Current Status of Recommendations for International Radiation Protection in Republic of Korea

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Abstract. This document contains how Republic of Korea has implemented IAEA GSR part3 and IAEA SSR-6 since 2014 IAEA Integrated Regulatory Review Service(IRRS). Republic of Korea received various recommendations and suggestions through IRRS and is striving to harmonize with international standards. Rather than the incomplete classification of exposure situations in the IAEA GSR part3, we intend to apply practical standards and values to radiological protection. Non-controversial standards and values such as tissue weighting factor, radiation weighting factor, dose limit for crystalline lens, and dose conversion coefficient will soon be reflected. However, we plan to regulate the justification, optimization, calculation method of the derived limit, and commodities or consumer product by reflecting the domestic situation. International harmonization is a very important part of transport, we plan to amend domestic laws and regulations in accordance with the IAEA SSR-6. Some of them are already reflected and others are preparing to be revised.

KEYWORDS: IAEA GSR part3, IAEA SSR-6, regulation, radiation protection, transport

1 INTRODUCTION

Republic of Korea requested an IRRS mission for radiation protection part in 2014 when IAEA GSR part3[1] was released. We received recommendations and suggestions to incorporate some of the IAEA GSR part3 into the Nuclear Safety Act. We received recommendations on justification, supervised area setting, transport, internal exposure, radon exposure, and suggestions on optimization, single dose recording system, and justification/optimization of radiation treatment in the medical field. Milestones have been established and implemented for follow-up actions. I would like to summarize how far it has progressed now and in what direction it will proceed in the future. In addition, the transport regulations have also been partially revised to reflect IAEA SSR-6[2], and items that have not yet been revised are being prepared and we would like to share them with you.

2 IAEA GSR PART3 IMPLEMENTATION STATUS BY TOPIC

2.1 Justification

Radiation safety regulations for radioactive isotopes and radiation generating devices are classified into notifications/permits according to usage and risk, and production/sales/mobile use/use according to the purpose of use. Basically, once a license is obtained, it is admitted that it is justified to use it for its purpose. However, even institutions that have already been approved may be restricted certain actions in detail as not being justified. Inspection of city gas pipes or heating pipes that are frequently operated in urban areas are restricted in order to reduce the risk of exposure to radiation workers and the general public by replacing Ir-192 with Se-75, which has a low radiation energy. The enforcement rule was revised in July 2020. Although not reflected in the law, there are cases where it is prohibited as an illegal act through an official letter.
It is not reflected in the statute, but there are cases where it is prohibited through official documents as not justified acts. Some students took pictures of each other by using radiation generator in the field of health-related education, but it was interpreted as not justified because they could practice using a human body model. In the future, interpretation and guidance on justification such as human body scans for security purposes and consumer products are required.

2.2 Optimization

We always pay attention to pursuing low exposures as it should pursue low levels within reasonably achievable limits. The Republic of Korea intends to go in the direction of presenting guidelines so that operators can judge themselves without being forced by regulatory bodies on a uniform basis. In consideration of the radiation exposure dose of workers and the socioeconomic value of reducing radiation exposure, we plan to present exposure level guidelines for each sector. Licensee can set dose constraints by comparing past exposure records or subdividing each radiation worker according to the type of operation.
There is no separate dose limit in the medical field because there is a great benefit for the purpose of patient treatment, but the radiation should be administered/irradiated as prescribed by a doctor.
The dose calibrator, instruments for measuring radioactivity of radiopharmaceuticals, periodically should be checked whether the amount of radioactivity is properly measured according to the radionuclide, and the radiation treatment device should be checked for each item periodically whether the radiation beam is irradiated at the desired position and the desired amount.

2.3 Dose limit (Tissue weighting factor, Radiation weighting factor)

The changed dose limit, radiation weighting factor, and tissue weighting factor will soon be reflected in the Nuclear Safety Act. The reduced dose limit for crystalline lens is still 150mSv per year, and it is estimated using Hp(10). Radiation workers who perform production and synthesis work in radioisotope production facilities already wear ring badges on their fingers to measure the equivalent dose to the skin, and the numbers are being recorded and managed.
Medical proton accelerators, Medical heavy particle accelerators, and heavy ion accelerators for research are being introduced. While it is a principle to comply with the ICRP60 based Nuclear Safety Act, the latest international recommendations are followed if values are not available. Some of the accelerating beam types and energy, nuclear response data, and decay data were calculated with the latest data.

2.4 Exemptions

Exempt radiation sources are managed as exempt radiation sources even if they exceed the exemption amount according to ICRP 104[3], and there are no separate obligations for exempt radiation sources users. We are also grasping the overall distribution of exempt consumer products such as Am-241 smoke detectors and H-3 safety indicator lamps through the seller's records. It has been more than 10 years since the justification decision for consumer products exempted for use, it is necessary to reconsider whether it can still be justified.
With the approval of RAON, a heavy ion accelerator for the generation of rare radioisotopes, it is necessary to reflect the IAEA GSR part3 exemption criteria for unlisted radionuclides. A moderate amount is applied to radioisotope immunity and a bulk concept of 1 ton or more is applied to release. However, in the trade of raw materials, residues and products contaminated with radioactive isotopes, it is difficult to approach only with the concept of exemption because there are cases in which large quantities are imported. Internationally agreed procedures and figures are needed for trade in commodities containing radioactive isotopes.

2.5 Derived limit

Derived limit (annual limit on intake, derived air concentration, effluent control limit) is currently presented as a value that can satisfy 20mSv and 1mSv per year based on the IAEA Safety Series 115 dose conversion factor. The small-scale radioisotope licensee is applied as a table of emission control standards calculated under conservative conditions unlike nuclear power plants that calculate emission control standards through direct dose evaluation with ODCM. ICRP OIR 1~4[4] have been updated with elaborate breathing and ingestion models, which are mostly reduced from previous dose conversion coefficients (Sv/Bq), as shown in Figure 1. The new inhalation dose conversion factor 75% is less than the previous value, and the new ingestion dose conversion factor 89% is less than the previous value. Once the ICRP OIR part 5 and the dose conversion factor for the public are derived, it will be applicable to all radioisotopes. The effluent control limit will be calculated with the reduced dose conversion factor and the public dose constraint, not to the public dose limit. In addition, a conservative but relatively

reasonable dilution factor will be applied to introduce dose constraints without significant regulatory impact.

Table 1. Reference of Derived Limit

Terms	Reference	
	As Is	To Be
Calculations method of annual limit of intake	ICRP61(1991)	Rational calculation formula considering dose constraint and dilution factor
Dose conversion factor	IAEA Safety Series 115 (1996)	OIR part 1~5 (2015~)
Reference man	ICRP23(1975)	ICRP110(2009)

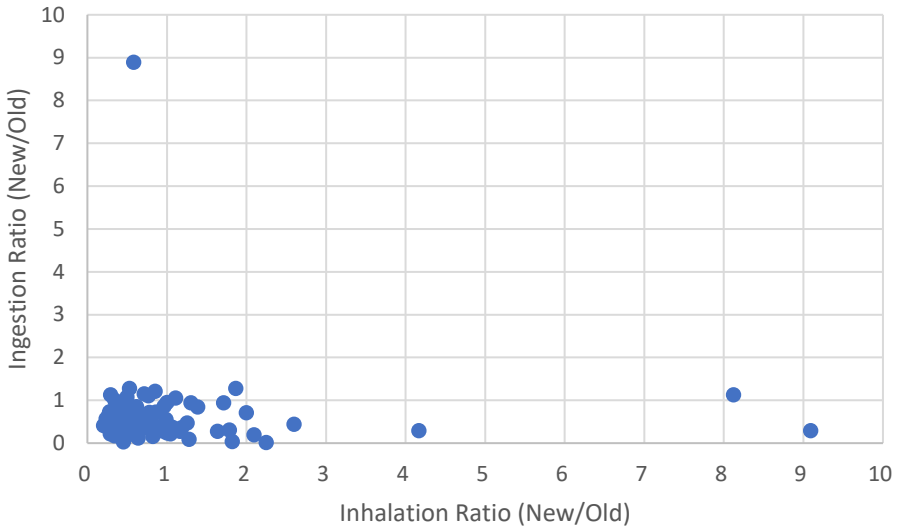

Figure 1. The updated dose conversion factor ratio of inhalation and ingestion

2.5.1 Inhalation

As-Is

The radiation worker's annual intake limit and derived air concentration were calculated using the worker's dose conversion factor based on the particle size of 5㎛ AMAD (Activity Median Aerodynamic Diameter), and considered the working time of 2000 hours and the respiratory rate of 1.2 ㎥/hr. Effluent control limit during exhausting is a derived value that corresponds to 1mSv when the exhausted radioactive material is inhaled. Therefore, the difference between the radiation worker and the public in the dose limit (1/20), in the respiratory rate and exposure time (1/3), and dose conversion coefficient by age group (1/2) are weighted. However, effluent control limit during exhausting was calculated based on the particle size of 1 ㎛ AMAD of radiation worker's dose conversion factor.

There are several radioisotopes that have been further subdivided into consideration. Tritium in the form of tritium water (HTO) was set in consideration of both inhalation and skin absorption. Considering skin absorption as 0.5 of inhalation, therefore the derived value was divided by 1.5. External exposure by noble gas was considered the difference between the public and the radiation worker's exposure time (1/4.38).

To-Be

Since ICRP OIR part 5 and the general public dose conversion coefficient have not been published, there is no set, and the following discussion is underway. In the new calculation formula, it is discussed that the discharge time fraction (52hr/168hr=0.31), wind direction (0.25), particle size correction (1.5,

1 ㎛ AMAD compared to 5 ㎛ AMAD OIR), and age correction (1.8, respiration rate by age group compared to adults) are being considered.

2.5.2 Ingestion

As-Is
Effluent control limit during drainage is a derived value that corresponds to 1 mSv of the exposure dose received when the water is ingested. Assuming that 2L is consumed per day, the difference in the dose limit between the public and the radiation worker (1/20) and the difference in the dose conversion coefficient by age group (1/2) between the public and the radiation worker were weighted.

To-Be
Since ICRP OIR part 5 and the general public dose conversion coefficient have not been published, there is no set, and the following discussion is underway. In the new calculation formula, it is discussed that discharge time fraction (52hr/168hr=0.31), Decay factor (only radioisotopes with a half-life of 2 days or more taking into account the minimum water purification time of 14 hours), age correction (2.6, ICRP89[5] energy consumption difference by age group) are being considered.

3 IAEA SSR-6

3.1 Simplified transport documents for L type packages

A radioactive material carrier shall prepare transport documents containing information on the conveyance. The transport documents consist of statement on transport of radioactive materials; package inspection records; declaration. The same request was made for L type packages, but the contents of the transport documents are to be simplified by referring to international standards. The L type packages has been revised to only the grey shaded portions in Table 2 and package inspection records, and the declaration is exempted.

<table>
<tr><th colspan="2">Statement on transport of radioactive materials</th><th>Package inspection records</th><th>Declaration</th></tr>
<tr><td>1. Transport name and description</td><td>8. Transport index (Yellow packages)</td><td rowspan="8">·Check contents for suitability by package type</td><td rowspan="8">·Contents that the consignor has complied with the technical standards for transport</td></tr>
<tr><td>2. UN dangerous goods class number “7”</td><td>9. CSI (only fissile material)</td></tr>
<tr><td>3. UN No.</td><td>10. Identification mark (if there is competent authority approval certificate)</td></tr>
<tr><td>4. Radioisotope name or symbol</td><td>11. packages in an overpack</td></tr>
<tr><td>5. Descriptions of the physical and chemical forms of radioactive material, indication of special radioactive materials or low-dispersible radioactive materials</td><td>12. exclusive use shipment (in case of)</td></tr>
<tr><td>6. Maximum radioactivity</td><td>13. Total radioactivity</td></tr>
<tr><td>7. Category of the package</td><td>+ Fissile material mass and reasons for exemption (If applicable)</td></tr>
</table>

3.2 Fissile material transport

All the changes made in the fissile material exemption criteria were amended, but the calculation method for the nuclear critical safety index, subcritical requirements, transport index calculation methods for small amounts of fissile materials have not yet been reflected.
Cargo containers were classified into small and large. It was applied to transport index limits regarding freight containers and transport means under non-exclusive use. It also was applied to criticality safety index limits. The newly UN3507 number was added.

3.3 Contents that need to be amended in the future

For the following items, the IAEA SSR-6 contents have not yet been amended.

(a) Contents approval/notification related to SCO-Ⅲ
(b) Transitional provisions to previous transport regulations
(c) Design approval certificate of low dispersible radioactive material
(d) Certain shipments approval (transport of B(M) packages with discharge function, transport of CSI 50 or higher, etc.)

4 CONCLUSION

In order to harmonize with international standards, IAEA main recommendation documents are reviewed by comparing with domestic laws and regulations. If necessary, long-term research projects are also carried out, and international standards are reflected by amending laws and establishing guidelines.
The recently revised IAEA Radiation Protection Principles and Transport Standards may conflict with other countries if they are not reflected in domestic laws and regulations, so harmonization with international standards is particularly important. Justification and optimization of the concept of radiation protection without specific implementation guidelines is being researched to revise it considering domestic acceptability. We are preparing to revise the Enforcement Decree of the Nuclear Safety Act by reflecting the dose limit or the dose conversion factor for which the standard has been changed. Some of the transport standards have been partially reflected, but some have not yet been reflected, so efforts are being made to revise them continuously.

5 REFERENCES

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[4] ICRP, 2015~2019. Occupational Intakes of Radionuclides part 1~4. ICRP Publication 130, 134, 137, 141.
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