REGULATORY APPROACH FOR LIFE EXTENSION OF NUCLEAR POWER PLANTS IN CANADA

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ABSTRACT

Canadian nuclear utilities have recently completed the Pickering A Units 1 and 4 and Bruce A Units 3 and 4 return to service projects. Other similar projects which have been announced include New Brunswick Power Nuclear's decision to proceed with the Point Lepreau life extension, and Bruce Power's plans to go ahead with the life extension of Bruce A Units 1 and 2.

The projects to date have been carried out within the existing Canadian nuclear regulatory framework and the operating licenses issued by the Commission for each facility. Key regulatory goals have been to:

- ensure adequacy of the scope of refurbishment and safety upgrades proposed by the licensee; and
- verify the proper execution of that work by the licensee, prior to return of the unit to service.

This paper describes elements of the CNSC requirements and regulatory oversight plans to achieve these goals. Work is ongoing to develop formal regulatory guidance.

INTRODUCTION

In recent years, Canadian nuclear utilities have completed several refurbishment projects, notably the return to service of the Pickering A Units 1 and 4 and Bruce A Units 3 and 4. New Brunswick Power Nuclear Corporation recently announced a decision to proceed with the Point Lepreau life extension project with on-site refurbishment planned to start in 2008. Bruce Power has announced plans for the life extension of Units 1 and 2. Projects for other facilities also are under consideration.

The projects to date have been carried out within the existing Canadian nuclear regulatory framework and the operating licenses issued by the Commission for each facility

In Canada, the operating life of a plant has not been defined in regulation. Plants are licensed to operate provided that the licensee can demonstrate that the facility will not pose an unreasonable risk to health, safety, security and the environment and will conform with Canada's international obligations.

Renewal of the operating licence at intervals, currently, every five years for power reactors, affords periodic review and updating of the design and the basis for safe operation of the plant. Nevertheless, life extension projects represent by their nature a commitment by the operator to long-term, continued operation of the facility. The CNSC considers it to be in the public interest that before any such project proceeds there is assurance that the facility will meet appropriate standards for safe and secure operation over its planned life, and that the refurbishment work is done properly.

Accordingly, key regulatory goals for life extension projects are:

- ensure adequacy of the scope of refurbishment and safety upgrades proposed by the licensee; and
- verify the proper execution of that work by the licensee, prior to return of the unit to service.

The regulatory requirements that have been established for such projects, and elements of the regulatory oversight activities to achieve these goals are outlined below.

ESTABLISHING THE LIFE EXTENSION WORKSCOPE

The following steps have been required of licensees in establishing the scope of work:

- perform an Environmental Assessment (EA);
- carry out an Integrated Safety Review (ISR); and
- based on the results of the EA and ISR, develop an integrated implementation plan for the necessary refurbishment, safety upgrades and compensatory measures to ensure the

facility will pose no unreasonable risk to health, safety, security and the environment and will conform with Canada's international obligations over the proposed life.

Environmental Assessment

Pursuant to the Canadian Environmental Assessment Act (CEAA), an EA for the project needs to be completed with a positive decision before any regulatory approvals or licensing actions are given that enable the project to proceed.

A screening EA has been required under the CEAA regulations for past and present life extension projects. However, a new EA may not be needed at the time of the life extension, if the requirements of the CEAA Exclusion List Regulations are met.

In establishing the scope of a project for a screening environmental assessment under the CEAA, the physical works that are involved in the proposal and any specific undertaking that will be carried out in relation to those physical works must be determined

The scope of a screening environmental assessment under the CEAA includes all the factors identified in paragraphs 16(1) (*a*) to (*d*) of the CEAA and, as provided for under paragraph 16(1) (*e*), any other matter that the CNSC requires to be considered. Paragraphs 16(1) *(a)* to (*d*) require that the following factors be included:

- the environmental effects of the project, including the environmental effects of malfunctions or accidents that may occur in connection with the project and any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out;
- the significance of the effects identified above;
- comments from the public that are received in accordance with the CEAA and its regulations; and
- measures that are technically and economically feasible and that would mitigate any significant adverse environmental effects of the project.

The EA typically includes the following [1]:

- spatial and temporal boundaries of the assessment;
- description of the existing environment;
- assessment and mitigation of environmental effects including a description of assessment methodology, the effects of the phase of project (e.g. construction), and the effects of normal operations, malfunctions and accidents, and natural hazards.
- cumulative environmental effects;
- significance of residual effects; and
- stakeholder consultation.

Integrated Safety Review

The Integrated Safety Review (ISR) is an assessment of the plant design and operation performed in accordance with the IAEA Periodic Safety Review (PSR) guidance [2]. The ISR is a comprehensive self-assessment carried out by the licensee. It is considered an effective way to obtain an overall view of actual plant safety, to determine reasonable and practical modifications that should be made in order to maintain a high level of safety, and to improve the safety of older nuclear power plants to a level approaching that of modern plants.

The ISR involves a comparison of the actual state of the plant and plant performance with modern high-level safety goals and requirements, taking into account operating experience in Canada and around the world, new knowledge from research and development activities, and advances in technology.

In the IAEA PSR document, there are fourteen safety factors organized into five subject areas to facilitate the review (Table 1). In addition, there is a global assessment to integrate the results of the review of individual safety factors. Security and safeguards would also be reviewed.

Table 1: IAEA Periodic Safety Review Safety Factors

IAEA Periodic Safety Review Safety Factors	
Plant	Plant Design Actual Condition of Systems, Structures and Components Equipment Qualification Ageing
Safety Analysis	Deterministic Safety Analysis Probabilistic Safety Analysis Hazard Analysis
Performance and Feedback of Experience	Safety Performance Use of Experience from other Plants and Research Findings
Management	Organization and Administration Procedures Human Factors Emergency Planning
Environment	Radiological Impact on the Environment

Integrated Implementation Plan for Safety Improvements

The licensee assessed the results of the EA and the ISR and develop an integrated implementation plan for the necessary corrective actions, safety upgrades and compensatory measures to ensure the facility will not pose an unreasonable risk to health, safety, security and the environment and will conform with Canada's international obligations over the proposed life. All generic action items and station-specific actions items need to be reviewed and each need to be resolved to the extent practical.

As part of the ISR, licensees are expected to compare the facility with modern safety standards for design and operation and to propose measures to address any shortfalls. Licensees may elect to submit cost-benefit information in support of their proposed workscope [3].

In assessing the adequacy of the life extension workscope proposed by the licensee, CNSC staff reviews the Environmental Assessment Study Report and the Integrated Safety Review report, and takes into consideration information gathered through its own regulatory oversight activities.

The CNSC assesses the proposed workscope against:

- NSCA, regulations, standards, guides
- Information gathered on station-specific performance though our regulatory oversight program
- deterministic safety criteria;
- operating experience (station-specific, CANDU-specific, world-wide);
- expert knowledge;
- insights from probabilistic safety analysis;
- PSR review criteria; and
- modern international standards where applicable.

The CNSC notifies the licensee of its assessment of the proposed workscope, either accepting it or requiring changes. Subsequently the licensee proceeds with execution of life extension activities.

Once the licensee has notified the CNSC of its intent to proceed with life extension, pre-requisites for start-up following the life extension work are identified. These pre-requisites are introduced via incorporation of specific conditions in the operating licence. Approvals to carry out specific activities may also be needed once life extensions activities have commenced in the field.

VERIFICATION OF EXECUTION OF LIFE EXTENSION ACTIVITIES

Once life extension activities are underway, the licensee needs to have acceptable programs for the control of all life extension activities, and to support normal operation, as required by the operating licence.

Requirements for project execution include acceptable programs in the following areas:

- Quality Management;
- Configuration Management;
- Management Activities to Control Outage;

- Control of Contractors;
- Radiation Protection;
- Design/Engineering Change;
- Commissioning;
- Personnel Qualification and Training;
- Conventional Health & Safety;
- Waste Management;
- Emergency Preparedness;
- Environmental Protection;
- Security; and
- Safeguards.

Regulatory verification of project execution includes assessment of engineering change submissions, and inspections of licensee procurement, construction and commissioning activities. Engineering change, procurement, construction and commissioning are to be performed in accordance with CNSC requirements and appropriate industry standards. The CNSC also assesses the adequacy of updates of licensee programs for the operation and maintenance of the plant. In addition, there will be verification that the programs for the control of life extension activities are adequate.

The CNSC expects the licensee to carry out a thorough commissioning plan for a life extension project. If relevant system baseline data is available from past commissioning, then it can be referenced. However, if commissioning baseline data is no longer available, it will have to be regenerated.

Commissioning is divided into three phases (Phases A to C). Phase A confirms correct installation of new equipment and confirms fitness for service of new and existing plant features through a program of individual component and integrated system testing. Phase B activities are carried out at low reactor power and focus on confirming the reactor behaviour under these conditions. Phase C focuses on demonstrating that the reactor and systems perform as expected at power levels up to full reactor power.

Following the return to full power operation, the CNSC will continue to monitor facility operation through its regulatory oversight program.

PUBLIC HEARING PROCESS

At the hearings for renewal of the licence that will be in effect at the time of life extension activities, the licensee must show to the Commission that it is qualified and will make adequate provision for protection of health and safety in carrying out for the contemplated life extension

activities. Staff will recommend license conditions that require the licensee to demonstrate completion of prerequisites, and to gain the approval of the designated officer or the Commission before the stages of return to service.

The decision regarding delegation of authority is rendered by the Commission following the process set out in the CNSC Rules of Procedure Regulations (SOR/DORS/2000-211) [4]. The Public Hearing is typically held over two days. The licensee and CNSC staff are required to submit information 30 days in advance of the Day 1 Hearing. A Day 2 Hearing is held about 60 days following the first hearing day. The public, the licensee and CNSC staff submit information 30 days prior to the Day 2 Hearing.

SUMMARY

Canadian nuclear utilities have completed several reactor refurbishment projects and further such projects are planned.

The projects to date have been carried out within the existing Canadian nuclear regulatory framework and the operating licenses issued by the Commission for each facility. The CNSC's regulatory goals for life extension projects are:

- obtaining assurance of the adequacy of the scope of refurbishment and safety upgrade work proposed by the licensee; and

- verifying the proper execution of that work by the licensee, prior to return of the unit to service.

To achieve these goals, licensees are expected to perform an EA under the Canadian Environmental Assessment Act, to perform an ISR following the guidance in the International Atomic Energy Agency Guide on Periodic Safety Review, and to incorporate the results of the EA and the ISR into a comprehensive implementation plan for refurbishment, safety upgrades and compensatory measures.

The CNSC assesses the proposed life extension work scope, evaluates the licensee programs for the control of all life extension activities, and evaluate engineering, procurement, construction and commissioning activities carried out during the refurbishment outage.

REFERENCES

1. Canadian Nuclear Safety Commission, "EA Guidelines (Scope of Project and Assessment), Environmental Assessment of a Proposal for the Refurbishment for Life Extension and Continued Operations of Bruce A Reactors at the Bruce A Nuclear Generating Station (Bruce A NGS)", July 14, 2005.

2. IAEA Periodic Safety Review of Nuclear Power Plants Safety Guide, Safety Standards Series No. Ns-G-2.10, Vienna 2003.

3. CNSC Regulatory Policy, "Considering Cost-benefit Information", October 2000.

4. CNSC Rules of Procedure Regulations, SOR/DORS/2000-211, May 31, 2000.