energy should all be considered. For some design changes, it is possible to calculate benefits in terms of improvement to core melt frequency using probabilistic tools. With this information, cost of options and their benefit would be compared to select an optimum option that achieves the best possible improvement to the system design.

2.4 Evaluation of Non-Compliances Using IAEA Criteria

The following criteria are quoted from IAEA Guide 50-SG-012 to review non-compliances or shortcomings (IAEA term). Each non-compliance is reviewed on a case-by-case basis to determine the appropriate criterion (one or more of six) to be used.

1. *Existing national policies on the operation of nuclear power plants.* There are cases where compliance with the original safety standards when the plant was designed is an acceptable basis for operation throughout the operational life or at least the design life. Unless the original safety standards were clearly inadequate, a country may allow continued operation of a plant if the unresolved shortcomings do not cause non-compliance with the original safety standards.

2. *The remaining period of operation proposed by the owner/operator.* If the period is sufficiently short, the risk associated with continued operation with some shortcomings may be judged acceptable during this period, if adequate remedial measures can be in effect.

3. T*ime required to implement corrective actions.* If the time required to implement

corrective actions (modification) is considerable and the period of benefit short, then it may not be reasonable for a regulator to demand that the actions be taken. Should the modification be necessary, then continued operation should not be permitted until it is implemented or adequate interim measures have been taken.

4. *Use of PSA.* If the results of an adequate PSA are available and the PSA is acceptable to the regulators it may be used as a measure of the risk posed by each of the unresolved shortcomings. PSA information is clearly helpful, but the uncertainties in data and technique do not allow decisions on continued operation to be made on the basis of PSA results alone.

5. *Deterministic consideration of the total effect on the safe plant operation of all unresolved shortcomings and all corrective actions and strengths identified in Step.1.* There is no obvious or verified procedure available at present other than a 'standback' review and the use of expert judgement.

6. *Use of cost-benefit analysis*

3. CONCLUSIONS

This paper discusses the process for the review of Pickering 'A' design against the selected regulatory documents and CSA standards. It describes the methodology used for the selection of regulatory documents and CSA standards, review process used including treatment of non-compliances.

This methodology is being used to review the Pickering 'A' design against the relevant standards to either identify modifications that could be implemented to ensure conformance to the extent practicable or develop justification to support the remaining difference.

4. REFERENCES

1. "Periodic Safety Review of Operational Nuclear Power Plants - A Safety Guide", International Atomic Energy Agency, Safety Series document number 50-SG-O12, 1994.

Table 1: List of Regulatory Documents and CSA Standards Selected for Review

Document Number	Title
AECB Regulatory Document R-7 (1991)	Requirements for Containment Systems for CANDU Nuclear Power Plants
AECB Regulatory Document R-8 (1991)	Requirements for Shutdown Systems for CANDU Nuclear Power Plants
AECB Regulatory Document R-9 (1991)	Requirements for Emergency Core Cooling Systems for CANDU Nuclear Power Plants
AECB Regulatory Document R-77 (1987)	Overpressure Protection Requirements for Primary Heat Transport Systems in CANDU Power Reactors Fitted with Two Shutdown Systems
CAN/CSA-N285.6 Series-88 (series of 9 standards)	Material Standards for Reactor Components for CANDU Nuclear Power Plants
CSA-N287.1-93	General Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants
CAN/CSA-N287.2-M91	Material Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants
CSA-N287.3-93	Design Requirements for Concrete Containment Structures for CANDU Nuclear Power Plants
CAN3-N288.3.2-M85	High Efficiency Air-Cleaning Assemblies for Normal Operation of Nuclear Facilities
CAN3-N290.1-80	Requirements for the Shutdown Systems of CANDU Nuclear Power Plants
CAN3-N290.4-M82	Requirements for the Reactor Regulating Systems of CANDU Nuclear Power Plants
CAN/CSA-N290.5-M90	Requirements for the Support Power Systems of CANDU Nuclear Power Plants
CAN3-N290.6-M82	Requirements for Monitoring and Display of CANDU Nuclear Power Plant Status in the Event of an Accident