Nuclear Safety, Control & Licensing for CANDU Reactors

Dr. Nisheeth Bahadur

36 Oakmeadow Blvd., Scarborough, Toronto, Ontario M1E 4G1, Canada and nisheethpb@yahoo.ca

I. INTRODUCTION

A strong regulatory framework is of utmost importance for any nuclear installations to ensure safety & protection of people and the environment. In Canada, nuclear power plants have been producing electricity commercially since the early 1960s. Currently, five plants in three provinces house 22 nuclear power reactors, contributing to about 15 percent of Canada’s electricity. All nuclear power reactors in Canada are CANDU (Canadian Deuterium-Uranium) reactors.

The Canadian Nuclear Safety Commission (CNSC) regulates the use of nuclear energy and materials to protect health, safety, security and the environment; to implement Canada’s international commitments on the peaceful use of nuclear energy.

The CNSC's regulatory framework consists of laws passed by Parliament that govern the regulation of Canada's nuclear industry, and regulations, licenses & documents that the CNSC uses to regulate the industry (Figure 1). The CNSC is committed to providing regulatory instruments; published regulatory documents are considered to be living documents, and subject to regular review.

II. BACKGROUND: NUCLEAR REGULATORY ENVIRONMENT IN CANADA

In Canada, nuclear regulation is solely a federal jurisdiction, and provincial government agencies have no regulatory responsibilities specific to nuclear generation. All nuclear facilities and nuclear-related activities in Canada are regulated by the Canadian Nuclear Safety Commission (CNSC), under the Nuclear Safety and Control Act (NSCA).

The regulatory philosophy of the CNSC is:

- **Licensees are responsible for** the protection of the environment, the health and safety of persons and the maintenance of national security, and implementation of Canada's international commitments,
- **The CNSC is responsible for** regulating licensees assessing whether licensees are compliant with the NSCA, regulations, and meet international obligations on the peaceful use of nuclear energy.

**Legal Basis: Act, Relevant Regulations & Regulatory Criteria**

The purpose of Nuclear Safety and Control Act is to limit the risks to national security as well as to public health & safety and to the environment. The main powers under this Act are to make regulations, establish safety principles/ criteria, communicate to the public, perform authorizations/ regulatory reviews, issue licenses, and ensure compliance.

Other applicable federal acts, under which the CNSC has specific responsibility, include the Canadian Environmental Assessment Act (CEAA) and the Nuclear Liability Act (NLA). The CNSC is responsible for conducting an environmental assessment when the test of the CEAA is met. The NLA provides for compensation for damage or injuries due to nuclear accidents.

A license may be issued or renewed if the applicant is qualified to carry on the activity. For the purpose of ensuring compliance with the NSCA and the regulations, the Commission appoints inspectors and designated officers.

**Operating Licence & Licence Condition Handbook (LCH)**

Within the legal authority given by the NSCA, the CNSC issues licences. A licence is a legal document. The licence...
holder (or licensee) is fully and legally responsible to follow and comply with the licence. The Operating License is a contract between the station and the CNSC describing how the station will be operated. It requires the licensee to provide evidence that chronic and acute radiological risks associated with the location, design, and operation of the station are within licensing limits. Licensing conditions are elaborated in the LCH, which provides compliance verification criteria, establishes process for records & document management so that CNSC staff as well as station can ensure compliance.

III. PURPOSE & SIGNIFICANCE OF DOCUMENTS: LINKAGE TO LICENCE

The licence application forms part of the licensing basis. Documents and conditions directly referenced in the licence also form a part of licensing basis. Power plants are required to operate their facility in accordance with the licensing basis and hence their licence application.

Within the operating licence for nuclear stations, there are a number of documents quoted. These documents include:

- Technical and national standards such as Canadian Standards Association (CSA standards), referenced in the licence
- CNSC regulatory documents & guides, referenced in the licence
- Licensee-produced documents such as management system and program implementing documents, Operating Policies & Principles, Safety Report, and Security Report.

Some documents require CNSC approval to modify (e.g. OP&Ps, Radiation Protection requirements), and some require CNSC to be notified. Violation of a licence condition is a violation of the licence. Therefore, to ensure that the station is complying with all the conditions in the licence, plant organization produces a set of internal documents of various levels so that the organizational activities are managed within these documents.

Several examples are given below for some documents, to explain their purpose and significance. Similar explanation exists for other documents referenced in the licence.

- CSA standard N286-05 places quality assurance requirements on the licensee. The station has to produce a set of Management System documents to show all activities in the station meet the quality requirements.
- CNSC regulatory document S-99 describes reporting requirements for operating the nuclear plant. Power stations report non-compliances on a quarterly basis to the CNSC.
- Regulatory standard S-210 provides high level requirements for a maintenance program.
- Power plants are to maintain the minimum shift complement as specified in Appendix A of the licence following the guidance provided in CNSC Regulatory Guides G-323. To comply this, Power plant monitors and controls the hours of work and shift schedules of persons working on safety-related systems as per their procedure. Non-compliances are reported quarterly to the Commission.
- Power plants are to implement and maintain Level 1 and Level 2 Probabilistic Safety Assessment in accordance with CNSC regulatory document S-294.
- CNSC regulatory document RD-360 (Life Extension of NPPs). The purpose of this document is to inform licensee about the steps and phases to consider when undertaking a project to extend the life of a NPP.

Safe Operating Envelope (SOE)

The SOE specifies the parameters and system conditions that should be observed and controlled to keep operations within the limiting assumptions, which are typically captured in OP&Ps or embedded in operating procedures. Nuclear plant’s SOE consists of Operating Safety Requirements (OSRs) and Instrumentation Uncertainties. Operating limits are considered to be fundamental to the licensing for the plant operation. Analysis in support of safe operation is valid only within a specified range of analyzed plant operating states, i.e. within the safe operating envelope. Operating outside of the safe operating envelope, in an unanalyzed state, violates the terms of the Operating License and is not acceptable. OP&P also limit the authority of key operating staff to preserve adequate defense in depth, and include good operating practices based on industry operating experience and nuclear safety principles. The Shift Manager, Control Room Shift Supervisor, and Authorized Nuclear Operator (ANO) ensure that day to day plant operation remains within the safe operating envelope, adhering rigorously to the OP&Ps, and by following operating instructions. Plant procedures ensure that parameters stay within normal operational ranges well within the boundary set by the safe operating envelope.

The overall framework of a large number of requirements, conditions, limits etc. are managed with the nuclear safety practice, briefly described below in Figure 2. This sketch shows how nuclear safety is managed, margins are maintained and series of documents are produced at each layer of defence. A station organization systematically and logically defines and develops documents to support each layer of the Safety Barrier shown e.g. a Safety Case. The Safety cases will be supported by Safety Analysis and Safety Report etc. Safety
margins will be reviewed when detailed design is done and Design Basis is developed, leading to again a set of documents and so on. This will lead to, ultimately, a detailed set of procedures which the staff are trained to and required to follow for day to day operations and meeting reporting requirements.

Figure 2: Nuclear safety maintained through margins & series of documents at each layer of defense

Compliance

Previous sections discussed how nuclear power stations implement their programs in accordance with the documentation submitted and follow the commitments made in the application. The organization as a whole uses these station documents to make sure all the licence requirements are being met. Stations use internal Quality Assurance documents to check for this compliance. CNSC uses their defined processes to report on station compliance and the gaps that may exist. If power station is found to be in non-compliance, the CNSC enforcement process will used to address the issue.

IV. CONCLUSION

To protect the public and the environment from the effects of radiation, the CNSC under the NSCA issues Licence to the organizations to operate and maintain the nuclear facilities. To support the licensee, the CNSC issues a range of documents e.g. guides and standards which specify the bounds and limits for carrying out the operational activities. In addition, the other relevant documents are referenced e.g. CSA, which also become part of the License.

The License holder is responsible for following these documents by preparing details of application and implementation including training and certification, and some of these may require concurrence & approval from the CNSC.

A. Abbreviations and Acronyms

ANO: Authorized Nuclear Operator
CNSC: Canadian Nuclear Safety Commission
CEAA: Canadian Environmental Assessment Act
CSA: Canadian Standards Association
LCH: License Condition Handbook
NLA: Nuclear Liability Act
NSCA: Nuclear Safety and Control Act
OP&Ps: Operating Policies &Procedures
OSRs: Operating Safety Requirements
SOE: Safe Operating Envelope

ACKNOWLEDGMENT

I gratefully acknowledge the help and technical assistance provided by my colleagues at Ontario Power Generation and Bruce Power.

REFERENCES