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The Concept of Underlying Purpose and Its Application in Nuclear Regulatory Exemptions

GWANYOUNG KIM*, GEONWOO KIM
Korea Institute of Nuclear Safety, Daejeon, Republic of Korea
**Corresponding author: gykim@kins.re.kr*

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1. Introduction

Korea's nuclear safety regulation has long emphasized formal compliance with prescriptive technical standards. However, with the introduction of new technologies such as Small Modular Reactors(SMRs), the diversity of reactor designs is expanding, and it has become evident that applying the existing standards, which were originally developed for large light-water reactors, uniformly to all designs has limitations.

In the United States, exemptions from regulations have been allowed for a long time under 10 CFR 50.12, and one of the main criteria for granting such exemptions has been whether the underlying purpose of the rule is met. This approach focuses not on the mechanical compliance with the wording of the regulation, but on whether the specific safety function intended when the rule was established is actually ensured.

In Korea as well, the Regulation on Technical Standards for Nuclear Reactor Facilities, Etc. provides the possibility of exceptional application, but in practice, the procedures and requirements have remained unclear. For this reason, the administrative rule currently under development (tentatively titled Regulation on the Approval of Alternative Application of Technical Standards for Nuclear Reactor Facilities) intends to introduce the concept of the underlying purpose as a requirement, thereby providing a basis for judging the appropriateness of regulatory application [1].

This paper examines the legislative history of 10 CFR 50.12 and exemption cases of the U.S. NRC to review how the concept of the underlying purpose has been practically applied. Based on this, it discusses the establishment and applicability of the concept of the underlying purpose in Korea's regulatory framework.

2. Concept and History of Underlying Purpose in the U.S. NRC

The U.S. exemption rule, 10 CFR 50.12, was enacted in 1972 and has been revised twice. The major milestones are shown in Table I.

Table I: History of 10 CFR 50.12

Date	Content
Mar. 21, 1972	[37 FR 5748] Initial enactment of 10 CFR 50.12 [2]
Mar. 3, 1975	[40 FR 8789] Adjustment of requirements: legal conditions, public safety elements [3]
Dec. 12, 1985	[50 FR 50777] Structuring of exemption requirements and introduction of "underlying purpose" [4]

In the 1985 revision, which is currently applied, the concept of "special circumstances" was introduced in order to increase predictability of the exemption process and prevent its misuse. Among them, (a)(2)(ii) is as follows:

> *"Application of the regulation in the particular circumstances would not serve the underlying purpose of the rule or is not necessary to achieve the underlying purpose of the rule"*

However, there is no official definition of underlying purpose in 10 CFR 50, 10 CFR 52, Reg. Guide, or any other document. The 1985 Federal Register[4] explains this requirement as follows:

> *It must be understood here that the underlying purpose of the rule should be something more specific than achieving adequate safety protection. Otherwise all of the safety requirements in 10 CFR Part 50 become subject to open litigation, and the exemption process becomes open ended. Rather, the specific objective of the regulation must be ascertained from the rule itself or the underlying rulemaking proceeding (for example, the specific purpose of 10 CFR § 50.46 would be assuring a coolable core during and after postulated loss-of-coolant accidents).*

The Federal Register also explicitly recognizes that generic regulations cannot predict all nuclear plant situations, and that in some cases, compliance with the regulation may actually hinder the safety objective, emphasizing the effectiveness of alternative measures:

> *it provides explicit recognition that generic regulations cannot consider all the relevant factors for a particular plant and that, in some cases, detailed plant requirements are inappropriate either because they would not, on a given plant, achieve the intended end result of the regulation, or because there are alternative and*

possible more effective means for achieving the underlying purpose of the regulation.

With regard to the identification and application of the underlying purpose, the NRC internal staff guidance (LIC-103)[5] states as follows:

The TB staff is more familiar with the technical requirements associated with a particular regulation and is expected to have a good understanding of the underlying purpose of the rule.

In this way, as described in the Federal Register and NRC staff guidance, even in the U.S. regulatory system the underlying purpose is not a concept formally defined in statutes or guidance, but should be understood as the specific safety objective derived from the text of each regulation and its rulemaking process. In other words, the underlying purpose means not an abstract assurance of safety, but the actual function that the regulation intends to achieve.

3. Underlying Purpose in NuScale Design Certification (DC)

The NRC approved NuScale's US600 Design Certification (DC) application, which was submitted in January 2017, in February 2023. In NuScale's DC application, exemption items are organized in a separate section (Part 07, "Exemptions"), and for each of the 17 items, the underlying purpose of the related regulation is first specified[6]. It is also stated that all 17 items satisfy the provision of 10 CFR 50.12 (a)(2)(ii). Table III summarizes selected exemption provisions from the application along with their underlying purposes.

4. History of Domestic Technical Standards and Applicability of Underlying Purpose

In Korea, the highest regulation for technical requirements of nuclear facilities, the Regulation on Technical Standards for Nuclear Reactor Facilities, Etc., began as a Presidential Decree in 1971 and has undergone several changes in form and title[7]. The major milestones are shown in Table II.

Table II: History of the Regulation on Technical Standards for Nuclear Reactor Facilities, Etc.

Date	Content
Jan. 1971	Enactment of the Regulation on Technical Standards and Security Measures for Nuclear Reactor Facilities (Presidential Decree)
Sep. 1982	Transferred to the Enforcement Decree of the Atomic Energy Act
Apr. 2000	Enactment of the Regulation on Technical Standards for Nuclear Reactor Facilities, Etc. as a Ministerial Ordinance of the Ministry of Science and Technology
Nov. 2011	Converted into a regulation of the Nuclear Safety and Security Commission (Regulation on Technical Standards for Nuclear Reactor Facilities, Etc.) (current)

However, unlike in the United States, domestic regulations do not have separately documented legislative intent or background for each provision, making it difficult to directly identify the underlying purpose of each provision. Therefore, in practice, it is useful to refer to cases of the U.S. 10 CFR 50 Appendix A (General Design Criteria), which is very similar to the domestic regulation.

For example, the underlying purpose of Article 24 (Electric Power System) can be understood as "ensuring sufficient electric power to perform safety functions." This is in a similar context to the U.S. AP1000 case, where the exemption from GDC 17 (requirement for independence of offsite power systems) was accepted based on the alternative measure of passive safety systems. Such an approach suggests that, in Korea as well, it is possible to review regulations by focusing on whether the original safety objective is achieved beyond the formal wording of the rule, while reflecting technological developments and design characteristics.

5. Challenges and Considerations of Underlying Purpose Centered Regulation

Introducing the concept of the underlying purpose as a criterion for regulatory application is an institutional advancement, but in actual operation there are several challenges.

First, there is a need for both review experience and consistency of interpretation. Since domestic regulation has traditionally been operated with an emphasis on compliance with the wording of the rules, the process of deriving and evaluating the underlying purpose may face a lack of initial experience and differences in interpretation depending on diverse technical backgrounds. This could lead to inconsistencies in judgments among reviewers and lower the predictability of regulatory operation.

Second, there is the difficulty of adapting to a new approach. Domestic regulation has long focused on clear compliance with the written rules, so the approach centered on the underlying purpose may be unfamiliar both to reviewers and to applicants. As a result, at the initial stage, certain trial and error may occur in the operation of the system.

Third, there is insufficient preparation on the part of applicants. In order for applicants to clearly derive the underlying purpose and demonstrate the safety of alternative measures, considerable technical data and reasoning are required. However, in the early stage of the system, such understanding and preparation may be inadequate, and frequent delays in reviews or incomplete submission of materials may occur.

To overcome these limitations, it is necessary to strengthen the capability to derive the underlying purpose of technical standards through education, training, expert consultation, and regulatory research, and to establish a foundation for consistent application to exemption reviews. However, since such efforts take time, in the early stage of the system it is most important to secure coherence in the interpretation and application of the underlying purpose through close communication and cooperation among applicants, reviewers, and experts.

6. Conclusions

The underlying purpose can be defined as the original safety objective that the technical standard intended to achieve according to its intent and rationale at the time of enactment. Regulation based on the underlying purpose has significant meaning in that it focuses not only on whether the wording of the rule is followed, but also on whether the safety function actually intended by the regulation is achieved. However, the premise of this approach is the strict demonstration, through scientific analysis and objective data, that safety is never compromised.

In Korea as well, during the early stage of introducing the system, it is particularly important to enhance the capabilities of both the regulatory authority and applicants, and to ensure consistent interpretation and accumulation of cases. Through such efforts, the establishment of the underlying purpose concept will improve the flexibility and effectiveness of nuclear regulation in Korea, and ultimately contribute to strengthening essential safety.

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Table III: Exemption Provisions and Underlying Purposes Cited in the NuScale DC Application

Provision	underlying purpose
10 CFR 50.46a and 10 CFR 50.34(f)(2)(vi) Reactor Coolant System Venting	To prevent the accumulation of noncondensible gases that may inhibit core cooling during natural circulation.
10 CFR 50.44 Combustible Gas Control	To prevent a loss of containment structural integrity, safe shutdown functions, or accident mitigation features caused by a hydrogen combustion event.
10 CFR 50.62(c)(1) Reduction of Risk from Anticipated Transients Without Scram	To reduce the risk associated with an anticipated transient without scram (ATWS) events.
10 CFR 50, Appendix A(GDC), Criterion 17 (Electric Power Systems)	To ensure sufficient electric power is available to accomplish plant safety-related functions.
10 CFR 50, Appendix A(GDC), Criterion 33 (Reactor coolant makeup)	To provide "protection against small breaks in the reactor coolant pressure boundary.”
10 CFR 50, Appendix A(GDC), Criterion 52 (Capability for containment leakage rate testing)	To provide design capability for testing that assures that leakage integrity of containment is maintained and that containment vessel (CNV) leakage does not exceed allowable leakage rate values.
10 CFR 50, Appendix K, Emergency Core Cooling System Evaluation Model	To ensure that the consequences of postulated LOCAs from a spectrum of pipe break sizes and locations are conservatively calculated by the LOCA evaluation model.