Development Methodology of Improved Standard Technical Specification for Wolsong CANDU-6 Nuclear Power Plants

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1. Introduction

This paper describes a development methodology and up-to-date results of the Improved Standard Technical Specification (ISTS) for Wolsong CANDU-6 nuclear power plants. The development work was initiated due to the following drawbacks in the Current Technical Specifications (CTSs): excessive surveillance requirements; selection of Limiting Conditions for Operation (LCOs) without objective selection criteria; and lack of consideration for the accumulation of operational experience and technological development. Wolsong CANDU-6 ISTS has been developed to relocate unnecessary LCOs that are irrelevant to plant safety; to apply any improvements gained from operational experiences or researches; to reinforce technical bases; and to place greater emphasis on human factor principles in order to make technical specification clearer and easier to understand. Wolsong CANDU-6 ISTS is expected to be utilized as the standard technical specification for the preparation of Wolsong-1 Improved Technical Specification (ITS) for continued operation.

2. Methodology and Results

In this section the overall methodology for LCO selection is described with the results.

2.1 Selection Criteria for LCOs

The selection criteria for LCOs conform to Announcement No. 2009-37 [1], which is based on 10 CFR 50.36. The 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.

2.2 Selection Criteria Application Guide

The selection criteria have been applied to select the LCOs for CANDU-6 ISTS as follows. This selection criteria application guide is established considering the NRC staff's view [2].

Criterion 1

The objective of criterion 1 is to select only the installed instrumentation which is used to detect actual leaks of the reactor coolant. Therefore, the instrumentation used to detect precursors to an actual breach of the reactor coolant pressure boundary integrity or instrumentation to identify the source of actual leakage is not applicable to criterion 1 (e.g., loose part monitoring system in Wolsong Unit 1, seismic instrumentation of Wolsong Units 1 and 2).

The related instrumentations for CANDU-6 plants are as follows: annulus gas system to detect pressure tube leaks, D_2O-In-H_2O leak detection system to detect steam generator tube leaks or recirculated cooling water system heat exchanger leaks, tritium in the air monitor to detect reactor coolant leaks into the reactor building, and D_2O storage tank level indicator to monitor reactor coolant inventory change due to leaks.

Criterion 2

This criterion includes active design features (e.g., regional overpower protection system handswitch) and operating restrictions (e.g., pressure/temperature limits) needed to exclude unanalyzed accidents and transients.

Initial conditions captured by criterion 2 are not limited to only process variables directly monitored and controlled from the control room. These could also include other features or characteristics that are specifically assumed in the design basis accidents and transient analyses even if they cannot be directly observed in the control room (e.g., channel power peaking factor).

Variables that an operator cannot control are not applicable to criterion 2 as follows: geometry factors (e.g., total number of channels, the number of helium bottles in the moderator cover gas system), passive components (e.g., rupture disk) and properties (e.g., gap

conductance).

The system (or component) which is not credited in safety analysis is not applicable to this criterion (e.g., reactor control system, condenser steam discharge valve, and atmospheric steam discharge valve).

Criterion 3

It is the intent of this criterion to capture into the TS only those structures, systems, and components that are part of the primary success path in the safety sequence analysis.

Also captured by this criterion are those support and actuation systems that are necessary for items in the primary success path to successfully function. The primary success path for a particular mode of operation does not include backup and diverse equipment (e.g., the D_2O feed system which is a backup to fill up the D_2O storage tank, and the emergency cooling water supply system which is a backup to the Raw Service Water System for the cooling of standby diesel generators).

Criterion 4

The LCO related to the instrumentation of the Secondary Control Area and those related to operating modes 3, 4 and 5 are selected by criterion 4 through reviewing the operating experience and risk insights.

2.3 LCO Selection Process

The process of LCO selection for CANDU-6 ISTS is shown in Figure 1.

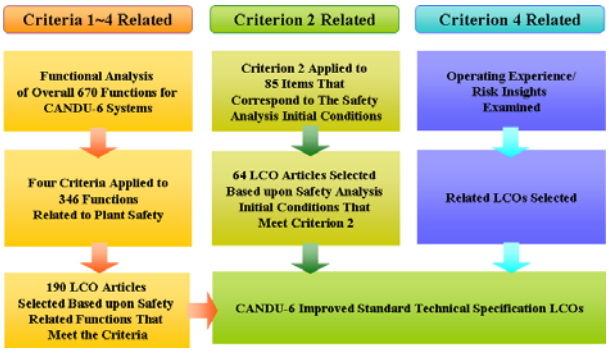

Fig. 1. Process of LCO selection

Classifying and rearranging the LCOs as shown in Figure 1, 72 LCOs are finally selected as Wolsong CANDU-6 ISTS LCOs. The reduction degree in the number of LCO items is ~36% when compared to Wolsong Units 2,3,4 LCOs.

3. Conclusions

The description methodology of Wolsong CANDU-6 ISTS has been changed from descriptive to diagrammatic and eliminated confusions by utilizing logical operator (and/or). In addition, the significant terminologies are composed of solid gothic characters to offer clear distinctive symbols which contribute to strengthen user friendliness as well as human engineering elements.

The rationalization has been achieved by optimizing ISTS with the elimination of unnecessary LCOs, relocations and unification. The Wolsong CANDU-6 ISTS has been developed as the first one in the world by strengthening LCO selection criteria as well as technical bases according to 10 CFR 50.36.

Wolsong CANDU-6 ISTS has been submitted to the regulatory authority for review and approval and it is expected to be utilized as the improved standard technical specification for the preparation of Wolsong-1 ITS that is required for the continuing operation as well as for the preparation of Wolsong 2,3,4 ITS.

REFERENCES

[1] Korea Ministry of Education, Science and Technology, “Announcement No. 2009-37: Announcement for Criteria Related to the Preparation of Technical Specifications,” 2009.
[2] U.S. Nuclear Regulatory Commission, “NRC staff review of nuclear steam supply vendor owners groups’ application of the commission’s interim policy statement criteria to standard technical specification,” 1988.
[3] Korea Electric Power Research Institute, “Development of Monitoring Technology for Effect of CANDU Maintenance,” R-2007-2-112, 2008.
[4] Korea Hydro & Nuclear Power Co., Ltd., “Safety Analysis Data List,” 59RF-03500-SAL-001 Rev. A, 2008.
[5] Korea Hydro & Nuclear Power Co., Ltd., “Wolsong-2/3/4 Final safety analysis Report.”
[6] U.S. Nuclear Regulatory Commission, “Standard Technical Specifications Westinghouse Plants,” NUREG-1431 Rev. 1, Nuclear Regulatory Commission, 1995.
[7] U.S. Nuclear Regulatory Commission, “Standard Technical Specifications Combustion Engineering Plants,” NUREG-1432 Rev. 1, Nuclear Regulatory Commission, 1995.
[8] U.S. Nuclear Regulatory Commission, “Implementation of Programmatic and Procedural Controls for Radiological Effluent Technical Specifications,” Generic Letter 89-01, 1989.
[9] U.S. Nuclear Regulatory Commission, “Removal of Component Lists from Technical Specifications,” Generic Letter 91-08, 1991.
[10] U.S. Nuclear Regulatory Commission, “Relocation of Selected Technical Specifications Requirements Related to Instrumentation,” Generic Letter 95-10, 1995.