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Initial Global Development and Licensing of the CANDU-6 ISTS

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1. Introduction

The nuclear industry in the USA recognized a need to improve technical specifications (TS) after the Three Mile Island (TMI) accident, and an improvement program was therefore initiated in 1984. The NRC issued several improved standard technical specifications (ISTSs) for typical nuclear reactors. In Canada, the CANDU Owner's Group (COG) issued the Safe Operating Envelope (SOE) principles and guidelines [1], and Canadian utilities initiated SOE projects on the basis of the COG guidelines, which were converted to the CSA N290.15 specification [2] in 2010.

The goal in the development of Wolsong CANDU-6 ISTS is to improve plant safety practically by formulating safe Limiting Conditions for Operation (LCOs), improving the actions and surveillance requirements pertaining to safety and operability, and reinforcing technical bases to enable the first CANDU-6 ISTS to be developed and licensed anywhere in the world.

2. LCO Selection

The conditions under which it is acceptable to continue operation considering the operating state of a given plant are termed the "Conditions of Operability". These stipulations are used to determine the level of severity of an abnormal condition in terms of the impact on safety-related performance at the system or functional level. LCOs specify the conditions of operability and represent the lowest functional capability or performance level of the equipment or the operating parameters, as determined in the safety analysis.

The selection criteria for LCOs conform to Announcement No. 2009-37 [3], which is based on 10 CFR 50.36. LCOs should be selected for each item, meeting one or more of the following criteria:

Criterion 1: Installed instrumentation that is used to detect, and indicate in the control room, a significant abnormal degradation of the reactor coolant pressure boundary.

Criterion 2: A process variable, design feature, or operating restriction that is an initial condition of a design-basis accident or transient analysis that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

Criterion 3: A structure, system, or component that is part of the primary success path and which functions or actuates to mitigate a design-basis accident or transient that either assumes the failure of or presents a challenge to the integrity of a fission product barrier.

Criterion 4: A structure, system, or component which operating experience or probabilistic risk assessment has shown to be significant to public health and safety.

The process of LCO selection for Wolsong ISTS is shown in Figure 1. On the basis of the overall 670 functions for Wolsong CANDU-6 systems, 346 functions were classified as those related to plant safety. Then, after applying the four criteria to the 346 items, 190 functional items that need to be selected as LCOs were classified. Reviewing Safety Analysis Data List and Chapter 15 in the FSAR related to safety analysis, 85 initial conditions were classified. Applying Criterion 2 to those 85 conditions, 64 articles that need to be selected as LCOs were classified. Four items related to operating experience or probabilistic risk assessment insights, which are significant to public health and safety, were selected as LCOs according to Criterion 4.

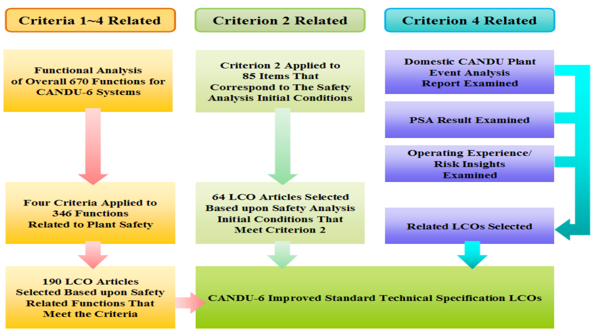

Figure 1. Process of LCO selection

3. Improvements

The comprehension of the technical bases of each LCO is enhanced by describing the background, applicable safety analyses, LCO, applicability, required actions, surveillance requirements, and references for "Chapter 2.0 Safety Limits" and "Chapter 3.0 Limiting Conditions for Operation and Surveillance Requirements" in "Part 1: Operation of Reactor Facilities" according to the ISTS writer's guideline.

After classifying and rearranging the LCOs described earlier, 72 LCOs were finally selected as Wolsong ISTS LCOs. The LCO selection results are summarized in Table 1.

Table 1. Summary of LCO Selections

Category	Number of articles
Wolsong 2, 3 and 4 LCO	113
Wolsong ISTS LCO	72
Comparison with Wolsong 2, 3 and 4 TS	
Added LCO	3
Relocated LCO	21

AS summarized in Table 1. Two LCO's are added, first one is the poison concentration in Moderator system and the other is side to side flux tilt of the core. These are based on criterion 2.

The inter-related LCOs are merged and some items are relocated after reviewing the Pressurized Water Reactor (PWR) ISTS examples [4,5]. The items related to the release of radioactive effluents are relocated based on GL 89-01 [6]. The equipment list (e.g., the reactor building isolation valve list) is deleted based on GL 91-08 [7]. Partial items related to instrumentation in a non-safety context, such as seismic instrumentation and turbine overspeed protection, are relocated based on GL 95-10 [8].

LCOs are defined considering a single failure criterion in the case of redundant systems/ components in order to ensure a level of redundancy necessary for safe operation.

Ambiguous contents in LCOs or required actions are described with clarification through the verification process with site staff.

Taking into account site applicability, the surveillance period of the concentration in the gadolinium nitrate solution was amended from "7 days" to "1 month" regarding poison tanks in Shutdown System Number Two. Relief of the surveillance period is done by utilizing risk information from the system reliability analysis and reviewing the performance history regarding the concentration change trend.

4. Conclusions

The development of Wolsong CANDU-6 ISTS has had several effects, such as the securing of international competence for CANDU plant safety technology by establishing the ISTS-related technical bases aimed at practical and safe operations and the lessening of responsibilities on utilities and regulatory bodies. Safety and serviceability have also been improved for CANDU operations as human factor engineering is strongly taken into account.

Wolsong ISTS is laid out according to 10 CFR 50.36, as the first such example in the world, enabling Korea to become, with its operation of both PWR and PHWR, the first country in the world to have developed a unified version of TS. Korea will be regarded as a model nation for the countries seeking to operate both PWR and PHWR facilities.

5. References

[1] COG, "Principles and Guidelines for the Definition, Implementation and Maintenance of the Safe Operating Envelope at CANDU Power Plants in Canada," COG Report 02-901, 2003.

[2] CSA, "Requirements for the Safe Operating Envelope of Nuclear Power Plants," N290.15, 2010.

[3] Korea Ministry of Education, Science and Technology, "Announcement No. 2009-37: Announcement for Criteria Related to the Preparation of Technical Specifications," 2009.

[4] U.S. Nuclear Regulatory Commission, "Standard Technical Specifications Westinghouse Plants," NUREG-1431 Rev. 1, Nuclear Regulatory Commission, 1995.

[5] U.S. Nuclear Regulatory Commission, "Standard Technical Specifications Combustion Engineering Plants," NUREG-1432 Rev. 1, Nuclear Regulatory Commission, 1995.

[6] U.S. Nuclear Regulatory Commission, "Implementation of Programmatic and Procedural Controls for Radiological Effluent Technical Specifications," Generic Letter 89-01, 1989.

[7] U.S. Nuclear Regulatory Commission, "Removal of Component Lists from Technical Specifications," Generic Letter 91-08, 1991.

[8] U.S. Nuclear Regulatory Commission, "Relocation of Selected Technical Specifications Requirements Related to Instrumentation," Generic Letter 95-10, 1995.