Technical basis of 'Standards for Limitations on Locations of Nuclear Reactor Facility Sites'

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1. Introduction

The Nuclear Safety and Security Commission enacted and implemented the *Standards for Limitations on Locations of Nuclear Reactor Facility Sites* (Notice of the Nuclear Safety and Security Commission, tentative title in English) on January 20, 2026. This Notice replaces Appendix No. 2 of the *Siting Criteria of Nuclear Facilities* (the repealed Notice of the Nuclear Safety and Security Commission). The newly enacted Notice specifies detailed criteria for radiation dose exposure in the event of a radioactive material release accident, as delegated under Article 5 Paragraph 2 (Limitations on Location) of *the Rules on Technical Standards for Nuclear Reactor Facilities, Etc.*

Appendix No. 2 of the repealed Notice directly adopted 10 CFR 100.11; however, it did not adopt 10 CFR 100.3, which provides definitions of the relevant terms, resulting in a lack of legal consistency. In addition, 10 CFR 100.11 specifies dose limits based on whole-body dose and thyroid dose, rather than effective dose as recent recommendation of the ICRP.

The newly enacted Notice is developed to address the limitations of the repealed Notice and to introduce substitutionary provision for reactors with different characteristics, such as small modular reactors (SMRs) which is known as having retention characteristics of relatively more retarded radionuclides. Furthermore, to enhance regulatory clarity, some assumptions such as Article 5 Paragraph 4 that had previously been provided only at the level of regulatory guide are partially incorporated into the Notice.

This paper presents the technical background of each provision of the Standards for Limitations on Locations of Nuclear Reactor Facility Sites.

2. Technical Background of Individual Provisions

The Standards for Limitations on Locations of Nuclear Reactor Facility Sites consist of seven articles and three supplementary provisions. Among these, Article 1 (purpose of the Notice) stipulates the legal basis delegated under *the Nuclear Safety Act*, *the Enforcement Decree of the Nuclear Safety Act*, and the *Rules on Technical Standards for Nuclear Reactor Facilities, Etc.*

Article 3 defines the scope of application of the Notice as delegated by *the Nuclear Safety Act* and *the Rules on Technical Standards for Nuclear Reactor Facilities, Etc.*

Article 7 specifies the period for examination on amending the Notice in accordance with Article 8 (Stipulation of Effective Period and Re-Examination Period of Regulations) of *the Framework Act on Administrative Regulation*.

The supplementary provisions specify the effective date of the Notice; transitional measures under which matters that are already licensed, or for which licensing applications had been submitted and were under review prior to the enactment of the Notice, remain subject to *the Siting Criteria of Nuclear Facilities*; and amendments to two Notices that reference the *Siting Criteria of Nuclear Facilities*, reflecting its repeal and ensuring consistency in the relevant provisions of those Notices.

The provisions described above are not technical in nature, but rather reflect considerations of legal consistency or policy decisions. Accordingly, the technical background of Articles 2, 4, 5, and 6 is presented in sequence below.

2.1 Technical Background of Article 2 (Definitions)

Article 2 defines the **population center distance** and the **low population zone**. To ensure regulatory consistency, these definitions are established with reference to 10 CFR 100.3, which provides the terminology definitions associated with 10 CFR 100.11 that had been adopted by the previous Notice. However, among the sentences included in the definition of the low population zone in 10 CFR 100.3, sentences that could conflict with the subordinate regulatory framework under the *Nuclear Safety Act*, and thereby cause regulatory ambiguity, are not incorporated to provision.

2.2 Technical Background of Article 4 (Limitation on Population Center Distance)

Article 4 specifies the requirement that the population center distance shall be at least one and one-third times the distance from the reactor facility to the outer boundary of the low population zone. This requirement is identical to that set forth in 10 CFR 100.11(a)(3), which had been adopted by the previous Notice, and has

therefore been retained without modification in consideration of regulatory consistency.

2.3 Technical Background of Article 5 (Methods for Evaluating Radiation Dose in the Event of a Radioactive Material Release Accident)

Article 5 specifies the requirements for methods used to evaluate radiation doses in the event of an accident. With respect to 10 CFR 100.11, which had previously been simply adopted by reference in the previous Notice, the provisions are either maintained at an equivalent level or updated to reflect advances in science and technology.

Article 5 consists of four paragraphs. Paragraph 1 provides declarative requirements for the general evaluation methodology for the nuclear reactors and the fuel cycle facilities. Paragraph 2 specifies requirements to be considered when evaluating the fission product inventory from reactor core. Paragraph 3 presents radiation source term models that may be applied in dose evaluations for reactors. Paragraph 4 specifies requirements for assumptions necessary for the evaluation, including atmospheric dispersion factors, exposure pathways, dose coefficients, and breathing rates for internal dose calculations.

Paragraph 1 sets forth general requirements for radiation dose evaluation, stating that "radiation doses shall be evaluated by conservatively assuming a hypothetical accident involving the release of radioactive materials from a reactor facility." This provision is introduced given that this Notice applies not only to reactor facilities but also to nuclear fuel cycle facilities.

Paragraph 2 specifies requirements to be considered in order to conservatively evaluate the fission product inventory within the reactor core. These requirements are established with reference to U.S. NRC Regulatory Guide (RG) 1.195 and RG 1.183. This provision is established in consideration of regulatory consistency and conservatism.

Paragraph 3, Item 1, presents a radiation source term model applicable to large light-water reactors. This model is identical to the loss-of-coolant accident (LOCA) source term model presented in RG 1.183 revision 1. Compared to RG 1.183 revision 0, RG 1.183 revision 1 provides a source term model applicable to a broader range of fuel burnup condition (up to a maximum rod-average burnup of 68 gigawatt-days per metric ton of uranium and fuel enrichments up to 8 weight-percent uranium-235, including chromium-coated cladding with thicknesses less than 50 μm and chromia-doped fuel up to 0.16 weight-percent). However, SAND2011-0128, which provides the technical basis for RG 1.183 revision 1, explains that the differences between the two source term models arise primarily from differences in the source term calculation methodology rather than from differences in fuel burnup conditions. Accordingly, the source term specified in RG 1.183 Rev. 1 reflects more up-to-date scientific and technological knowledge than that of RG 1.183 rev. 0. Therefore, this Notice adopts the source term of RG 1.183 Rev. 1 rather than that of RG 1.183 rev. 0.

Paragraph 3, Item 2, establishes an exception provision allowing the application of source terms other than those specified in RG 1.183 Revision 1. This provision is intended to permit the application of alternative source terms when differences in design characteristics exist, while limiting their use to source terms whose technical validity has been demonstrated to be equivalent to those specified in the Notice. Here, "technical validity" refers to the application of a systematic evaluation methodology equivalent to those used in reports such as NUREG-1465, SAND2011-0128, SAND2023-01313, and TR-0915-17565-NP-A. These reports present source term models based on procedures including: (a) analysis of accident scenarios considering reactor design characteristics; (b) calculation of source terms for each accident scenario using validated codes—covering radionuclide group modeling, release durations by radionuclide group, and release fractions by radionuclide group; and (c) selection of representative source term models for reactor designs using appropriate statistical methods.

Paragraph 4, Item 1, limits the atmospheric dispersion factors to be applied in dose evaluations to those specified as "Atmospheric dispersion factor in the event of an accident" in Article 17 of the *Technical Standards for Investigation and Evaluation of Meteorological Conditions at Nuclear Reactor Facility Sites* (Notice of the Nuclear Safety and Security Commission). This provision is established in consideration of regulatory consistency and conservatism.

Paragraph 4, Item 2, specifies the exposure pathways to be considered in radiation dose evaluations. External exposure from the radioactive plume and internal exposure due to inhalation shall be considered, while internal exposure due to ingestion and external exposure from ground deposition shall not be considered. This reflects regulatory consistency with existing evaluation methodologies developed to confirm reactor design characteristics based on availability of protective actions such as evacuation.

Paragraph 4, Item 3, specifies dose coefficients with reference to ICRP Publication 119 and ICRP Publication 144 from the International Commission on Radiological Protection (ICRP). Meanwhile, the ICRP has published ICRP Publication 158 as a successor to ICRP Publication 119. Upon sufficient verification of the suitability and integrity of ICRP Publication 158, the dose coefficients referenced to ICRP Publication 119 in the Notice may be replaced with dose coefficients referenced to ICRP Publication 158.

Paragraph 4, Item 4, specifies breathing rate values to be used in internal radiation dose calculations. The specified values are based on ICRP Publication 2 and are identical to those presented in RG 1.183 and RG 1.195. Although other publications issued after ICRP Publication 2—such as ICRP Publication 23, ICRP Publication 66, and the UNSCEAR 1988 Report—have presented alternative breathing rate values, these values are of a similar magnitude to those based on ICRP Publication 2. Therefore, in consideration of regulatory consistency, the breathing rate values previously applied in regulation were incorporated into the Notice.

2.4 Technical Background of Article 6 (Radiation Dose Limits in the Event of a Radioactive Material Release Accident)

Article 6 specifies radiation dose limits applicable to accident conditions for the purpose of site location restrictions. At the exclusion area boundary, the effective dose shall not exceed 250 mSv during the two-hour period following the accident that results in the greatest exposure. At the outer boundary of the low population zone, the effective dose shall not exceed 250 mSv over the period during which radioactive materials pass completely in the form of a radioactive plume.

Because the *Standards for Limitations on Locations of Nuclear Reactor Facility Sites* apply not only to reactor facilities but also to nuclear fuel cycle facilities, the use of a dose quantity suitable for addressing a wide range of radionuclides arising from diverse design characteristics is considered appropriate.

This provision is developed with reference to the accident dose limits specified in 10 CFR 50.34, as required by 10 CFR 100.21. However, effective dose, rather than effective dose equivalent, is adopted. This choice is based on recommendations of ICRP regarding the use of effective dose. In addition, in the Republic of Korea, effective dose has already been introduced for dose limits during normal operation and for dose limits specified in accident management plans, making this approach appropriate from the perspective of regulatory consistency. In the United States, the use of effective dose in place of effective dose equivalent has also been considered (SECY-01-0148, SECY-08-0197, and SECY-16-0069), but such consideration was discontinued on the grounds that the similarity between dose equivalent and effective dose did not justify the associated costs and regulatory burden.

Under 10 CFR, the U.S. accident dose limit of a total effective dose equivalent (TEDE) of 250 mSv (25 rem) is based on NBS Handbook 69, which is the same document cited as the basis for the whole-body dose limit of 250 mSv specified in 10 CFR 100.11. That document explains 250 mSv as a dose limit applicable to radiation workers in accident or emergency situations. In the Korean regulatory framework, a dose limit of 500 mSv is permitted for radiation workers during emergency situations. Nevertheless, for the purpose of site location restrictions, the effective dose limit of 250 mSv is selected to preserve conservatism and to ensure consistency with the dose criteria (e.g., a 250 mSv whole-body dose) established under the former Notice.

3. Conclusions

This study presents the technical background of the regulatory requirements specified in the *Standards for Limitations on Locations of Nuclear Reactor Facility Sites*, which is newly enacted to replace Appendix No. 2 of the former *Siting Criteria of Nuclear Facilities*.
The key technical considerations underlying the development of the Notice are summarized as follows:
To address the lack of legal consistency in the previous Notice, definitions of the population center distance and the low population zone are established with reference to 10 CFR 100.3, while excluding provisions that could cause regulatory ambiguity within the subordinate regulatory framework under the Nuclear Safety Act.
The radiation source term model specified in the Notice is updated to reflect the model presented in RG 1.183 revision 1. In addition, an exception provision is introduced to allow the application of mechanistic source terms for reactor designs with different characteristics, such as SMRs, provided that their technical validity is demonstrated through a systematic evaluation methodology.
Effective dose is adopted as the dose quantity for accident dose limits, in place of the whole-body dose and thyroid dose previously used. This change aligns with ICRP recommendations and is consistent with the dose requirements already employed in the Korean regulatory framework for normal operation and accident management. The dose limit of 250 mSv is retained in consideration of conservatism and regulatory continuity.
Assumptions for dose evaluation, including atmospheric dispersion factors, exposure pathways, dose coefficients, and breathing rates are specified in the Notice to enhance regulatory clarity.
The result of this study is expected to support a clearer understanding of the Notice and its application in the regulatory review of nuclear reactor facility siting.

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