

Comparative Analysis and Improvement Directions for PHWR In-Service Inspection Technical Standards

Eric Yee*, Kwando Lee

KEPCO International Nuclear Graduate School
658-91 Haemaji-ro, Seosaeng-myeon, Ulju-gun, Ulsan, 45014, Korea
*Corresponding author: eric.yee@kings.ac.kr

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1. Introduction

In-service inspection (ISI) is an important safety management activity used to verify the integrity of safety related systems and components during nuclear power plant operation. The applicable technical standards and their editions directly affect inspection scope, intervals, and evaluation requirements.

In the Republic of Korea, ISI is conducted in accordance with the Nuclear Safety and Security Commission (NSSC) Notice, "Regulations on In-Service Inspection of Reactor Facilities."

For pressurized heavy water reactors (PHWRs), CSA N285.4 and CSA N285.5 are applied as principal ISI standards, while CSA N287.7 is also applied to relevant inspection areas. The applicable edition is based on the latest edition issued at least one year before the start of the inspection interval.

Accordingly, the Korean PHWR ISI framework provides an explicit rule for selecting applicable editions for each inspection interval.

Canada also applies CSA N285 series standards to CANDU nuclear power plants. CSA N285.0 establishes general requirements for pressure retaining systems, components, and supports, while CSA N285.4 and N285.5 provide detailed periodic inspection requirements within their respective scopes.

Although both Korea and Canada use CSA standards, they differ in how the standards, and their editions are incorporated into the regulatory framework.

This study compares the Korean and Canadian PHWR ISI frameworks with respect to regulatory basis, technical standard structure, edition selection, and regulatory implementation, and proposes improvement directions for the Korean system.

2. Comparison of PHWR ISI Technical Standard Frameworks

2.1 Republic of Korea

In Korea, PHWR ISI requirements are specified through the NSSC regulatory framework.

CSA N285.4 and CSA N285.5 are directly specified as applicable ISI technical standards. The applicable editions of CSA N285.4, N285.5, and N287.7 are determined based on the latest editions issued at least one year before the start of the inspection interval.

The licensee prepares a 10 year long-term ISI plan and submits it to the NSSC before the start of the inspection interval. The plan includes the applicable technical standards, effective editions, and any necessary modifications or limitations.

This approach provides a clear reference date for edition selection and enables updated technical requirements to be periodically incorporated into the ISI program.

2.2 Canada

In Canada, the CNSC regulates nuclear power plants under the Nuclear Safety and Control Act and associated regulatory requirements.

CSA N285.0 provides general requirements for pressure retaining systems, components, and support in CANDU nuclear power plants. CSA N285.4 specifies periodic inspection requirements for CANDU plant components, including pressure retaining systems and fuel channels, while CSA N285.5 applies to containment system components.

In Canada, applicable CSA standards and editions are managed in conjunction with the plant license, licensing basis, and approved licensee programs.

Therefore, publication of the new CSA edition does not necessarily mean immediate application to all operating plants. Its implementation may depend on the regulatory and licensing framework applicable to each facility.

2.3 Comparison of Korea and Canada

The PHWR ISI technical standard application frameworks in Korea and Canada can be summarized as follows.

Table I. Comparison of PHWR ISI Technical Standard Application Frameworks

Item	Republic of Korea	Canada
Regulator y authority	NSSC	CNSC
Regulator y basis	Nuclear Safety Act and NSSC Notices	Nuclear Safety and Control Act, Regulations, and plant licenses

CSA framework	N285.4 and N285.5 directly specified	N285 series standards managed with the licensing basis
CSA N285.0	Not directly specified as an ISI standard	General requirements standard for pressure-retaining systems and components
Edition selection	Latest edition issued at least one year before the inspection interval	Managed in connection with the plant license and licensing basis
Inspection program	10 year long term ISI plan	Managed through approved licensee programs and licensing requirements
New edition application	Reflected based on the regulatory reference date	Applied through regulatory and licensing review

The principal difference is not whether CSA standards are applied, but how new editions are incorporated into the regulatory framework.

Korea applies a reference date-based system that generally introduces the latest applicable CSA edition into the next inspection interval. Canada manages technical standards and editions in conjunction with the licensing basis of each plant.

2.4 Applicability of New Editions

Revisions to CSA standards may change inspection scope, sample size, inspection intervals, or evaluation methods.

For PHWR components such as pressure tubes and feeders, such changes may affect inspection workload, radiation exposure, inspection feasibility, outage duration, and plant operation.

Therefore, when applying for a new edition, the following factors should be considered:

1. Safety benefits of revised requirements
2. Major changes from the previous edition
3. Plant design and operating characteristics
4. Previous inspection results and degradation trends
5. Radiation exposure and inspection feasibility
6. Impact on outage duration and plant operation

A systematic review of these factors can support a technically justified application of new CSA editions.

3. Conclusions

Korea and Canada both apply CSA N285 series standards to PHWR and CANDU plant inspection, but their regulatory implementation approaches differ. Korea directly specifies detailed CSA standards in the

NSSC regulatory framework and applies the latest applicable edition based on a defined reference date before each inspection interval.

Canada manages CSA standards and editions in conjunction with plant licenses, licensing bases, and approved programs.

The Korean approach has the advantage of clear edition selection and periodic incorporation of updated technical requirements. However, when a new edition introduces significant changes to inspection scope or methods, its applicability to domestic PHWRs should be carefully evaluated.

Accordingly, the following improvements may be considered:

First, the relationship among CSA N285.0, N285.4, N285.5, and other related standards should be more clearly reflected in the Korean regulatory framework.

Second, major technical changes introduced by new editions should be systematically identified and evaluated before incorporation into long term ISI plans.

Third, safety benefits, plant operating experience, degradation trends, inspection feasibility, and radiation exposure should be considered together when evaluating new inspection requirements.

These measures could improve regulatory consistency while ensuring that updated CSA requirements are applied in a manner appropriate to the design and operating characteristics of Korean PHWRs.

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